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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Seventy-first Meeting
Montreal, 2-6 December 2013

Addendum

STATUS REPORTS AND COMPLIANCE

This document is issued to **add** a section on projects with specific reporting requirements.

1. This section addresses the projects and activities for which specific reports were requested in previous meetings and those requiring the Executive Committee attention. These reports are arrange in the following parts:

Part V:	Extension of Haiti institutional strengthening project (phase III)
Part VI:	Methyl bromide project in Guatemala
Part VII:	National CFC phase-out management plan in Philippines (progress report)
Part VIII:	2010 CTC verification report and status of CTC phase-out in process agent (phase II) applications in China
Part IX:	Progress report on the implementation of the chillers projects
Part X:	Completion of CFC, CTC, and halon projects approved after 2009
Part XI:	Financial Audit Report for the halon, CFC production and foam sector plans in China
Part XII:	Resource mobilization for climate co-benefits
Part XIII:	HCFC demonstration projects

2. Each part contains a brief description on progress, and the Secretariat's comments and recommendations.

PART V: EXTENSION OF HAITI IS PROJECT (PHASE III)

Progress report

3. In line with decision 70/4(b)(iv)[1] UNEP reported that it organized an official mission to Haiti in July 2013 during which the technical and financial report was submitted to the National Ozone Unit (NOU) for clearance. According to UNEP, this report has not been cleared yet by relevant authorities. UNEP also advised that the new IS agreement between the Ministry of Environment and UNEP has been drafted and is awaiting signature by the Ministry of Environment. On this basis, UNEP has not been able to release the fund balance. Two national consultants and one regional consultant have been recruited to assist the NOU in implementing activities such as data collection and verification, and training workshops for customs officers. The recruitment process of the refrigerant expert is underway.

Secretariat's comments

4. Noting that the agreement between the Ministry of Environment and UNEP is awaiting signature, the Secretariat was unable to recommend, at this time, the release of the fund balances.

Secretariat recommendation

5. The Executive Committee may wish to request an update to the 72nd meeting on the clearance of technical and financial report and the signing of the new institutional strengthening (IS) agreement for Haiti that will enable the release of funds balance.

[1] UNEP was requested to provide an update to the 71st meeting on the production and submission of the technical and financial report and the signing of the new institutional strengthening (IS) agreement.

PART VI: MB PROJECT IN GUATEMALA

Background

6. Further to a review of the MB consumption data in Guatemala, the Secretariat noted a deviation by Guatemala from the level reported under Article 7 of the Montreal Protocol for 2012. Accordingly, the Secretariat requested UNIDO to submit a progress report to the 71st meeting on the current status of implementation of the MB project, including a detailed explanation as to why the consumption in 2012 was above that allowed under the Agreement with the Executive Committee, together with a revised action plans to meet the targets as required by the Agreement.

Progress report

7. The Executive Committee has approved the following projects for the complete phase-out of MB in Guatemala:

(a) At its 22nd meeting, US $440,000 was approved for a demonstration project on four alternatives to the use of MB: steam pasteurization, non-soil cultivation, solarisation, and low-dose chemicals, in combination with integrated pest management;

(b) At its 38th meeting, US $3,257,377 was approved for a national phase-out of MB project to phase out 468 ODP tonnes in 2005; and

(c) At its 59th meeting an additional US $2,313,047 was approved as the total funds available to phase out 265.7 ODP tonnes, resulting in the complete phase-out of controlled uses of MB.

8. The MB consumption reported by the Government of Guatemala for 2010 to 2012 and the level allowed by the Agreement with the Executive Committee is shown in Table 1. As explained by UNIDO, the 2012 MB consumption exceeded the maximum allowable level because the current law on import quotas could not be modified to reduce the consumption of the five melon growers currently consuming MB. Phase-out reductions of MB were only agreed with consumers, including a transnational corporation which is not eligible for funding, on a voluntarily basis, which resulted in reductions in consumption of MB since 2009.

Table 1

MB CONSUMPTION IN GUATEMALA

Description	MB consumption (ODP tonnes)		
	2010	2011	2012
Allowed under agreement	265.7	217.7	117.7
Actual consumption (Article 7)	249.0	211.1	139.8
Difference	(16.7)	(6.6)	22.1

9. The delays in the implementation of the project have been related to a delay in delivering part of the equipment to the beneficiaries; more time than expected to reach an agreement on the level of MB consumption among melon growers; change in the bidding process requested by the Government to allow the procurement of part of the equipment locally after the bidding process was completed by UNIDO; preparation of the premises for the installation of the equipment; and longer time required for customs and tax exemption process.

10. In its Agreement, the Government committed to completely phase out MB consumption by 1 January 2013. However, UNIDO indicated that about 110.0 ODP tonnes of MB consumption will be consumed in 2013 and there is no assurance that the country will not import MB in 2014. Accordingly, the Government of Guatemala has prepared an action plan to completely phase out the consumption of MB by 1 January 2015 which includes, *inter alia*, providing training and technical assistance to the companies and to the Agriculture Institute in Zacapa.

11. With respect to the funding of US $2,313,047 approved at the 59th meeting, UNIDO reported a balance of US $682,947 as at 31 October 2013 as presented in Table 2.

Table 2

MB PROJECT FUNDS BALANCES IN FGUATEMALA (UNIDO COMPONENT) (US $)

Tranches	Funding	Disbursement	Balance	Funds to be returned	Remaining funds available
First	1,300,000	1,247,794	52,206	0	52,206
Second	943,047	312,306	630,741	210,000	420,741
Total	2,243,047	1,560,100	682,947	210,000	472,947

Secretariat's comments

12. Given the current situation of the MB consumption in Guatemala and taking into consideration the fact that the country was unable to meet the 2012, 2013 and probably the 2014 MB reduction targets, UNIDO is proposing to return US $210,000 from the funds approved under the second tranche of US $943,047, representing 22.3 per cent of the second tranche, while UNEP is proposing to return US $35,000 from the total funds approved for UNEP of US $70,000.

13. The remaining funds available for UNIDO (US $420,741 after returning US $210,000 plus agency support cost of US $15,750) will be used to finalize the installation of the equipment already purchased, the procurement of additional equipment and accessories, and the completion of the training programme. The remaining funds available for UNEP, (US $35,000 after returning US $35,000 plus agency support cost of US $4,550) will be used to update the legislation and include the banning of MB imports, address the issue related to the sustainability of the adoption of alternatives and dissemination of results amongst major stakeholders.

14. The Government of Guatemala is confident that its action will enable the country to complete the phase-out of MB by 1 January 2015 in accordance with the Montreal Protocol.

Secretariat's recommendations

15. The Executive Committee may wish to:

(a) Note:

(i) The progress report on the implementation of the methyl bromide (MB) phase-out project in Guatemala submitted by UNIDO on behalf of the Government of Guatemala contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1;

(ii) With concern the deviation of the MB consumption from the 2012 target established in the agreed conditions for the phase-out of MB in Guatemala and

the potential deviation in consumption for the years 2013 and 2014;

(iii) That the Government of Guatemala agreed to return US $265,300 to the Multilateral Fund from the funds approved after the 59th meeting, consisting of US $210,000, plus agency support cost of US $15,750 from UNIDO and US $35,000, plus agency support cost of US $4,550 from UNEP by the 72nd meeting;

(iv) That the Government of Guatemala has committed to completely phase out all controlled uses of MB by 1 January 2015 instead of 1 January 2013; and

(b) Request UNIDO and UNEP to submit:

(i) A progress report to the 73rd meeting including the ban on the import of controlled uses of MB as of 1 January 2015 and the actions undertaken to ascertain the long sustainability of the alternative technologies; and

(ii) The project completion report no later than the last meeting of the Executive Committee in 2015.

PART VII: PHILIPPINES: NATIONAL CFC PHASE-OUT MANAGEMENT PLAN (PROGRESS REPORT) (UNEP)

Background

16. At the 66th meeting, the Executive Committee in decision 66/15(f)(ii), *inter alia*, approved the annual implementation plan under the national CFC phase-out plan (NPP) for the Philippines for April 2012 to April 2013, and the activities contained therein, for the disbursement of no more than US $471,630 for this period and requested UNEP to provide a report at the 70th meeting on progress made. At the 68th meeting, in approving the 2013 work plan for the remaining funds under the NPP for the Philippines, the Executive Committee, in decision 68/20, *inter alia*, approved the 2013 annual implementation plan under the NPP and the activities contained therein, and the disbursement of no more than US $330,000, in line with decision 66/15(f)(iii); approved the transfer of US $1,077,221, plus agency support costs for UNEP, from NPP to stage I of the HPMP; requested UNEP to submit a report on implementation of the activities to the 71st meeting and to return any remaining balances of the NPP as of 31 December 2013 to the Multilateral Fund.

17. UNEP on behalf of the Government of the Philippines has submitted a progress report on the activities undertaken in 2013.

Progress Report

18. The overall work plan and the corresponding budget is summarized in Table 3 below:

Table 3: NPP work plan for Philippines (April 2012-December 2013)

Activity	Approved at the 66th meeting (US $)	Approved at the 68th meeting (US $)	Total (US $)
Project management unit (PMU) operations (maintenance and operating expenses)	165,946*	100,000	265,946
Support the Department of Transport and Communication-(DOTC)- Land Transportation Office (LTO) for the		100,000	100,000

Activity	Approved at the 66th meeting (US $)	Approved at the 68th meeting (US $)	Total (US $)
enforcement of the Joint Administrative Order on the Mobile Air Conditioners (MAC)'s registration (CFC)			
Conduct of verification audits for CFCs and HCFCs for 2011 to 2012 Conduct of customs officers training workshop	65,000		65,000
Updating of the Code of Practice (COP) Manual on Refrigeration and Air-conditioning (RAC)	190,684**		230,684
Continuing assessment and monitoring of the service shops; voucher grantees to ensure the continuing use of the equipment provided by the project; and assistance to regular compliance monitoring in all regions		40,000	
Train-the-trainer program for the updated COP manual on RAC			
Technical Assistance for MAC inspection and training			
Strengthen the capacity of RAC and MAC service sector to conduct good practices including recovery and recycling of ODS (CFC)		90,000	90,000
Continuing collection, transport and storage of recovered refrigerants from service shops and chiller owners nationwide.	30,000		30,000
Intensified and target-oriented sectoral and public awareness campaigns; advocacy and communication skills enhancement training	20,000		20,000
Total	**471,630**	**330,000**	**801,630**

* This amount includes US$ 22,396 for retroactive financing

** This amount includes US$ 20,684 retroactive financing for the outstanding payments for equipment delivered to service shops

19. The current progress report (as of 25 October 2013) is summarized below:

(a) The terms of reference for the verification audit have been prepared, the audit firm have been hired, and the results of the audit will be ready by the last quarter of 2013;

(b) The COP manual for RAC have been revised and is being used during training of service technicians; and four train-the trainer workshops with a total of 82 participants on the use of the new COP was completed;

(c) A technical training-study tour was held in China in August 2013 to ensure compatibility of the Philippines licensing system with the Chinese web-based tracking system and help improve monitoring of ODS imports; consultations on developing updated customs training manual were held, and training of customs will be undertaken;

(d) National workshops to support the assessment and monitoring of service shops voucher grantees were conducted; a survey of these grantees was finalized; and national consultations on the implementation of circular mandating inspection of MAC systems prior to the renewal of vehicle registration was finalized;

(e) Specifications of refrigerant identifiers were finalized, and bidding for procurement has not been completed yet;

(f) Collection of recovered refrigerants from service shops and chiller owners continued;

(g) Awareness raising activities through the enhancement of communication and advocacy skills of the regional offices continued; and

(h) The PMU continued operation during this period.

Financial report

20. Of the total US $801,630 approved for the remaining activities in the NPP, US $340,005 had been disbursed as at the end of October 2013. The remaining funds are planned for disbursement until December 2013.

Secretariat's comments

21. The Secretariat's noted the high expenditure linked to the operations of the PMU (US $153,000) out of a total expenditure funding of (US $340,000), and the low level of progress on the substantive activities. In responding to these concerns, UNEP indicated that the expenditures for staff travel was considered an important capacity building component by the Government in order to have trained people to look after sustaining CFC phase-out once the project is closed at the end of the year. UNEP further noted that these activities were approved by DENR management as per the national regulations and procedures. In addition, the PMU has not hired its full complement of staff in order to prepare for closing the project at the end of the year.

22. In response to the low of level progress, UNEP mentioned that in addition to the consultation meetings to disseminate the COP, four workshops were also completed with 139 trainers trained. The delay in the purchase of the refrigerant identifiers (which should have been distributed and used) was due to the failure of the bidding process because of national accounting rules and regulations. It indicated that this was being resolved and the equipment purchase should be completed before the end of the year.

23. The Secretariat also drew UNEP's attention to decision 68/2(d) and reiterated that under no circumstances could any expenditures be made after December 2013, and requested UNEP to ensure that reporting is properly completed and the balances are returned to the closest meeting possible.

Secretariat's recommendation

24. The Executive Committee may wish to consider:

(a) Noting the progress report submitted by UNEP for the national CFC phase-out plan (NPP) work plan for the Philippines covering the period April 2012-October 2013 contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1; and

(b) Requesting UNEP to submit to the 72nd meeting a financial report of the NPP as of 31 December 2013 and to return the remaining funds to the Multilateral Fund at that meeting.

PART VIII: CHINA: 2010 CTC VERIFICATION REPORT AND STATUS OF CTC PHASE-OUT IN PROCESS AGENT (PHASE II) APPLICATIONS (WORLD BANK)

25. In response to decision 70/4, the Work Bank has submitted to the 71st meeting a verification report related to the sector plan for phasing out CTC as process agent (phase II) in China. The report contains verifications for both production and consumption of CTC as process agent use in 2010.

CTC consumption

26. A World Bank expert team conducted site verification on five of the six plants whose contracts for phasing out CTC as process agent use in their production were completed in 2010. The team could not visit Sanonda (Jingzho) Pesticides and Chem Co., Ltd as the plant was closed and its facilities were dismantled. This was confirmed by the Government of China.

27. The verification shows that all five enterprises visited have stopped using CTC as process agent in their production processes and dismantled the CTC-using facilities. One enterprise (Shunde Antai Printing Ink Chemical Co.) closed its CTC-using production line and purchase CTC-based product (CPP/CEVA)[2] from the market. The remaining four enterprises converted into non-CTC based processes. All of the CTC in stock and that extracted from the production facilities during closure were either used up or sold to eligible buyers.

CTC production

28. A World Bank expert team conducted verifications on seven of the 13 enterprises that were producing CTC for controlled uses in 2010. The aggregated production of the seven selected plants accounts for 80.35 per cent of the total production in 2010.

29. The verification team confirmed that, in 2010, the seven producers did not receive a production quota for controlled uses of CTC from the Ministry of Environmental Protection of China (MEP). All CTC produced in that year was either used as feedstock or sold to licensed dealers. A total of 1,882.45 metric tonnes (mt) of CTC containing residues were generated by the seven plants with a CTC content ranging from 10 to 90 per cent. The residues were either further purified to produce commercial product, or sent to licensed chemical waste disposal companies for incineration or fed back to production lines for further reaction.

30. As reported by MEP, of the total CTC produced in 2010, 179.3 mt was used as process agent for chlorosulphonated polyethylene (CSM) production, 256.9 mt was for laboratory use and 1,558 mt was used as feedstock for CFC production. China also used 65,267.0 mt of CTC as non-ODS feedstock.

Secretariat's comments

31. The Secretariat noted that all CTC producers were verified by a national audit agency and a sample of it were independently verified by the World Bank. This meets the conditions stipulated in the CTC phase-out agreement (phase II). As reported by the World Bank, a licensing and quota system for controlling the production and consumption of ODS, including CTC has been in place and operating, which will enable China to achieve compliance with control targets, including CTC as process agent use in future years.

Secretariat's recommendation

32. The Fund Secretariat recommends that the Executive Committee take note of the verification report on the sector plan to phase out CTC for controlled use (phase-II) in China contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1 and request the World Bank to submit the project completion report to the 72nd meeting in accordance with decision 68/4.

[2] Chlorinated polypropane/chlorinated ethylene vinyl acetate.

PART IX: PROGRESS REPORT ON THE IMPLEMENTATION OF CHILLER PROJECTS

Brazil: Report on the 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 (UNDP)

Colombia: Report on the 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 (UNDP)

Côte d'Ivoire: ODS phase- out in 50 existing centrifugal chillers units (Government of France/UNIDO)

Cuba: 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 (UNDP/Government of Canada)

Syrian Arab Republic: Status report on the demonstration project on the replacement of CFC centrifugal chillers (UNIDO)

Africa Region: Status report on the strategic demonstration project for accelerated conversion of CFC chillers in 5 African Countries (Cameroon, Egypt, Namibia, Nigeria, Senegal and Sudan) (UNIDO)

Europe Region: Status report on the demonstration project on the replacement of CFC centrifugal chillers in Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Romania, and Serbia (UNIDO)

Latin America and the Caribbean Region: 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 (UNDP)

Global: Report on the global chiller replacement project (World Bank)

Background

33. Through decision 68/8(c), the Executive Committee requested the Secretariat to prepare annually a report on on-going chiller projects, highlighting key progress in implementation of activities, further information on co-financing arrangements, information on ODS replaced and energy-efficiency gains achieved through chiller conversions, with a first annual report to be presented to the 71st meeting. In addition, through decisions 70/8, 70/9, 70/11 and 70/12 the Committee requested status reports on several on-going chiller projects for the 71st meeting. In line to these decisions, relevant implementing agencies submitted progress reports on the status of implementation of the chiller projects to the 71st meeting.

Secretariat's comments

34. Most of the chiller projects were approved at the 47th (November 2005) and 48th (April 2006) meetings, i.e. are by now about eight years under implementation. In addition, the project for ODS phase-out in 50 existing centrifugal chillers units in Côte d'Ivoire, was approved at the 37th meeting (July 2002) for implementation by the Government of France and transferred to UNIDO at the 57th meeting (March-April 2009), i.e. is by now over 11 years under implementation from the time the project was first approved.

35. The Secretariat has consulted with the respective implementing agencies to determine suitable dates for completing the related projects and return of balances to the Multilateral Fund. Relevant information on the chiller projects is provided in Table 4.

Table 4 – Dates of approval and completion of chiller projects

Country / Region	Title	Agency	Approved (meeting)	Completion date	Approved (US $)	Fund return (US $)
Brazil	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	UNDP	47	Dec-17	1,000,000	17,319
Colombia	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	UNDP	47	Dec-17	1,000,000	361,802
Côte d'Ivoire*	ODS phase-out in 50 existing centrifugal chillers units	France / UNIDO	37	Dec-13	1,000,000	968,360
Cuba**	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	UNDP, Canada	47	Completed	984,353	13,501
Syrian Arab Republic	Demonstration project on the replacement of CFC centrifugal chillers	UNIDO	47	Dec-13	585,961	210,532
Africa	Strategic demonstration project for accelerated conversion of CFC chillers in 5 African Countries (Cameroon, Egypt, Namibia, Nigeria and Sudan)	UNIDO, France, Germany, Japan	48	Dec-14	2,000,000	0
Latin America and the Caribbean***	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	UNDP	47	Completed	1,000,000	1,000,000
Europe	Demonstration project on the replacement of CFC centrifugal chillers in Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Romania, and Serbia	UNIDO	47	Dec-13	1,069,074	0
Global****	Global chiller replacement project (China, India, Indonesia, Malaysia and Philippines)	World Bank	47	Dec-17	6,884,612	3,149,056
Total					15,524,000	5,720,570

(*)UNIDO reported that the co-financing expected from the Agence Française de Développement (AFD) would not materialize and the co-financing was required to implement the project. In this context, this project is recommended for cancellation due to inability to obtain the required co-financing; the related recommendation is contained in paragraph 44(b)(v) of document UNEP/OzL.Pro/ExCom/71/6.

(**) The project was completed by December 2012, but is not yet financially completed. Based on expected expenditures, the return of US $13,501 to the Fund is expected to the 73rd meeting.

(***) The project was completed and US $1,000,000 was returned to the Fund at the 67th meeting (July 2012).

(****) The project as originally approved, included China, India, Indonesia, Malaysia and Philippines. During project implementation, China, Indonesia and Malaysia were unable to secure the required co-financing and, therefore, withdrew from the project; these countries were replaced by Argentina and Jordan. Activities in Jordan have been completed. On this basis, US $3,149,056 will be returned to the Fund.

36. Based on the information provided by UNDP, UNIDO, and the World Bank on the progress of implementation of the chillers projects, the Secretariat analysed and summarized the information in a tabular form (Table 5), providing an overview of the approved funding, expected co-funding, number of chillers to be replaced, and planned achievements when the projects will be completed. The tables provide the ratio between co-funding and funding and the cost/chiller.

Table 5: Relevant information on the chiller projects

Country		Approval	Current	Plan	Completion
Brazil	MLF funds (US $)	1,000,000	982,681	982,681	December 2017
	Co-funding (US $)	252,000	131,000,000	131,000,000	
	Chillers	12	2	Over 14	
	Ratio co-funding/funding	25.2%	13,330.9%	13,330.9%	
	MLF cost per chiller (US $)	83,333	491,341	n/a	
	MLF + co-funding cost per chiller (US $)	104,333	65,991,341	n/a	
Colombia	MLF funds (US $)	1,000,000	638,198	638,198	December 2017
	Co-funding (US $)	705,000	25,000,000	30,000,000	
	Chillers	13	13	15	
	Ratio co-funding/funding	70.5%	3,917.3%	4,700.7%	
	MLF cost per chiller (US $)	76,923	49,092	42,547	
	MLF + co-funding cost per chiller (US $)	131,154	1,972,169	n/a	
Cuba	MLF funds (US $)	984,353	970,852	Completed	
	Co-funding (US $)	410,125	730,000		
	Chillers*	7	9		
	Ratio co-funding/funding	41.7%	75.2%		
	MLF cost per chiller (US $)	140,622	107,872		
	MLF + co-funding cost per chiller (US $)	199,211	188,984		
Syrian Arab Republic	MLF funds (US $)	585,961	375,429	To be closed December 2013	
	Co-funding (US $)	27,195	253,944		
	Chillers**	3	3		
	Ratio co-funding/funding	4.6%	67.6%		
	MLF cost per chiller (US $)	195,320	125,143		
	MLF + co-funding cost per chiller (US $)	204,385	209,791		
Africa	MLF funds (US $)	2,000,000	1,562,751	2,000,000	December 2014
	Co-funding (US $)	477,876	644,444	644,444	
	Chillers	19	13	29	
	Ratio co-funding/funding	23.9%	41.2%	32.2%	
	MLF cost per chiller (US $)	105,263	120,212	68,966	
	MLF + co-funding cost per chiller (US $)	130,415	169,784	91,188	
Europe	MLF funds (US $)	1,069,074	823,990	1,069,074	To be closed December 2014
	Co-funding (US $)	416,175	356,057	416,175	
	Chillers	12	10	12	
	Ratio co-funding/funding	38.9%	43.2%	38.9%	
	MLF cost per chiller (US $)	89,090	82,399	89,090	
	MLF + co-funding cost per chiller (US $)	123,771	118,005	123,771	
Latin America and the Caribbean	MLF funds (US $)	1,000,000	0	Completed	
	Co-funding (US $)	690,000	160,000		
	Chillers	14	7		
	Ratio co-funding/funding	69.0%	16.0%		
	MLF cost per chiller (US $)	71,429	n/a		
	MLF + co-funding cost per chiller (US $)	120,714	22,857		

*In addition to 7 replacements, 5 conversions had been approved, but none implemented
**In addition to 3 replacements, 4 conversions had been approved, but none implemented

37. The global chiller project implemented by the World Bank has targeted a number of different countries as shown in Table 6.

Table 6 – Information related to the global chiller project

Status	Country	MLF funding (US $)		Co-funding (US $)		Number of chillers	
		By country	Total	By country	Total	By country	Total
As approved	China	6,884,612		13,769,224		150	
	India						
	Indonesia						
	Jordan						
	Malaysia						
	Philippines						
	Tunisia						
	[others]						
Current	Argentina	-	1,543,654	-	8,900,000	0	65
	India	502,439		6,300,000		34	
	Jordan	735,556		-		20	
	Philippines	305,659		2,600,000		11	
Plan	Argentina	1,000,000	3,735,556	-*	8,900,000	20	127
	India	1,000,000		6,300,000		34	
	Jordan**	735,556		-		20	
	Philippines	1,000,000		2,600,000		53	

* The World Bank informed that in Argentina a study has been initiated to assess the situation of the chiller sector, which may identify other potential sources of financing. The figure provided for co-funding is excluding the contributions by chiller owners, which have in some cases been included by other agencies in the reporting.
** The activities in Jordan have been completed.

38. The information contained in Tables 5 and 6 have been aggregated in Table 7. In doing so, it was noted that the projects in Brazil and Colombia had a major counterpart funding (US $156 million in total), and in the case of Brazil the actual number of chillers to be replaced has not yet been decided, which had a major weight in the assessment. The Secretariat has therefore provided some indicators excluding the chiller projects in these two countries.

Table 7 – Overall review of chiller projects

Aggregated	Approval	Current	Plan	Completion
MLF funds (US $)	14,524,000	6,897,555	9,771,790	December 2017
Co-funding (US $)	16,747,595	167,044,445	172,104,563	
Chillers	230	122	216	
Ratio co-funding/funding	115.3%	2,421.8%	1,761.2%	
MLF cost per chiller (US $)	63,148	56,537	45,240	
MLF + co-funding cost per chiller (US $)	135,963	1,425,754	842,020	
MLF + co-funding cost per chiller (US $) without Brazil, Colombia			102,970	

39. Based on preliminary estimates in particular for the replacement of chillers in Brazil, the cost per chiller replaced has been reduced from US $63,000 at the time of approval of the projects to US $45,000 assuming that the projects are implemented as planned. The co-funding has increased from US $17 million in the original projects to US $172 million (of which US $131 million are from Brazil and US $25 million from Colombia). Currently, the number of chillers to be replaced is almost the same as in the original proposal, but might increase depending on the further implementation of the project in Brazil. It is also to be noted that approximately US $5.7 million has been or will be returned to the Multilateral Fund.

40. No information was provided on energy efficiency. The Secretariat notes that this information is difficult to determine for several reasons, *inter alia*, that information on energy efficiency prior to conversion is only available in exceptional cases, thus improvements cannot be quantified.

Secretariat's recommendation

41. The Executive Committee may wish to consider:

(a) Noting the report on the chiller projects submitted by UNDP, UNIDO and the World Bank contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1;

(b) Requesting UNIDO to financially complete:

(i) The ODS phase-out in 50 existing centrifugal chillers units in Côte d'Ivoire, approved at the 37th meeting for the Government of France and transferred to UNIDO at the 57th meeting, by the end of 2013, and returning the remaining balances to the 72nd meeting;

(ii) The regional European demonstration project on the replacement of CFC centrifugal chillers in Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Romania, and Serbia approved at the 47th meeting, by the end of 2013, returning any remaining balances to the 72nd meeting, and submitting the project completion report no later than the 73rd meeting;

(iii) The demonstration project on the replacement of CFC centrifugal chillers in the Syrian Arab Republic approved at the 47th meeting, by the end of 2013, returning any remaining balances to the 72nd meeting, submitting the project completion report no later than the 73rd meeting;

(c) Requesting UNDP to continue implementing the 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 in Brazil, approved at the 47th meeting; submitting annual progress reports on the status of implementation in line with decision 68/8(c); financially completing the project and returning any remaining balances no later than the last meeting in 2017; and submitting the project completion report no later than the first meeting in 2018;

(d) Requesting UNDP to continue implementing the 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 in Colombia, approved at the 47th meeting; submitting annual progress report on the status of implementation in line with decision 68/8(c); financially completing the project and returning any remaining balances no later than the last meeting in 2017; and submitting the project completion report no later than the first meeting in 2018;

(e) Requesting the Governments of France, Germany and Japan, and UNIDO to continue implementing the project Strategic demonstration project for accelerated conversion of CFC chillers in five African countries (Cameroon, Egypt, Namibia, Nigeria and Sudan), approved at the 48th meeting, financially completing the project and returning any remaining balances no later than the last meeting in 2014, and submitting the project completion report no later than the first meeting in 2015; and

(f) Noting the return of US $3,149,056 by the World Bank from activities under the Global

chiller replacement project approved at the 47th meeting to the 71st meeting; and further requesting the World Bank to continue implementing the project in Argentina, India and the Philippines, submitting annual progress reports on the status of implementation in line with decision 68/8(c); financially completing the project and returning any remaining balances no later than the last meeting in 2017; and submitting the project completion report no later than the first meeting in 2018.

PART X: COMPLETION OF CFC, CTC AND HALON PROJECTS APPROVED AFTER 2009

Background

42. At the 70th meeting, the implementing agencies were requested not to incur any new commitments and to return funds balances for CFC, CTC, and halon projects approved prior to 2009 by the end of 2013, with some exceptions specified in decision 70/7(b)(ii).

43. During the Inter-agency Coordination Meeting held on 24-25 September 2013 in Montreal, the Secretariat stressed the need for closing all ongoing projects not related to HCFCs or methyl bromide and returning all the balances associated with completed projects. Also in the margins of the Twenty-fifth Meeting of the Parties in Bangkok, the Secretariat reviewed the CFC, CTC and halon projects approved from 2009 and beyond (Annex I), and further discussed with the implementing agencies on the need for closing them.

Secretariat's comments

44. Table 8 shows the number of ongoing projects that should have been closed or be closed as per completion date included in the original proposal or latest reported planned completion date.

Table 8

ONGOING CFC, CTC AND HALON PROJECTS APPROVED FROM 2009 AND BEYOND

Completion date	2010	2011	2012	2013	2014	2015	Total
Completion date per proposal	19	34	8	1	2		64
Latest reported planned completion date				59	4	1	64

45. There are four projects with a planned completion date in 2014:

(a) Terminal phase-out management plan (first tranche) for Haiti (HAI/PHA/58/INV/14): No significant achievement has been reported. UNDP and UNEP undertook a joint mission to Haiti to try to resolve the problems related to the delays. The completion date included in the original proposal was July 2011;

(b) National CFC phase-out plan: Final implementation plan for the Philippines (PHI/PHA/66/INV/94): UNEP reported to the 71st meeting that the Government implemented the planned activities under the work plan. According to UNEP, the project is expected to be completed by end of 2013. The completion date included in the original proposal is March 2014;

(c) Development of a guide for sustainable refrigerated facilities and systems, in cooperation with the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) (GLO/SEV/66/TAS/314). UNEP reported to the 70th meeting that it planned to sign the Agreement with ASHRAE by May 2013. The completion date included in the original proposal is April 2014; and

(d) National ODS phase-out plan (second tranche) for Yemen (YEM/PHA/60/INV/36). The Executive Committee approved at its 68th meeting the reallocation of the remaining funding from the national CFC phase-out plan of US $140,000, plus agency support costs of US $18,200 for UNEP, as agreed by the Government of Yemen in line with the implementation plan provided (decision 68/41). The completion date included in the original proposal was April 2011.

46. The Secretariat noted that delays on the completion of the projects varied between 10 and 44 months; all the countries with these projects have been in compliance with their phase-out obligations at least since 2010; the majority of the countries have an approved HPMP with the release at least of the first funding tranche. The Secretariat also noted the effort by a number of stakeholders in preparing progress reports on these activities and the associated administrative costs of maintaining these long delayed projects for which there is no more remaining compliance requirement.

47. Implementing agencies were requested to identify cases where there were compelling reasons not to operationally and financially complete these projects by their planned completion date. However, no request for extending completion beyond the planned completion dates were received.

Secretariat's recommendation

48. The Executive Committee may wish to request:

(a) That all of the 59 projects listed in Annex I to the present report should be considered operationally completed as at the planned completion date, that implementing agencies should not incur any new commitments after 2013, and to remove any of these projects from the list of those for which additional status report are requested in part IV, that the relevant implementing agencies return any unused balances from these projects as soon as possible but no later than the end of 2014; and that the relevant implementing agencies submit project completion reports no later than the last meeting in 2014; and

(b) That the project "Development of a guide for sustainable refrigerated facilities and systems, in cooperation with the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) (GLO/SEV/66/TAS/314)" implemented by UNEP with date of completion in 2014 should be considered operationally completed as at the planned completion date, and that UNEP return any unused balances from this project as soon as possible but no later than twelve months after the date of completion.

PART XI: CHINA: FINANCIAL AUDIT REPORT FOR THE HALON, CFC PRODUCTION AND FOAM SECTOR PLANS

Background

49. At its 56th meeting, the Executive Committee decided *inter alia* to continue monitoring activities and the utilization of project balances beyond the end of the agreements for the foams and halons and CFC production sector plans and the related accelerated phase-out sector plans in China, with the following simplified procedures:

(a) China would submit a final work plan for the foam sector with information on planned activities and associated funding. Each work plan would provide the activities and associated budget to be implemented in 2009 and beyond with the understanding that China had flexibility to make necessary adjustments to those plans, and would not be required to submit any additional work plans unless there were major changes made to them;

(b) China would continue to have independent financial audits conducted of the account of the three sector plans and would be provided to the Executive Committee on an annual basis from 2009 and beyond; and

(c) The World Bank would facilitate the review and submission of any adjustments to the work plans and financial audit reports to the Executive Committee, and submit the project completion reports upon the final expenditure of funds (decision 56/13).

50. At its 57th meeting, the Executive Committee approved the work plan for the foam sector in China for 2010 to 2012 (decision 57/14(c)(i)).

Financial reports submitted by the World Bank

51. In response to decision 70/4(b)(vi)[3], the World Bank has submitted to the 71st meeting the outstanding financial audit reports in relation to expenditures of funds for the China halon sector strategy, the agreement for the China production sector, and the agreement for CFC phase-out in the polyurethane foam sector in China. The summary report for the three plans as of the end of December 2011 and 2012 is presented in Table 9.

Table 9

FINANCIAL AUDIT REPORT FOR THREE SECTOR PLANS IN CHINA (US $)

Sector Plan	Funds approved	Work plans approved for balances (as at 2008/2009)[4]	Balances (as at the end of 2011)	Balances (as at the end of 2012)	Disbursement/ interest accrued in 2012
Halon	62,000,000	12,100,000	12,358,578	12,351,077	7,501
CFC production	150,000,000	8,500,000	8,679,621	6,700,783	1,978,838
Foam	53,846,000	4,900,000	9,391,738	9,245,438	146,300
Sub-total	265,846,000	25,500,000	30,429,937	28,297,298	2,132,639
Interest accrued			1,524,194	1,526,277	2,083
Total	265,846,000	25,500,000	31,954,131	29,823,575	2,130,556

Secretariat's comments

52. It could have been expected that the majority of the activities associated with the three sector plans should have already been completed, with the associated funds disbursed, considering that the last tranche for the foam sector plan was approved at the 56th meeting (November 2008) and that activities would have been completed by the end of 2012; the last tranche of the CFC production sector was approved at the 57th meeting (March-April 2009) and activities were to be completed by the end of 2013; and that the last tranche of the halon sector plan was approved at the 56th meeting, but no funds had been disbursed as at the end of 2012. However, as shown in the financial audit report, of the total balances of US $30,492,937 available at the end of 2011, only US $2,132,639 (of which US $1,978,838 was related to the CFC production plan) was disbursed as of the end of 2012. The outstanding balances amount to US $28,297,298 plus US $1,526,277 in interest accrued.

[3] The World Bank was requested, with regard to the implementation of the "China halon sector strategy", the "Agreement for the China production sector", and the "Agreement for CFC phase-out in the polyurethane foam sector in China", to report to the 71st meeting on the outstanding financial audit reports and to submit the project completion reports upon final expenditure of funds, as per decision 56/13.

[4] The budget for the halon sector is provided in Table 1 following paragraph 61 of document UNEP/OzL.Pro/ExCom/56/24; the budget for the CFC production sector is provided in the table following paragraph 119 of the same document; and the budget for the foam sector is presented in paragraph 22 of document UNEP/OzL.Pro/ExCom/57/15.

53. Based on the above facts, the Secretariat requested additional clarifications from the World Bank on the low level of disbursements, an explanation for how balances had increased from budgeted levels, and whether any funds had been utilized for other activities not identified in those budgets. The Secretariat also indicated that as the balances do not appear to have been needed for compliance, they should be returned to the Fund. The Secretariat further noted that:

(a) The Executive Committee has already approved in principle stage I of the HCFC phase-out management plan (HPMP) for China to meet the 2013 and 2015 compliance targets at a total value US $289.8 million including agency support costs. Funding for the third tranche of these plans has been submitted to the 71st meeting. If approved, the total funding approved for HCFC phase-out amounts to over US $208 million including agency support costs;

(b) In several non-low-volume-consuming (LVC) and LVC countries, remaining funding of CFC national phase-out plans were "re-allocated" for assisting those countries in phasing-out HCFCs (in several cases, the decision approving stage I of the HPMP explicitly indicated the amounts re-allocated for HCFC phase-out activities);

(c) At its 70th meeting, the Executive Committee requested bilateral and implementing agencies the return of balances for projects approved before 2009 for substances with 1 January 2010 phase-out (decision 70/7(b)(ii)) where the main reasons for closing those projects were that the funds were not needed for compliance and the administrative costs of agencies continuing to implement dormant projects; and

(d) As a reference, the estimated balance as of 2012 of over US $29.8 million (including interest accrued) from the three sector plans in China is equivalent to 50 per cent the total funding approved in principle for stage I of over 100 countries including agency support costs (i.e., US $59.4 million).

54. The Secretariat sought clarification on:

(a) Disbursement to-date by budget line for all sector plans noting that this information should be collected for project completion reports; however the Secretariat requested this information to determine if funds were used for activities not included in the approved budgets;

(b) The larger remaining balance of the sector plans than those approved or the low level of funding which might account for a reallocation of funding from other projects or other sources according to the Secretariat;

(c) Information the resolution of the legal issue identified in the verification report to the 65th meeting on the ability of transporting recovered halons to halon banks for recovery and recycling requested by decision 65/10(i)(ii).

55. In its response, the World Bank indicated that in its understanding of decision 56/13, the information being requested by the Secretariat was no longer required as it will be presented in the project completion reports (in line with decision 56/13(a)(ii)). The Bank further noted the enormous pressure on time constraints, significant challenges and work burden from the HCFC phase-out in China over the past three years, but that the Government of China was still implementing the three sector plans, and explained:

(a) With regard to the CFC production sector plan, almost all of the balance of US $6,700,783 had been committed by the end of 2012 for research and development of

ODS alternatives, operation for China Convention Centre, ODS import and export management, and technical support and workshop on ODS alternatives;

(b) With regard to the halon sector plan, a work programme for halon banking had been developed by the Foreign Economic Cooperation Office (FECO) and accepted by the Ministry of Public Security and the Bank. Activities were moving forward with the efforts of all stakeholders; a number of technical assistance activities on surveys and study, research and development of halon alternatives and substitutes, as well as the monitoring and supervision have been carried out; and discussions on the use of a bank of 2,400 metric tonnes of halon-1211 were on-going. The remaining US $12 million will be utilized as per the original work plan; and

(c) With regard to the foam sector plan, approximately US $6.8 million (of the balance) had been committed for research and development of ODS alternatives, technical service for foam enterprises for better application of new alternatives, and monitoring of CFC phase-out in the foam sector (the balance of US $2.4 million has not been committed yet).

56. The World Bank indicated that it was not acceptable or appropriate to compare China with other Article 5 countries, since situations in different countries vary. Moreover, China's ODS consumption accounts as much as half of all developing countries' consumption which makes the management of this substantive amount of ODS production and consumption much more complex than other Article 5 countries. It stated that the Executive Committee provided China with flexibility in the utilization of the funding approved as defined in the agreements to address these more complex situations and more challenging tasks, and that the questions raised by the Secretariat were beyond the requirement of the agreements and inconsistent with prior agreements between the Committee and the Government of China. The Bank also pointed out that the return of the unused balances was not part of the agreements with the Executive Committee.

57. The Secretariat also notes that the agreements for these three sector plans were to enable China to achieve compliance with relevant control targets of the Protocol. China has achieved and has been in compliance with those control measures to-date. Unanticipated balances remained as the sector plans were ending their agreements with the World Bank. In the light of this fact, the Secretariat raised the issue of the balances at the 56th meeting; as a result, the Executive Committee allowed for those balances to be used pursuant to decision 56/13.

58. With regard to the interest amounting to US $1,556,227 as at the end of 2012, the World Bank did not address the issue in its response to the Secretariat. It should be noted that all interest held by implementing agencies are returned to the Multilateral Fund. The Committee has also requested implementing agencies to submit to the Treasurer an annual audited financial statement including *inter alia* interest accrued (decision 70/20(c)) and for the Treasurer to record the interest earned from balances held by FECO for the stage I HPMP (decision 70/20(d)). The interest accrued from the funds held by FECO for these three sector plans should also be reported and recorded as interest accrued to the Multilateral Fund.

59. In addition to the clarification requested on the CFC production, halon and CFC foam sector plans, the Secretariat also requested information about the on-going process agent II sector plan (approved at a total funding of US $46.5 million), the solvent sector plan (US $52 million), and the refrigeration servicing plan (US $7,884,853). The Secretariat notes that these sector plans were not included in the financial audit report submitted by the World Bank, as they were not included in decision 56/13. The annual progress and financial report showed that all funds have been disbursed for these three sector plans except US $33,308 for the refrigeration servicing sector. However, it is not clear the extent to which funds disbursed to the implementing agencies have been disbursed by China to the

final beneficiaries. For example, the last work plan for the process agent II sector plan, submitted in 2011, indicated that as at the end of 2009, the World Bank had disbursed to China all the funding available but only US $35,417,962 was disbursed from China to the final beneficiaries leaving a balance of US $11,082,038 with only four of the 200 enterprises that had not completed phase-out activities under the plan.

Secretariat's recommendation

60. The Executive Committee may wish to:

(a) Note the financial audit reports submitted by the Government of China through the World Bank pursuant to decision 56/13 contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1;

(b) Request:

(i) The submission of the financial audit report pursuant to decision 56/13 to the 72nd meeting of the Executive Committee including the information requested in paragraph 54 of the current document with a view toward closing the projects and offsetting any remaining balances as at the end of 2014 against future approvals;

(ii) That future financial audit reports of each sector plan should provide information on all funds from the Multilateral Fund that are being held by China for disbursement to final beneficiaries, and the interest accrued from those balances;

(iii) That the total interest accrued by the Government of China to implement activities pursuant to decision 56/13 should be offset against future funding approved for China and reported in the annual audited financial reports referred to in decision 70/20(c) and the Treasurer should record such interest as requested in decision 70/20(d), and

(iv) That data on funds held by the Government of China for the process agent II sector plan, the solvent sector plan and the refrigeration servicing plan should be provided in any future financial audit report.

PART XII: RESOURCE MOBILIZATION FOR CLIMATE CO-BENEFITS

Global: Resource mobilization for climate co-benefits (UNDP)

Background

61. At the 69th meeting, UNDP submitted the final report on resource mobilization for climate co-benefits in line with the decisions of the Executive Committee. After considering the report and the activities described therein, the Executive Committee, in decision 69/4(d) requested UNDP, *inter alia*, to provide by the 71st meeting, copies of the proposals or a description of the projects initiated with funds provided under this project, and a more detailed final report on processes and approaches used to mobilize additional resources, as well as lessons learned to this exercise, ensuring that the elements described in decisions 63/20(a)(ii) and 68/4(c)(ii) were included, where this information was available.

Progress report

62. The final report provided a historical overview of the work undertaken by UNDP for resource mobilization since the 57th meeting; on processes and approaches used in implementing the resource mobilization funds approved at the 63rd meeting; the potential to address climate benefits through the carbon markets, taking into account the current developments in the market as well as the existing constraints that limit maximizing the potential of these markets as a source of co-financing; and a brief analysis on the possibility of combining and sequencing environment finance including specific examples.

63. UNDP further noted that due to the uncertainty of the carbon market at the present time, other options that could find better acceptability with Article 5 countries could be in the form of grants, through opportunities available from the Global Environment Facility (GEF) and the Climate and Clean Air Coalition (CCAC) Trust Fund. The GEF also offered new prospects with the current direction of the GEF VI replenishment which includes a chemicals strategy that would open possibilities for linking HCFC phase-out management with projects that are outside the current System for Transparent Allocation of Resources (STAR).

64. In exploring the two options outlined above, UNDP included:

(a) A proposal for funding by the GEF for Indonesia focusing on financing of energy-efficiency improvements in the air-conditioning and refrigeration sectors developed in collaboration with UNDP's GEF-Climate Mitigation team; and

(b) A feasibility study for replacing the existing population of HCFC/HFC-based air-conditioning equipment in Maldives with district cooling technology, which is currently ongoing and funded by the CCAC Trust Fund.

65. Both projects are expected to be implemented back to back and it is anticipated that these will result in additional climate benefits to the HCFC phase-out.

66. At the 69th meeting, UNDP already provided information on the elements described in decisions 63/20(a)(ii) and 68/4(c)(ii) as shown in Table 18 of document UNEP/OzL.Pro/ExCom/69/5.

Secretariat's comments

67. At the 69th meeting, UNDP reported that they were exploring bilateral opportunities for demonstration and application of low-global warming potential (GWP) and energy efficient technologies in India, Indonesia and Malaysia covering the polyurethane (PU) foam and commercial air-conditioning and refrigeration sectors. In clarifying with the Secretariat why these were removed from the report, UNDP explained that these projects will continue strictly as bilateral cooperation and not be within the funded resource mobilization exercise, as requested by the donor country.

68. UNDP also took into account the Secretariat's concern that the report lacked conclusions and a possible way forward after the resource mobilization exercise, and revised the document accordingly. The conclusions are summarized below:

(a) Public finance is critical to removing barriers to climate technologies and attracting direct investment, and the Multilateral Fund and the GEF as well as bilateral donors have an important role to play. The resource mobilization funding provided by the Multilateral Fund allowed UNDP access to other sources of funds to prepare the mentioned projects which would not have been possible otherwise;

(b) The funding provided under resource mobilization by the Multilateral Fund and the mandate given with this approval was critical to the success of this exercise as it enabled UNDP to recover costs for activities that were considered "non-eligible" under the current guidelines of the Executive Committee;

(c) Project cycles of potential partners (i.e. GEF) and the Multilateral Fund may need to be synchronized in order to provide more efficient assistance, avoid delays and encourage participation of countries. For instance, with regards to the GEF, such harmonization would allow for funds from the Multilateral Fund to be used as a source of co-finance required by GEF, and GEF funds can be used to bring the additional climate benefits desired;

(d) The approach used in developing the Indonesia project may be successfully replicated in other countries when harmonized project cycles are agreed;

(e) It is important to increase the understanding of both decision making bodies of the Multilateral Fund, the GEF and other potential partners on the common objectives of the projects being proposed and its expected results (i.e. HPMP and additional energy efficiency gains) to encourage faster approval;

(f) The experience with the CCAC which resulted in a feasibility study for Maldives could result in a demonstration project that may be applied to other countries especially small island developing States (SIDS) and promote innovative technology choices such as district cooling;

(g) To encourage and promote synergies among different funding mechanisms, the main challenge identified is how to simplify the complex arrangements to ensure that funding is made available on time for the country/company to make the necessary technology changes and therefore meet compliance without unnecessary delays. It may be possible to generate a replicable model if these barriers are removed at institutional level; and

(h) Bilateral assistance has proven to be a faster and more reliable source of funding, with minor interventions from external bodies and their decisions. The limitation would be how to ensure replication at a larger scale taking into account the possibly limited resources of potential bilateral partners, as well as their internal processes.

69. The final report revised by UNDP is attached as Annex II to this document.

Secretariat's recommendation

70. The Executive Committee may wish to note the final report on the resource mobilization for climate co-benefits submitted by UNDP contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1.

Global: Resource mobilization for climate co-benefits (World Bank)

Final report

71. The World Bank submitted the final report on resource mobilization for climate co-benefits in line with the decisions of the Executive Committee. The World Bank's study identified the potential investment opportunities and sources of co-financing to meet the additional costs of energy efficiency and climate mitigation benefits associated with the HCFC phase-out. The study also analyzes strategies that can maximize synergies with climate financing in general and in combination with the World Bank's

energy efficiency and climate mitigation portfolios. The study also provides an overview of the use of carbon finance in the past and outlines potential future opportunities for its use.

72. The key messages that are contained in the study are the following:

(a) An analysis of the impacts and benefits of HCFC phase-out show that savings related to electricity, whether at the individual consumer level or from reduced or avoided generation capacity at the country level, is a dominant factor in decision making for including energy considerations in the phase-out of HCFCs;

(b) There are a number of sources of financing that address energy efficiency gains of the HCFC phase-out, but challenges arise with respect to timing, approach, and implementation;

(c) Bringing together multi-source financing increases transaction costs associated with these activities;

(d) Good strategic planning and sectoral coordination at the country level are crucial to ensure that policies are aligned and opportunities to leverage financing are optimized; and

(e) There is scope for inclusion of Montreal Protocol related activities in energy-related activities under the World Bank's investments on clean energy.

73. The study also provided information on "cross-cutting elements" that need to be considered in pursuing options for broad financing packages such as additionality of the projects proposed; transparency and good governance; assurance that the projects would avoid perverse incentives for countries; exploring possibilities of profit-sharing, including return of funds to the Multilateral Fund; ensuring sustainability of the projects proposed; avoidance of duplication of similar projects; information on transaction costs, as required by decision 63/24(a) within the context of the overall report.

74. In response to decision 68/4(c)(ii), the World Bank provided a review of its experiences with the multi-sector financing approach used in the chiller projects that they had implemented. This is attached to the report. The main lessons learned in this exercise included the following:

(a) Carbon finance in itself has not driven the financing of chiller projects largely due to the doubts associated with it. In the context of chiller replacement, the principal barrier was the high opportunity cost of access to up-front financing for the investment;

(b) Project boundaries must be clearly defined against goals and objectives at the time of project design to generate maximum project impact. For instance, in the case of Thailand, the emphasis only on chiller replacement was too narrow to generate higher interest in the energy efficiency aspect; and

(c) Policies and objectives of funding institutions need to be harmonized in order to avoid issues related to opposing views with respect to commercial availability, cost-effectiveness, suitability including safety considerations of alternatives which pose barriers associated with the use of less proven alternative refrigerants.

Secretariat's comments

75. In reviewing the study, the Secretariat noted that it appeared to be a theoretical study of what currently exists as options for resource mobilization. While the World Bank had used specific projects as examples, it had not provided clear lessons from the process that led to the funding of such projects which

may be useful to the Multilateral Fund. The Secretariat observed that the overall context of the study would better serve the Executive Committee if such lessons could be given more priority and main conclusions from the report could be highlighted. The Secretariat also noted that it seems that the World Bank could be a possible source of financing if links between policies can be strengthened.

76. In their reply, the World Bank highlighted the fact that currently, investments under the Multilateral Fund for ODS phase-out in Article 5 countries are smaller than investments in energy-efficiency in related sectors in these countries. It is therefore important to identify ways by which these energy investments can be influenced more in order to maximize the climate benefits of the HCFC phase-out. The World Bank is currently embarking on internal activities to raise awareness of the different task teams to provide them with guidance and tools to fully take into account Montreal Protocol operations when working with their client countries on energy efficiency projects. However, this can be implemented more efficiently if the Multilateral Fund provides some dedicated and targeted funding to mainstream these efforts.

77. The World Bank also described ways by which specific projects included in the report could be linked to HCFC phase-out. For example in India, the approach to work with the equipment manufacturers to improve energy efficiency could be compatible and be associated with appliance manufacturers. This would require further study but the approach had already been tested through the Bank's project and could be modified for the Multilateral Fund's purposes.

78. The World Bank also acknowledged some of the Secretariat's comments and provided a revised document, in particular the conclusions and recommendations. The report of the World Bank is attached as Annex III.

Secretariat's recommendation

79. The Executive Committee may wish to note the final report on resource mobilization for climate co-benefits submitted by the World Bank contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1.

PART XIII: HCFC DEMONSTRATION PROJECTS

China: Demonstration sub-project for conversion from HCFC-22 to propane at Midea Room Air Conditioner Manufacturer Company (UNIDO)

Background

80. At its 61st meeting, the Executive Committee approved for China the demonstration sub-project for conversion of room air-conditioning compressor manufacturing from HCFC-22 to propane at Midea Room Air Conditioner Manufacturer Company (Midea)[5]. UNIDO has submitted to the 71st meeting an interim report on the demonstration project.

Progress report

81. The conversion of one production line at Midea Room Air Conditioner Manufacturer Company, completed in July 2013, has led to the development of room air conditioners using HC-290 (propane) as refrigerant; the related production processes have also been developed. Since in the production line flammable gases are handled, a safety certification by Technischer Ueberwachungs-Verein Rheinland Ltd (TUV) was sought in August 2013. After incorporating a number of comments and suggestions for further changes, a second visit was scheduled for October 2013. The converted production line will

[5] Document UNEP/OzL.Pro/ExCom/61/32

undergo a national acceptance process once TUV certification has been issued; the national acceptance process is a necessity for production lines using substances like HC-290.

82. The air conditioners have been developed, and an application for product certification has been submitted. This application to the certification authorities is meant to ensure consistency with the standard GB 4706.32, which allows the use of flammable refrigerants in air conditioning products in China. Since this is the first time that such a certification is being conducted, the progress in the certification process is taking more time than originally estimated.

Incremental cost

83. The project cost forming the basis for the Executive Committee approval amounted to US $3.125 million before applying a reduction for foreign ownership, and a partial cost sharing of the heat exchanger conversion since the converted capacity was substantially larger than for the air conditioners, the budget forming the basis for Executive Committee approval came to US $4.08 million. The actual expenditures for conversion amounted to US $3.94 million.

Secretariat's comments

84. Due to the foreign ownership component (40 per cent) and the fact that the heat exchanger manufacturing line converted had a larger capacity than the overall conversion, only 46 per cent of the costs agreed prior to the approval of the project were deemed eligible. The cost comparison demonstrated that the project implementation cost is close to the agreed project cost forming the basis for the Executive Committee approval. Not taking into account that the enterprise had foreign ownership and reducing the heat exchanger conversion cost to the actual capacity of the line, the conversion cost for this particular production line with a capacity of 200,000 units was US $2.95 million, leading to a cost-effectiveness of approximately US $15/kg. Experience from the implementation of CFC phase-out projects in the refrigeration manufacturing sectors suggests that these figures could be reduced with increasing experience in implementation, and with increasing size of the production line capacity.

85. Since large scale production has not commenced, it was not possible to provide information on the actual incremental operating cost (IOC).

86. It should be noted that the converted line at Midea was a fully integrated air conditioning manufacturing plant covering production of heat exchangers, tubing, housing, electrical components, assembly and charging. This is a different case than conversion projects for air conditioning manufacturers using pre-fabricated kits, which have only to be assembled and tested; the Multilateral Fund has already funded a number of these conversions as well. The conversion of such lines to hydrocarbon technology should be reduced by at least the cost component related to the heat exchangers which is approximately half of the overall conversion cost. With this, the ICC of such a conversion would be in the order of US $7.28/kg. However, the operating cost would be higher, since the cost related to the heat exchanger, borne by the manufacturer of the kit, would have to be incorporated in the price of the kit.

87. The report has provided valuable insight into the actual project costs. The cost items that were reported by UNIDO show some variation as compared to those in the original budget and will be useful for future cost discussions as well. However, the information provided does not allow generic conclusions related to ICC in particular or project cost in general for manufactures of room air conditioner equipment. The demonstration project was essential for the agreement of a substantial share of the room air conditioner manufacturing sector in China to convert their manufacturing facilities to HC-290 (propane) technology instead of the well-established alternative HFC-410A.

Secretariat's recommendation

88. The Executive Committee may wish to:

(a) Note the interim report on the demonstration sub-project for conversion from HCFC-22 to propane at Midea Room Air Conditioner Manufacturer Company in China by UNIDO contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1; and

(b) Request UNIDO to submit a final report to the 73rd meeting, on the understanding that it will only contain preliminary data on incremental operating cost.

China: Demonstration sub-projects for conversion of room air-conditioning compressor manufacturing from HCFC-22 to propane at Guangdong Meizhi Co. (UNIDO)

Background

89. At its 61st meeting, the Executive Committee approved for China the demonstration sub-project for conversion of room air-conditioning compressor manufacturing from HCFC-22 to propane at Guangdong Meizhi Co.[6] UNIDO has submitted to the 71st meeting an interim report on the demonstration project.

Progress report

90. The conversion of the product line was completed in August 2013, with trials planned to conclude by early 2014. The products, refrigerant compressors for room air conditioning equipment, have been developed and tested in the enterprise's own laboratory and at a third party laboratory. The product certification is on-going. It is assumed to achieve national acceptance of the converted production lines by early 2014.

91. Two types of HC-290 compressors have been developed. One type employs a conventional fixed speed drive and one a variable frequency drive using a 0.75 KW motor, leading to a co-efficient of performance of 4.12 to 4.33. The compressors have been fully developed for mass production, the production line achieving the same capacity as before the conversion (1,830,000 units per year). Mass production has not yet started; consequently, no information on the incremental operating cost (IOC) is available. However, UNIDO provided an estimate of the IOC at a level of US $5.50 per compressor produced. It is to be noted that according to the guidelines of the Multilateral Fund a conversion of a compressor production is not eligible for IOC.

Incremental cost

92. The project cost forming the basis for the Executive Committee approval amounted to US $3.05 million before applying a reduction for foreign ownership. The actual expenditure for conversion amounted to US $3.4 million (11.4 per cent higher than the original budget). However, as compared to the original budget, substantial re-arrangements took place. Originally expenditures for a new line to produce the casings for the compressor were foreseen at a level of US $132,000; however, the production was instead outsourced resulting in higher operating cost for the manufacturer. The cost for production equipment for the motor was almost US $1 million above the estimated figures; however higher level equipment was selected than originally planned, as such equipment would be essential to achieve the desired compressor performance. Investment costs related to research and development have not been included, since the enterprise already undertook the related efforts without funding from the Multilateral Fund.

[6] Document UNEP/OzL.Pro/ExCom/61/32

Secretariat's comments

93. Under the project, hydrocarbon compressors for room air conditioners were developed for production on a large scale, and the production was converted accordingly. The compressors developed are optimised for hydrocarbons as well as for low refrigerant volume, to minimise refrigerant content. Such compressors are currently not produced in other countries; thus this conversion project represents a genuine product and manufacturing process development and not only a technology transfer.

94. The Secretariat also noted UNIDO's preliminary estimate of the operating cost, which indicate operating costs higher than for the manufacturing of HCFC-22 compressors, but about 60 per cent lower than for HFC-410A compressors[7].

95. The report has provided valuable insight into the actual project costs. The cost items that were reported by UNIDO are the same as in the original budget, indicating that no major cost item was overlooked. However, the information provided does not allow generic conclusions related to ICC in particular or project cost in general for manufactures of compressors for room air conditioning equipment. The demonstration project was essential for the agreement of a substantial share of the room air conditioner manufacturing sector in China to convert their manufacturing facilities to HC-290 (propane) technology instead of the well-established alternative HFC-410A.

Secretariat's recommendation

96. The Executive Committee may wish to:

(a) Note the interim report on the demonstration sub-project for conversion of room air-conditioning compressor manufacturing from HCFC-22 to propane at Guangdong Meizhi Co. in China by UNIDO contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1; and

(b) Request UNIDO to submit the final report to the 73rd meeting.

China: Demonstration project for HFC-32 technology in the manufacture of small-sized commercial air-source chillers/heat pumps at Tsinghua Tong Fang Artificial Environment Co., Ltd. (UNDP)

Background

97. At its 60th meeting, the Executive Committee approved for China the demonstration project for HFC-32 technology in the manufacture of small-sized commercial air-source chillers/heat pumps at Tsinghua Tong Fang Artificial Environment Co., Ltd., implemented by UNDP[8]. A progress report on the demonstration project has been submitted to the 71st meeting.

Progress report

98. The conversion of the product line, the development of products, technical commissioning and training were completed in December 2012. The national acceptance process necessary for a production line using HFC-32 is expected to be completed by the end of 2013. The production has not yet started in full, and consequently no information on the actual incremental operating cost (IOC) is available. The information will be included in a final report.

[7] According to project proposals previously received by the Secretariat.

[8] Document UNEP/OzL.Pro/ExCom/60/24

Incremental cost

99. The project cost approved by the Executive Committee amounted to US $1.23 million, of which the ICC was US $552,928, including US $15,000 for dissemination of information at a technical assistance workshop. Taking into account the partial ineligibility of certain equipment items, the capital cost of the conversion was estimated at US $764,400. Information submitted by UNDP shows the actual conversion cost at US $830,350, 8.6 per cent higher than the estimated cost.

Secretariat's comments

100. The report has provided valuable insight into the actual project costs. The cost items that were reported by UNDP are the same as in the original budget, indicating that no major cost item was overlooked. However, the information provided did not allow generic conclusions related to ICC in particular or project cost in general for manufactures of mid-size heat pump and air conditioning equipment. The demonstration project was essential for the agreement of a substantial share of the industrial and commercial refrigeration and air conditioning sector in China to convert their manufacturing facilities to HFC-32 technology instead of the well-established alternative HFC-410A.

Secretariat's recommendation

101. The Executive Committee may wish to:

(a) Note the interim report on the demonstration project for HFC-32 technology in the manufacture of small-sized commercial air-source chillers/heat pumps at Tsinghua Tong Fang Artificial Environment Co., Ltd. in China by UNDP contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1; and

(b) Request UNDP to submit a final report to the 72nd meeting, on the understanding that it will only contain preliminary data on incremental operating cost.

China: Demonstration project for conversion from HCFC-22 technology to ammonia/CO_2 technology in the manufacture of two-stage refrigeration systems for cold storage and freezing applications at Yantai Moon Ltd. (UNDP)

Background

102. At its 60th meeting, the Executive Committee approved for China the demonstration project for conversion from HCFC-22 technology to ammonia/CO_2 technology in the manufacture of two-stage refrigeration systems for cold storage and freezing applications at Yantai Moon Ltd.[9], implemented by UNDP. A progress report on the demonstration project has been submitted to the 71st meeting.

Progress report

103. The project has been completed and it has successfully passed national acceptance in July 2013. The production line is operating; the incremental operating cost (IOC) will be disbursed to enterprise in the next two years, once sufficient sales have been taken place.

[9] Document UNEP/OzL.Pro/ExCom/60/24

Incremental costs

104. The project cost approved by the Executive Committee amounted to US $4.28 million, and included voluntary contribution of the manufacturer of US $321,000. Without the technology dissemination included in the project document the budget for ICC was US $3.01 million.

105. The actual expenditures for capital cost amounted to US $4.06 million or 34 per cent higher than estimated at the time of project approval. While some items turned out to be available at a lower price, several others were purchased at moderate cost increases. Cost increases occurred in the manufacturing of prototypes, from US $0.47 million to US $1.12 million[10;11], contributing 62 per cent to the cost increase.

Secretariat's comments

106. The project demonstrated the applicability of ammonia/CO_2 technology which was developed by an Article 5 country manufacturer, and has been presented in a number of different *fora*, including Montreal Protocol related-meetings. This development is likely to reduce barriers to CO_2 cascade technology in general, which could have applications in smaller-size equipment, such a frozen food cabinets in supermarkets.

Secretariat's recommendation

107. The Executive Committee may wish to:

(a) Note the interim report on the demonstration project for conversion from HCFC-22 technology to ammonia/CO_2 technology in the manufacture of two-stage refrigeration systems for cold storage and freezing applications at Yantai Moon Ltd. in China by UNDP contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1; and

(b) Request UNDP to submit a final report to the 72nd meeting, on the understanding that it will only contain preliminary data on incremental operating cost.

Global: Assessment of the use in Colombia of super-critical CO_2 technology for polyurethane spray foams

Background

108. At its 60th meeting, the Executive Committee approved the demonstration project to validate the use of super-critical CO_2 in the manufacture of sprayed polyurethane (PU) rigid foam in Colombia, to be implemented by the Government of Japan, on the understanding that the project was approved on an exceptional basis and would be the final and only validation project for super-critical CO_2 technology in the manufacture of sprayed polyurethane rigid foams (decision 60/29).

109. At its 69th meeting, the Executive Committee noted with appreciation an interim report submitted by the Government of Japan, and requested the finalization of the report including the additional information requested by the Secretariat in document UNEP/OzL.Pro/ExCom/69/5 (paragraph 103)[12].

[10] At the time of discussion of this budget item, the Secretariat pointed to the commercial value of prototypes and their respective parts, in particular for refrigeration equipment of this size and value. In general, cost for prototypes are highly dependent on the machine, labour and overhead rates applied to calculate the related manufacturing cost.

[11] It is difficult to assess whether any of the equipment purchased as part of the conversion represents actually an upgrade in technology; for such an assessment, a high degree of manufacturing expertise need to be available, as well as a detailed record of type of equipment used before the conversion and its condition.

[12] An economic assessment of the use of the super-critical CO_2 technology; a description of the polyurethane material required for the super-critical CO_2 technology and whether it is provided only by Achilles (the company that holds the patent for the technology), and the royalty fees

110. The Government of Japan has submitted to the 71st meeting the final assessment of the use of super-critical CO_2 technology in the manufacture of sprayed PU rigid foam in Colombia, including the additional information requested. The complete report, including an independent technical review, is contained in Annex IV of the present document.

Executive summary

111. Super-critical CO_2 is a non-flammable, zero ozone-depletion potential (ODP) and low global warming potential (GWP) technology developed in 2004 by Achilles Corporation[13] for the application of sprayed PU rigid foam. The basic principle of the technology is the modification of the conventional spray foam dispenser to add liquid CO_2 to a system normally formulated with water in order to form more isotropic cells that would improve the foam's properties (including dimensional stability, compression strength and thermal insulation) without increasing its density.

112. The demonstration, foam application and testing activities took place with assistance from UNDP at Espumlatex, the largest locally owned PU systems house. The technical assessment included issues related to processability (e.g. easiness to apply it, required modifications to the conventional equipment) and foam physical properties (reactivity, foam core density, thermal conductivity, compression strength, adhesion strength, water vapour permeability, water absorption, close cell content, dimensional stability, aging and fire performance).

113. Three qualitative factors were considered in the assessment: the technology, the foaming location and the foam density. Accordingly, super-critical CO_2-based foams were produced and compared against local, commercialised HCFC-141b-based formulations differing in water content and density. Production and testing took place in two locations differing in altitude, temperature and relative humidity (Barranquilla and Bogota). Conclusions from the final report are summarized in Table 10.

Table 10

CONCLUSIONS FROM THE ASSESSMENT OF SUPER-CRITICAL CO_2 IN SPRAY FOAM IN COLOMBIA

Results of the super-critical CO_2 assessment	**Compared to HCFC-141b foams**	
Processability under different temperature, altitude and humidity conditions	- Similar. Polyol and isocyanate components of both technologies were stable during the six months of project duration - It does not create any incremental industrial hygiene and safety hazard	
Foam physical properties	**Polyurethane (PUR)**	**Polyisocyanurate (PIR)**
Thermal conductivity	Higher but better aging. The difference between the two technologies decreased over time	Higher but better aging. The difference between the two technologies decreased over time
Aging behaviour in compressive strength	Similar. Values remained stable during six months	Similar. Values remained stable during six months
Dimensional stability at -20 ºC	Similar	Similar
Dimensional stability at 60 ºC and 96 per cent relative humidity	Improved	Similar in absolute values. However, while super-critical CO_2 experienced a negative change in volume, the HCFC-141b formulation experienced a positive change
Adhesion strength to galvanised steel	Similar	Lower

for foam enterprises that selected the super-critical CO_2 technology; a description of any modifications that would need to be made to spray equipment in the baseline (i.e., using HCFC-141b) for using the super-critical CO_2 technology; an indication of the minimum requirements, level of training and skills required by spray foam operators in Article 5 countries to successfully use the technology; and the main challenges encountered so far in applying the technology under the specific conditions in the country, and how they were addressed.

[13] Achilles Corporation is a Japanese firm involved in the manufacturing of plastic and shoe products, as well as insulating materials including PU foams.

Incremental costs	PUR	PIR
Retrofit of a typical spray machine to apply super-critical CO_2	From US $9,800 to US $13,700	From US $11,800 to US $15,700
FOB price in Japan of the super-critical CO_2 system (*)	US $7/kg	US $7/kg
Technology fees	Super-critical CO_2 technology is a patented technology owned by Achilles Corporation. The interested parties should come to an agreement with Achilles on technology fees.	

(*) The super-critical CO_2 technology is based on proprietary polyol and isocyanate formulations developed by Achilles.

Conclusion by the technical reviewer

114. The technical reviewer "supported the report as a high quality and very comprehensive review of super-critical CO_2 technology". The reviewer highlighted that the evaluation showed super-critical CO_2 technology as technically suitable for use as an option to replace HCFC-141b in the spray foam sector, and that there is no inherent barrier for rapid implementation provided that the limitations of CO_2-based foams are understood and are deemed to be acceptable (namely higher thermal conductivity that is likely to result in the need for an increased foam thickness, with related operating costs). The reviewer also highlighted that the evaluation showed super-critical CO_2 spray foam as a robust technology in terms of processing under the quite broad range of conditions tested, and as superior to CO_2 (water)-based foam technology. He stressed that a major element in the operating costs is the requirement to purchase the proprietary polyols from Achilles (the market price in Colombia could be twice that of the HCFC-141b-based formulation) and that it would be illustrative if examples of existing fees could be added to the report.

Secretariat's comments

115. The Secretariat noted the rigorous analysis undertaken to demonstrate the technical feasibility of this technology in different foams and under different climatic conditions. The Secretariat asked UNDP about the main incentives and barriers to adopting this technology in Japan and in Article 5 countries. UNDP explained that the main barriers for a wider penetration in Japan have been the required capital cost for the conversion, and in some specific uses requiring high thermal performance, the greater conductivity compared to HFC and HCFC systems. Information was also provided to the effect that the Japanese industry is modifying the standards to allow the replacement of HFC by water-based systems, and that the Government of Japan is establishing policies to ban the use of HFC in foam blowing, as well as providing financial aid to foam manufacturers to acquire the modified spray equipment to use the technology.

116. In Article 5 countries, the main barrier to the adoption of super-critical CO_2 will be the incremental capital cost incurred in the modification of the spray machine and technology fees. The demonstration project showed that, from a technical point of view, this technology could be successfully applied in Article 5 countries. The minimum requirements for systems houses to adopt the technology are technical capacity to design rigid foam formulations; human resources and simple laboratory facilities; and conventional blending facilities to prepare the formulated polyol side. A challenge for the systems houses will be the development of suitable water-based formulations that use locally available raw materials (polyols and isocyanate). A challenge for downstream users will be adequate training of the spray operators.

117. The implications of the higher thermal conductivity and lower adhesion showed in some cases by super-critical CO_2 were also discussed. UNDP explained that the higher thermal conductivity will not be a barrier to adoption of the technology in Article 5 countries, except for applications where a high thermal performance is required and thickness variations are not allowed. The lower adhesion showed by super-critical CO_2 in PIR foams will not discourage the adoption of the technology, as values are within industry standards. Furthermore, the adhesion values could be improved by modification of the polyols blend without incurring additional operating cost.

118. On the incremental capital cost, it was noted that while the cost of retrofitting the existing foam dispenser would vary from US $9,800 to US $15,700, not all dispensers can be retrofitted to operate with super-critical CO_2. For cases where the baseline dispenser cannot be retrofitted, the enterprise would need to add US $30,000 for a new dispenser able to be retrofitted. UNDP indicated, however, that most of the spray machines currently in the market can be retrofitted[14].

119. In responding to a question about how the incremental operating cost compares with other demonstrated technologies (i.e. methyl formate, methylal, pre-blended hydrocarbons), UNDP indicated that it would be difficult to establish such a comparison as the market penetration of these technologies is very low in the region. The Secretariat noted that although the incremental operational cost associated to the use of super-critical CO_2 systems compares favourably with that of HFC systems, it is much higher than that of HCFC-141b systems.

120. With regard to the expected cost of the technology transfer fee, UNDP indicated that it would depend on the amount of HCFC-141b to be phased out in each country. In the particular case of Colombia, where the technology was tested, UNDP concluded that all systems houses would be able to adopt the technology, but the high incremental cost involved (retrofit of dispensers and transfer fees) were a critical obstacle to entering into commercial agreements with Achilles.

Secretariat's recommendation

121. The Executive Committee may wish:

(a) To note with appreciation the report entitled "Assessment of the use in Colombia of super-critical CO_2 technology for polyurethane spray foam", submitted by the Government of Japan contained in document UNEP/OzL.Pro/ExCom/71/6/Add.1; and

(b) To request bilateral and implementing agencies to share the assessment report on super-critical CO_2, together with information on other alternatives, when assisting Article 5 countries in preparing projects for the phase-out of HCFC-141b in polyurethane spray foam applications.

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[14] The requirements for a spray foam machine to be retrofitted are: a working pressure of 2,000 psi (very common in this type of dispensers) and a piston stroke equal to or higher than 3 inches. The spray machines should be hydraulic or air-driven.

Annex I

COMPLETION OF CFC, CTC AND HALON PROJECTS APPROVED FROM 2009 AND BEYOND

COUNTRY	Agency	Code	PROJECT_TITLE
Algeria	UNIDO	ALG/PHA/58/INV/71	National phase-out plan (second tranche)
Bahrain	UNEP	BAH/PHA/59/TAS/21	Terminal phase-out management plan (second tranche)
Bolivia (the Plurinational State of)	Canada	BOL/PHA/57/TAS/32	Terminal phase-out management plan (second tranche)
Brazil	UNDP	BRA/PHA/59/INV/293	National CFC phase-out plan (eighth tranche)
Burundi	UNEP	BDI/PHA/62/TAS/26	Terminal phase-out management plan (second tranche)
Burundi	UNIDO	BDI/PHA/62/INV/27	Terminal phase-out management plan (second tranche)
Chile	Canada	CHI/PHA/60/INV/173	Servicing sector terminal CFC phase-out plan (second tranche)
China	UNIDO	CPR/REF/59/INV/490	Refrigeration servicing sector CFC phase-out plan (sixth tranche)
Congo (the)	UNIDO	PRC/PHA/60/INV/21	Terminal phase-out management plan (second tranche)
Cote d'Ivoire	UNIDO	IVC/PHA/58/INV/34	Terminal phase-out management plan (second tranche)
Cuba	UNDP	CUB/PHA/59/INV/44	National ODS phase-out plan for CFCs: 2009 and 2010 annual implementation plans
Djibouti	UNEP	DJI/PHA/59/TAS/17	Terminal phase out management plan for CFCs (second tranche)
Dominica	UNDP	DMI/PHA/61/INV/17	Terminal CFC phase-out management plan (fourth tranche)
Dominica	UNEP	DMI/PHA/61/TAS/18	Terminal CFC phase-out management plan (fourth tranche)
Ecuador	UNEP	ECU/PHA/61/TAS/48	National CFC phase-out plan (third tranche)
Ecuador	UNEP	ECU/PHA/61/TAS/50	National CFC phase-out plan (fourth tranche)
Ecuador	UNEP	ECU/PHA/61/TAS/52	National CFC phase-out plan (fifth tranche)
Egypt	UNIDO	EGY/PHA/60/INV/101	National CFC phase-out plan (fourth and fifth tranches)
Equatorial Guinea	UNEP	EQG/PHA/57/TAS/04	Terminal phase-out management plan (first tranche)

Eritrea	UNEP	ERI/PHA/63/TAS/08	Terminal phase-out management plan for CFCs (second tranche)
Eritrea	UNIDO	ERI/PHA/63/INV/09	Terminal phase-out management plan for CFCs (second tranche)
Grenada	UNEP	GRN/PHA/59/TAS/15	Terminal phase-out management plan (third tranche)
Guinea	UNIDO	GUI/PHA/60/INV/24	Terminal phase-out management plan (second tranche)
Haiti	UNDP	HAI/PHA/58/INV/14	Terminal phase-out management plan for Annex A Group I substances (first tranche)
Haiti	UNEP	HAI/PHA/58/TAS/15	Terminal phase-out management plan for Annex A Group I substances (first tranche)
Honduras	UNEP	HON/PHA/59/TAS/32	Terminal phase-out management plan (second tranche)
India	IBRD	IND/PHA/58/INV/434	CTC phase-out plan for the consumption and production sectors: 2009 annual programme
Iran (the Islamic Republic of)	UNIDO	IRA/HAL/63/TAS/198	Halon management programme
Iraq	UNEP	IRQ/PHA/63/TAS/14	National phase-out plan (second tranche)
Iraq	UNEP	IRQ/PHA/58/TAS/10	National phase-out plan (first tranche)
Iraq	UNIDO	IRQ/FOA/57/INV/06	Conversion from CFC-11 to methylene chloride in the production of flexible slabstock foam at Al Hadi Co.
Iraq	UNIDO	IRQ/REF/57/INV/07	Replacement of refrigerant CFC-12 with isobutane and foam blowing agent CFC-11 with cyclopentane in the manufacture of domestic refrigerators and chest freezers at Light Industries Company
Iraq	UNIDO	IRQ/PHA/63/INV/15	National phase-out plan (second tranche)
Iraq	UNIDO	IRQ/PHA/58/INV/09	National phase-out plan (first tranche)
Lao People's Democratic Republic (the)	France	LAO/PHA/61/INV/21	Terminal phase-out management plan (second tranche)
Mauritania	UNEP	MAU/PHA/57/TAS/21	Terminal phase-out management plan for CFCs (second tranche)
Montenegro	UNIDO	MOG/PHA/58/INV/06	Terminal phase-out plan for CFCs (second tranche)
Mozambique	UNEP	MOZ/PHA/59/TAS/18	Terminal phase-out management plan (second tranche)
Nepal	UNDP	NEP/PHA/57/INV/26	Terminal phase-out management plan (second tranche)

Peru	UNIDO	PER/PHA/65/INV/44	Terminal phase-out management plan for Annex A Group I substances (first tranche)
Qatar	UNEP	QAT/PHA/59/TAS/14	Terminal phase-out management plan (second tranche)
Qatar	UNIDO	QAT/PHA/59/INV/13	Terminal phase-out management plan (second tranche)
Rwanda	UNEP	RWA/PHA/57/TAS/16	Terminal phase-out management plan for CFCs (second tranche)
Samoa	UNDP	SAM/PHA/57/INV/13	Terminal phase-out management plan (second tranche)
Saudi Arabia	UNEP	SAU/PHA/61/TAS/09	National phase-out plan (second tranche)
Saudi Arabia	UNIDO	SAU/PHA/61/INV/10	National phase-out plan (second tranche)
Serbia	UNIDO	YUG/PHA/60/INV/36	National CFC phase-out plan (fourth and fifth tranches)
Serbia	UNIDO	YUG/PHA/60/TAS/35	National CFC phase-out plan (first tranche)
Sierra Leone	UNEP	SIL/PHA/61/TAS/23	Terminal phase-out management plan (second tranche)
Swaziland	UNEP	SWA/PHA/59/TAS/15	Terminal phase-out management plan (second tranche)
Syrian Arab Republic	UNIDO	SYR/PHA/58/INV/99	National CFC phase-out plan (third tranche)
Tanzania (the United Republic of)	UNDP	URT/PHA/58/INV/28	Terminal phase-out management plan (second tranche)
Tanzania (the United Republic of)	UNEP	URT/PHA/58/TAS/27	Terminal phase-out management plan (second tranche)
Thailand	IBRD	THA/PHA/60/INV/154	National CFC phase-out plan: 2010-2012 annual implementation plan
The former Yugoslav Republic of Macedonia	UNIDO	MDN/PHA/59/INV/28	Terminal phase-out management plan for CFCs (fifth tranche)
Tunisia	UNIDO	TUN/PHA/68/INV/54	National ODS phase-out plan (second tranche)
Uruguay	UNDP	URU/PHA/60/INV/54	Terminal phase-out management plan for Annex A Group I Substances (third tranche)
Yemen	UNEP	YEM/PHA/60/TAS/35	National ODS phase-out plan (second tranche)
Yemen	UNIDO	YEM/PHA/60/INV/36	National ODS phase-out plan (second tranche)

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71st Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

RESOURCE MOBILIZATION FOR CLIMATE CO-BENEFITS

Final Report

2013

Contents

Executive Summary

The issue of resource mobilization has been under discussion by the Executive Committee for several years. UNDP submitted to the 57th meeting a request for a technical assistance project for mobilizing resources to maximize climate benefits at a total cost of US$ 250,000. At the 58th meeting UNDP re-submitted a more detail proposal describing project opportunities in two areas:

1. Bank management and ODS disposal projects, particularly related to end of life management of appliances. For example there were clear opportunities to use linkages with other programmes such as energy efficiency actions under the GEF to identify projects and leverage access to old appliances in order to ensure appropriate end-of-life management and tap into country specific initiatives towards energy savings gains in appliances replacement national programmes.
2. Co-funding opportunities in HCFC phaseout where additional climate benefits can be gained by additional investment in technology selection.

In view of lack of guidance on how climate benefits were to be calculated and whether costs could be considered incremental under the MLF, and according to ExCom Decision 58/37(g) UNDP re-submitted again the proposal (at the same total cost) for consideration of the 59th Meeting. The initial proposal was amended to take recent developments at that time into account and, in particular to allow for UNDP to proceed in parallel to the ongoing work on a possible Facility for Additional income (FAI) under the MLF. Matching co-funding from UNDP resources at a level of US $250,000 were mobilized (ExCom document 57/18).

As such, the activities were amended in two phases:

1. Phase I, which could commence immediately at that time which would provide concrete learning by doing case studies from 4 distinct pilot project proposals. These case studies would be of value irrespective of the eventual design of any FAI. The projects proposed included ODS destruction/end of life management such as the example for Ghana (illustrated in this report).
2. Phase II, which could have could have commenced at a later stage, would involve UNDP collectively analyzing these case studies in the context of any MLF mechanism for resource mobilization. The timing of this phase can align with future studies of any FAI.

At the 60th meeting there was a request to Secretariat to present the report of the Executive Committee in the FAI to the 30th OEWG, UNDP was requested to make a presentation of its issues paper developed on the Facility at the following events:

Date	Event	Place
30 March 2009	Side event at 57th ExCom meeting	Montreal, Canada
14 June 2009	Seminar on Environmentally Sound Management of Banks of Ozone Depleting Substances (Decision XXI/2)	Geneva, Switzerland
5 November 2009	Side event at 21st MOP “The Montreal Protocol and Mechanisms to Access the Carbon Markets”	Port Ghalib, Egypt

Funds to cover for staff time from the MDG Carbon Facility at UNDP for the preparation of several presentations and the issue paper, as well as travel, were covered by UNDP. Issue paper prepared can be accessed at http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Ozone%20and%20Climate/Issue_brief_2009_The_Facility_for_Additional_Income.pdf and also included as an Annex 1.

The Executive Committee after several meetings decided to drop the pursue of the FAI, and through Decision 63/20, approved US $200,000 plus agency fees for implementing agencies. For instance, for UNDP and UNIDO, the US $ 200,000 given to each agency were for the preparation of 4 and 2 projects respectively. UNDP was requested to prepare four pilot demonstration projects in the refrigeration and air-conditioning manufacturing sector to examine technical interventions to improve energy efficiency, national policy and regulatory measures to sustain such interventions in order to maximize the climate impact of HCFC phase-out, to be funded as resource mobilization activities.

UNDP sought bilateral cooperation and provided the Committee with steps pursued regarding such project ideas and informed on resources mobilized. Further to that, the bilateral donor requested UNDP remove those projects from the MLF funded Resource Mobilization (RM) exercise and continue them under bilateral cooperation only.

Meanwhile, UNDP progressed in other fronts, especially in cooperation with the GEF and CCAC in Indonesia (Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning- PENHRA) and Maldives (Feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives, with district cooling technology).

In view of the request of the Committee at its 70th meeting to provide copies of products/proposals and a more elaborate report, UNDP is seeking approval by the Committee to replace activities presented in previous reports with two projects mentioned above, i.e. for Indonesia and Maldives. UNDP believes the projects will fulfill the requirements under the Decision 63/20.

This report provides as attachments, both project proposals. In addition, the report also provides information of the model pursued and lessons learned. The table below provides the budget breakdown showing the current situation of expenses incurred in the pursuit of the Decision 63/20, for consideration of the Executive Committee.

Table: Resource Mobilization related costs (amounts in US$)[1]

Project	*Total Budget (excluding fees)*	*Total Expenses*	*Budget Balance*	*Remarks*
Development of GEF project "Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning" in Indonesia	-	150,000	(150,000)	UNDP staff and experts time and travel related to be cost recovered from RM project
MLF Resource Mobilization project GLO/SEV/63/TAS/306	200,000	64,768	135,232	MPU staff time, travel technology workshops and participation in meetings related costs
Project proposal and related meetings with CCAC partners and Maldives	-	30,000	(30,000)	Staff time and travel related to be cost recovered from RM project
Total	**20,000**	**244,768**	**(44,768)**	

[1] Please note that UNDP will have to fund the deficit of about $45K above, not taking into consideration previous proposals for development of projects under bilateral cooperation (USA).

Conclusions Drawn from the Resource Mobilization (RM) Exercise

From the UNDP report entitled Catalyzing Climate Finance - A Guidebook on Policy and Financing Options to Support Green, Low-Emission and Climate-Resilient Development (Version 1.0, UNDP, 2011)[2], and from the MLF RM exercise, some general and specific conclusions can be drawn which we found pertinent and worth summarizing.

General conclusions

1. Over 90 percent of climate change finance is sourced from private markets (venture capital, asset financing, etc.). However, public finance is critical to removing barriers to climate technologies and attracting direct investment.
2. Developing the capacity of low-income countries to create conditions that enable public and private investment flows to address pressing environmental problems is a key priority to finance the transition toward a low-emission climate-resilient society.
3. Rather than being a problem of capital generation, the key challenge of financing the transition toward a low-emission and climate-resilient society is to redirect existing and planned capital flows from traditional high-carbon to low-emission, climate-resilient investments.

Specific conclusions

UNDP drawn the following conclusions specifically related to the MLF funded Resource Mobilization exercise.

1. Public finance is critical to removing barriers to climate technologies and attract direct investment and the MLF and the GEF as well as bilateral donors have an important role to play. The experience showed that without the added MLF incentive, access to other sources of funds to prepare the mentioned projects with HPMP links would not happen. UNDP also found that bilateral partners as well funding from the Climate and Clean Air Coalition, CCAC, have an important role to play.
2. While the GEF is an important partner regarding the mobilization of additional resources for maximization of climate benefits, lessons learnt from “Chillers projects” related submissions to the GEF indicated that it is necessary to have project cycles to be somehow synchronized as to avoid long delays in funding (with loss of co-financers and lack of interest of clients in developing countries).
    a. In average, GEF full size project development processes may take 3 to 8 years, depending on many factors, including but not limited to GEF availability of resource to respond to large pipeline of climate mitigation projects, including from previous replenishment cycles. In view of the long waiting list of projects, prioritization of pipeline entry by implementing agencies is an issue to overcome. If MLF and GEF projects cycle are synchronized and depending on the will of different partners including GEF Council members, the duration can be

[2] Available on http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/environmental-finance/low-emission-climate-resilient-development/in-focus/catalyzing-climate-finance/UNDP-Financing-v3-web.pdf

substantially reduced and MLF funds for HPMPs can be used as the source of co-finance required by GEF and GEF funds can be used to bring the additional climate benefits desired.

b. The GEF VI Chemicals Strategy is a good example to look into. It addresses HPMP links outside the Climate Mitigation focal area (outside STAR) and projects would fall under Strategic Objective 2: reduce the prevalence of harmful chemicals and waste (complete de phaseout of ODS in CEITs and assist Article 5 countries under the Montreal Protocol to achieve climate mitigation benefits).

c. Lack of understanding of MLF projects and GEF project objectives which are different may cause GEF Council members to block approval of HPMP linked projects, an additional risk to be considered.

d. UNDP believes that the approach used in Indonesia can be successfully replicated provided those bottlenecks are resolved at the institutional level.

3. Climate related fund raising expertise is not currently funded by the MLF for the agencies' Montreal Protocol Units, whose staff were recruited to prepare and implement eligible MLF projects. It is important that the Executive Committee looks into this new role which is outside MLF mandate (and agreed fees) if agencies are to be requested to replicate these projects beyond the RM funded work.

4. It is clear that for UNDP to succeed in the RM exercise, a different Business Model was required internally to enable UNDP to mobilize additional resources for maximization of climate benefits. There were additional costs involved mostly for cost recovery of non-eligible work. Therefore, project preparation funding for RM by the MLF was critical to the success of this exercise and at the same time to avoid to cross-subsidization of funds.

5. CCAC experience was successful with the approved feasibility study for Maldives, with an "out of the box" approach regarding technology choices, such as District Cooling. UNDP believes that once the study is finalized this demonstration project could be used by other countries, specially SIDS.

Introduction

The issue of resource mobilization has been under discussion by the Executive Committee for several years. The reason UNDP is bringing the history back on the table is to highlight the fact that the process to agree on a model and implement it, on top of getting the MP bodies, including the agencies and countries ready to absorb different models, is lengthy and costly. At the same time, it was important to gain experience and better understand the evolving business models.

The peak timeframe for implementation of HPMP Stage-I in A5 countries is during 2012-2015. During the implementation of HCFC phase-out in enterprises/sub-sectors/sectors involved in HPMP Stage-I, there is a unique window of opportunity to tap into if time permits to phase-in alternative technologies that are low-GWP, safe, cost-effective and energy-efficient, and thus maximize climate benefits of HCFC phase-out in HPMP Stage-I and beyond. his window is narrow and needs to be fully leveraged, because the enterprises would already be in the process of plant/process modifications during HCFC phase-out, and they may be reluctant to carry out plant/process modifications again/frequently.

For the countries that needed to address refrigeration and AC manufacturing sectors at Stage I, this window is very narrow due to time constraints.

In the Air Conditioning and Refrigeration Sectors, additional opportunities exist for maximizing climate benefits through energy-efficiency enhancements, because of the intense energy use by the equipment, which contributes 60-90% to the lifecycle emissions.

Technical interventions needed to achieve additional climate benefits such as energy-efficiency enhancements, outside of the objective of phasing out HCFCs, may not be eligible for funding from the MLF.

Taking the above into account, UNDP has sought to mobilize resources from bilateral and multilateral sources as well as the private sector, which would be applied at the enterprise/sub-sector/sector level, to achieve/maximize climate benefits, beyond those that would be normally available through funding for HCFC phase-out alone.

Through Decision 63/20, the Executive Committee (ExCom) approved US $200,000 plus agency fees for UNDP, for the preparation of four pilot demonstration projects in the refrigeration and air-conditioning manufacturing sector to examine technical interventions to improve energy efficiency, national policy and regulatory measures to sustain such interventions in order to maximize the climate impact of HCFC phase-out, to be funded as resource mobilization activities on the following conditions:

(i) That UNDP inform the Executive Committee of the four proposals specified above no later than the 67th meeting, noting that this would be submitted for information only and that these proposals would not be funded under the Multilateral Fund;

(ii) That an interim report would be provided at the 66th meeting, which would include an update on the activities so far undertaken and address the following elements:

a. Additionality of the projects proposed;
b. Transparency and good governance, as well as covering the cash flow;
c. Assurance that these projects would avoid perverse incentives for countries;
d. Exploring possibilities of profit-sharing, including return of funds to the Multilateral Fund;

e. *Ensuring sustainability of the projects proposed;*
f. *Avoidance of duplication of similar projects;*
g. *Information on transaction costs.*

At its 69th meeting the Executive Committee considered UNDP's report and decided (decision 69/4):

(i) To note the report on resource mobilization for climate co-benefits submitted by UNDP contained in document UNEP/OzL.Pro/ExCom/69/5;

(ii) To request UNDP to provide by the 71st meeting:

a. *Copies of the proposals or a description of the projects initiated with funds provided under this project;*
b. *The final report providing more detailed information on the processes and approaches used to mobilize additional resources, as well as lessons learned related to this exercise, ensuring that the elements described in decisions 63/20(a)(ii) and 68/4(c)(ii) were included, where this information was available;*

(iii) To request UNDP to provide a report to the Executive Committee on the results of the projects funded from the resource mobilization exercise once they had been implemented.

The expected outcome of the funding approved for UNDP for resource mobilization, was initially the development of the above four proposals, demonstrating the maximization of climate benefits during HCFC phase-out. It may be noted that preparing such proposals is meaningful only if the corresponding financing for the proposals is also mobilized, to ensure resources to successfully implement these proposals, and serve as an example of how such projects could be replicated in future. Before embarking in a full-fledged effort UNDP considered several paths depicted in the following sections of this report.

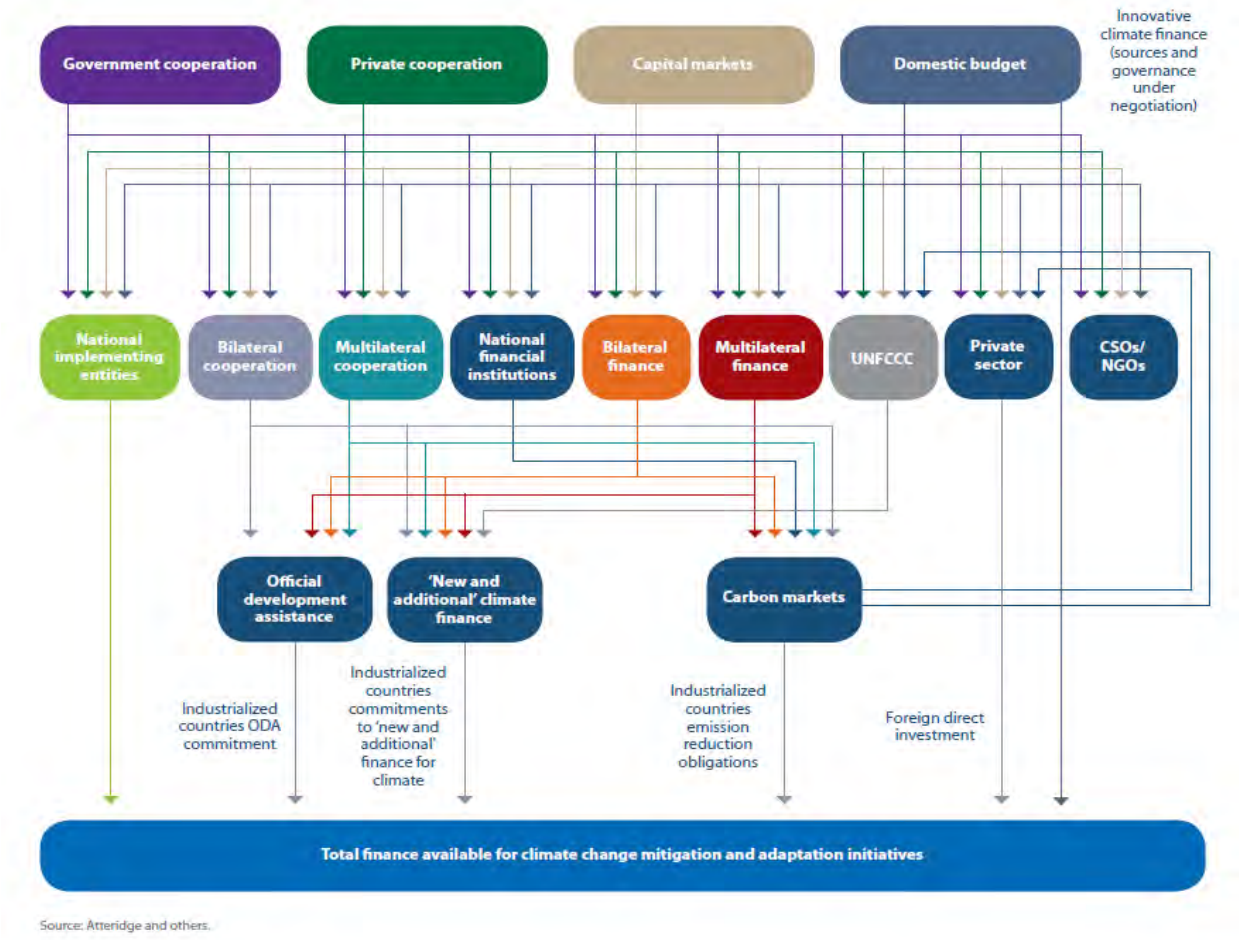
Overview

The Processes and Approaches Used to Mobilize Additional Resources

Montreal Protocol Unit ("MPU") at UNDP has been working with UNDP-GEF Climate Change and the MDG Carbon Facility teams on finding ways to finance MP projects with a view to maximize climate co-benefits. Since 2009 UNDP has been contributing to the discussions regarding the Special Funding Facility for Additional Income from Loans and Other Sources (MLF ExCom Decision 57/37). These contributions have resulted in a number of lessons learnt and guided UNDP on the next steps to take.

Catalyzing Climate Finance

UNDP's experience and contributions to climate finance for sustainable development over the years is summarized in a UNDP guidebook called *Catalyzing Climate Finance*[3]. The figure below depicts sources, agents and channels for climate finance[4].



[3] Catalyzing Climate Finance- A Guidebook on Policy and Financing Options to Support Green, Low-Emission and Climate-Resilient Development —Version 1.0, UNDP, 2011.
http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/environmental-finance/low-emission-climate-resilient-development/in-focus/catalyzing-climate-finance/UNDP-Financing-v3-web.pdf

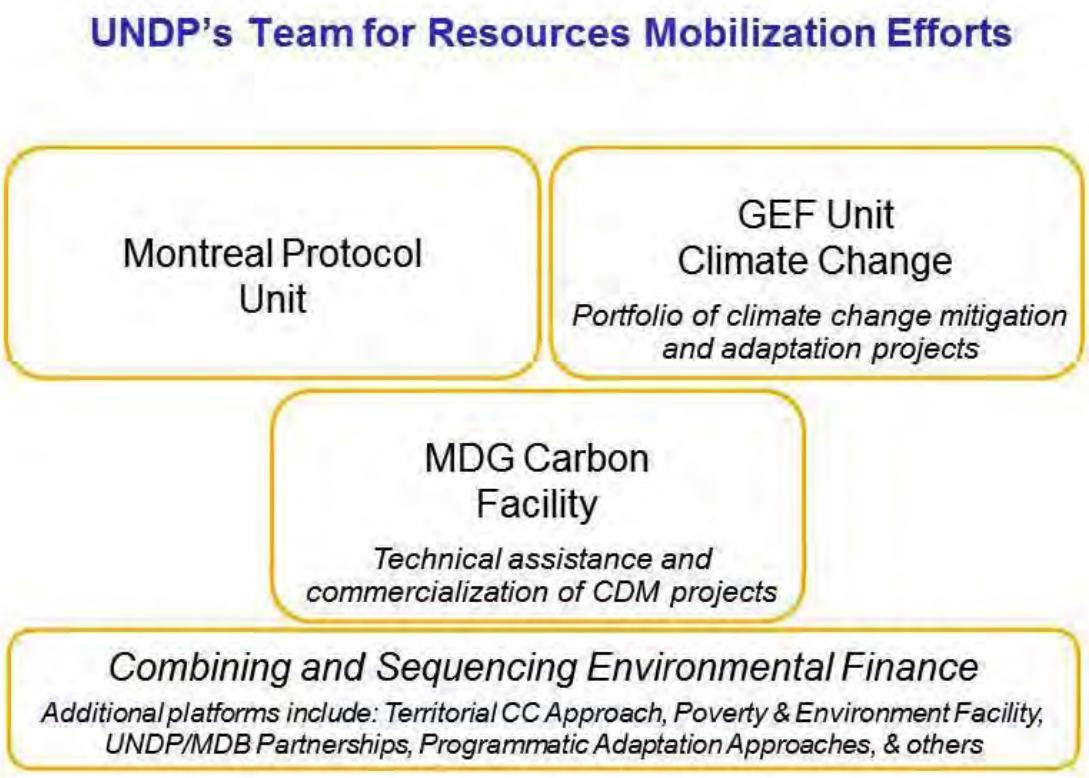
[4] page 63 of the reference 1.

Some lessons learnt and views expressed in the UNDP report which we find relevant to share are below:

- *"Rather than being a problem of capital generation, the key challenge of financing the transition toward a low-emission and climate-resilient society is to redirect existing and planned capital flows from traditional high-carbon to low-emission, climate-resilient investments.*
- *Only a limited number of developing countries are currently benefitting from these new financing opportunities, as their markets are not yet in a position to attract climate investments. Contrary to the view that a post-2012 global climate policy regime should focus on the largest GHG-emitting countries the guidebook argues that a failure to provide fair access to climate finance to all developing countries would have severe political, financial and climate change consequences.*
- *Developing the capacity of low-income countries to create conditions that enable public and private investment flows to address pressing environmental problems is a key priority to finance the transition toward a low-emission climate-resilient society.*
- *Throughout the entire policy evaluation and (country) selection exercise, it will be critical to involve all stakeholders, including representatives from the business and finance communities. In policy-dependent markets, investors need to be confident that governments are fully committed and have the capacity to implement policy change. Misgivings on government commitment or the effectiveness of chosen policy and regulations will have consequences on the cost of capital. The higher the risk associated with a given set of national policies and regulations, the higher the cost of capital charged by lenders, and the higher the returns required by equity investors for taking that risk.*
- *Climate finance is sourced either from capital markets or government budgets, and channeled through various multilateral and bilateral agencies, the UNFCCC and a multitude of private financial intermediaries*
- *Over 90 percent of climate change finance is sourced from private markets (venture capital, asset financing, etc.). However, public finance is critical to removing barriers to climate technologies and attracting direct investment."*

UNDP Business Model for Resource Mobilization Efforts

It was clear from the outset that the UNDP Montreal Protocol Unit (MPU) would need additional expertise to engage in the resource mobilization to maximize climate co-benefits of its work. Therefore, MPU approached the UNDP GEF-Unit team as well as the MDG carbon team, and brought to their attention the opportunity to combine and sequence different sources of funds to maximize climate co-benefits.



In conducting its preparatory work that culminated in the Resource Mobilization proposals, UNDP-MPU, the UNDP-GEF Climate change mitigation and MDG Carbon Facility teams studied the various sources, agents and channels identified in the figure above. As a result, the potential for finance which UNDP found applicable to the sectors under HPMP development and implementation, and worth pursuing were:

- **Carbon finance (considering current limitations); and**
- **ODA based assistance with private sector co-financing, either through the GEF and or bilateral channels.**

The follow up discussions were focused on pipeline prioritization, project development and submission process, in the regular project cycle, using expertise from MP, Climate and Carbon finance teams at UNDP, on a cost recovery basis. Each of the above bullet points will be addressed in turn.

Carbon Finance

The potential to address the full scope of climate benefits through the carbon markets

There are potentially 3 forms of interactions for ODS management with the carbon markets:

- Energy efficiency gains from HCFC phase-out
- Direct emission avoidance from HCFC phase-out
- Direct emission avoidance from ODS destruction

The applicability of different carbon markets to each of these three areas varies. Around the world, there are a number of different carbon markets in operation or under development, either taking the form of compliance or voluntary markets. The most established market is the Clean Development Mechanism (CDM). Recently, a number of new national or regional cap-and-trade mechanisms, such as in California, Australia, Brazil and India, with associated offset programmes have been established or are being established.

UNDP has noted that, currently, the relevance of carbon markets to the HPMPs appears to be primarily targeted towards climate benefits from energy efficiency At the same time, the contribution of energy efficiency climate benefits may be relatively minor in the key sectors in which HCFC phase-out will take place. This will likely result in small financial flows and make transactions costs a sensitive issue.

As such UNDP's commentary in 2009 and 2010 noted that, in aiming to develop carbon markets as a source of financing, the opportunity would be to seek include direct emissions from both HCFC phase-out *and* ODS destruction activities (collectively, 'ODS Direct Emissions'). UNDP noted that this departed from the mandate given by the Executive Committee at the time to focus the current work on HCFC phase-out (Decision XIX/6). However, UNDP noted that targeting ODS Direct Emissions would address the full range of climate benefits, with the largest greenhouse gas (GHG) impacts, and maximize the possible financial flows from the carbon markets.

UNDP Considerations on the Carbon Markets

UNDP's commentary in 2009 and 2010 on carbon markets and ODS management noted that ODS Direct Emissions were not recognized at the time by the oversight frameworks which create and drive the compliance carbon markets. Rather, they were new and innovative areas of the voluntary carbon markets. UNDP noted that the necessary oversight framework to ensure high quality, robust credits for ODS Direct Emissions was only beginning to be developed by certain voluntary carbon market standards, and the quality of these standards was not yet assured. Equally importantly, demand for credits from ODS Direct Emissions under the voluntary market was uncertain at the time, and the outlook for voluntary market demand was likely to remain low.

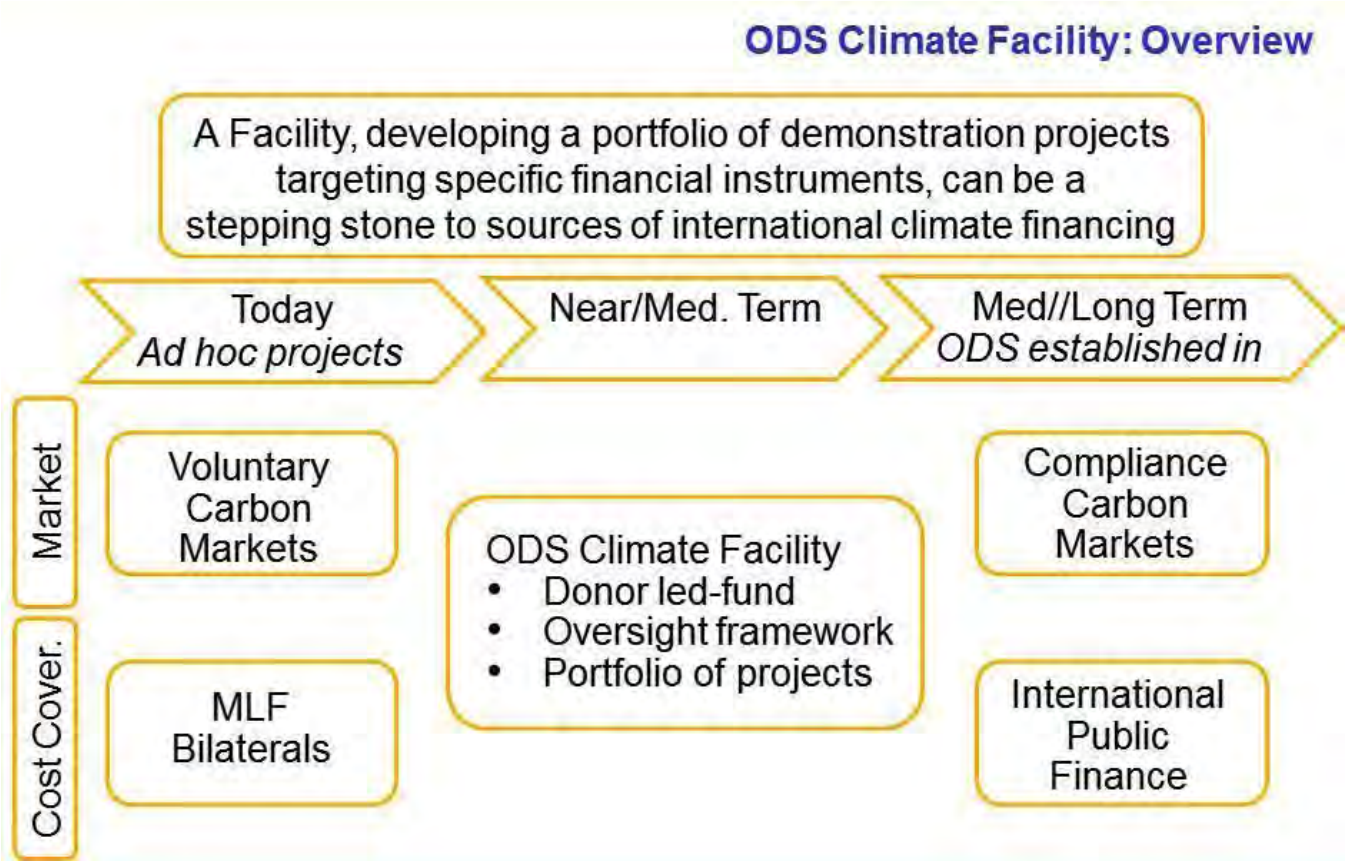
For these reasons, UNDP suggested in 2009, in the context of the design of the Facility for Additional Income (FAI), that consideration be given to redesigning the FAI to assist in the development of the then immature carbon markets for ODS Direct Emissions. UNDP termed this proposal the ODS Climate Facility. In the longer term, UNDP proposed that that the goal could be for ODS Direct Emissions to be part of the compliance markets, and for the a price to

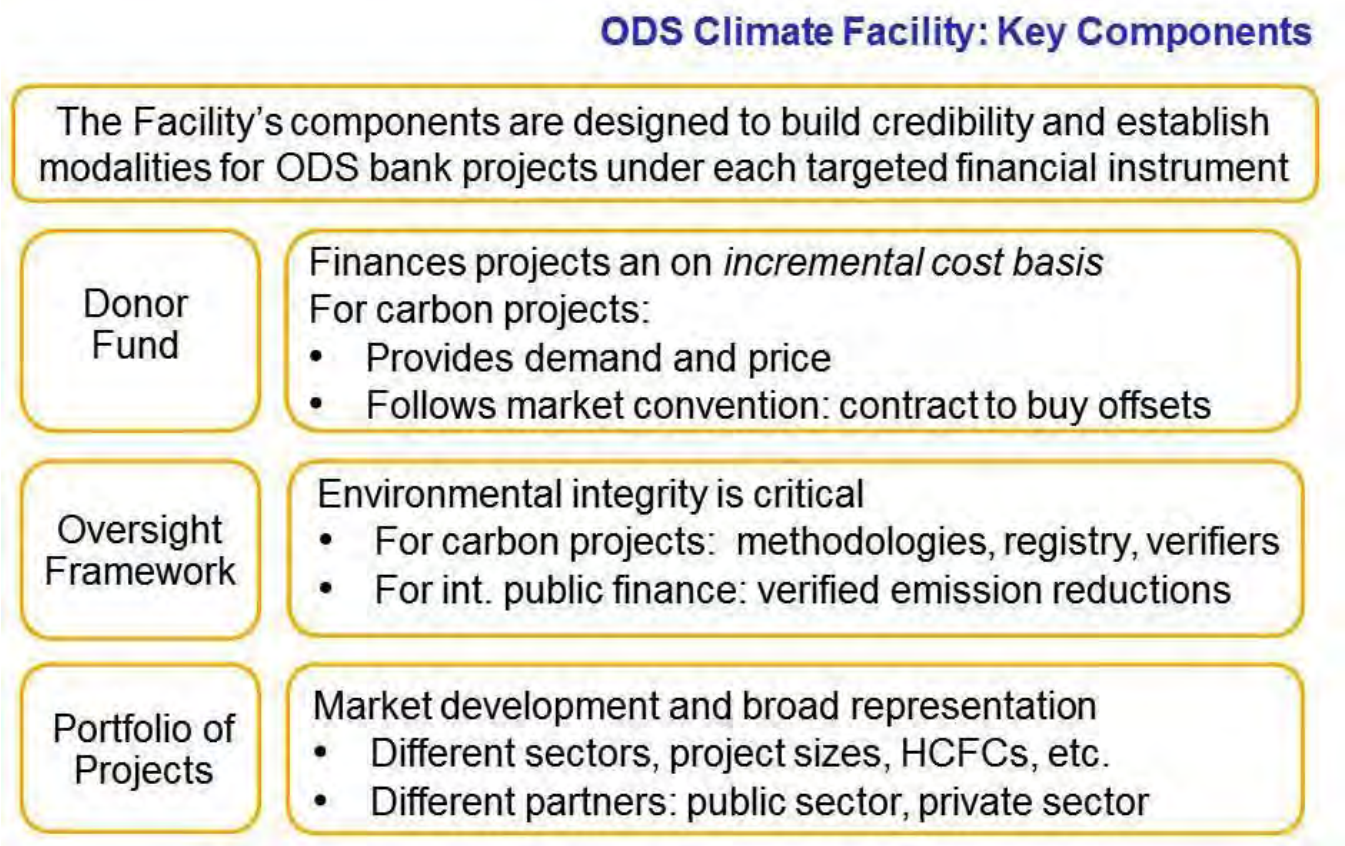
be placed on carbon related to ODS management. The ODS Climate Facility could assist in achieving this objective.

At the 21st MOP in Egypt and other previous meetings(as below) UNDP made various presentations regarding the ODS Climate Facility. Document UNEP/OzL.Pro/ExCom/58/49 refers to a UNDP proposal on the ODS Climate Facility.

Date	Event	Place
30 March 2009	Side event at 57th ExCom meeting	Montreal, Canada
14 June 2009	Seminar on Environmentally Sound Management of Banks of Ozone Depleting Substances (Decision XXI/2)	Geneva, Switzerland
5 November 2009	Side event at 21st MOP "The Montreal Protocol and Mechanisms to Access the Carbon Markets"	Port Ghalib, Egypt

The two figures below show slides from UNDP presentation at those events, setting out the short, medium and long term stages of an ODS Climate Facility, as well as the activities of an ODS Climate Facility in helping to establish long term carbon markets for ODS Direct Emissions.





Carbon Market Developments

Since the ODS Climate Facility was proposed in 2009, the carbon markets have had mixed developments. On the one hand CDM, in particular, and the European Union Emission Trading Scheme (ETS), have seen prices fall due to over-supply and low economic activity. On the other hand, a number of developing countries, and states/regions within these countries, are moving ahead fast with their own ETSs such as China, Brazil, India, etc. These new ETS are potentially interesting sources of funding. An example is California, which has now set up its own ETS, and is a source of demand for ODS credits.

In the current market environment, UNDP believes many parts of the ODS Climate Facility remain quite relevant today. In effect the ODS Climate Facility proposed ad hoc pilots, followed by fund-based pilots, followed by the carbon market taking over in 2020. This approach still holds, particularly with the timing to have a new international climate change agreement in place for 2020.

- With the carbon offset markets (e.g. CDM) currently struggling with low prices, fund-based approaches to performance-based payments for emission reductions can act as a bridge during this difficult market period, until 2020, when a new global agreement is targeted to come into place. Funds also have the ability to more accurately pay the real incremental cost of the action.

- Another recent development in carbon finance is that there is more of a move to sector-wide, rather than project-by-project, approaches to mitigation. The ODS Climate Facility is well suited to piloting and sponsoring such sector wide initiatives.

Official Development Assistance (ODA)

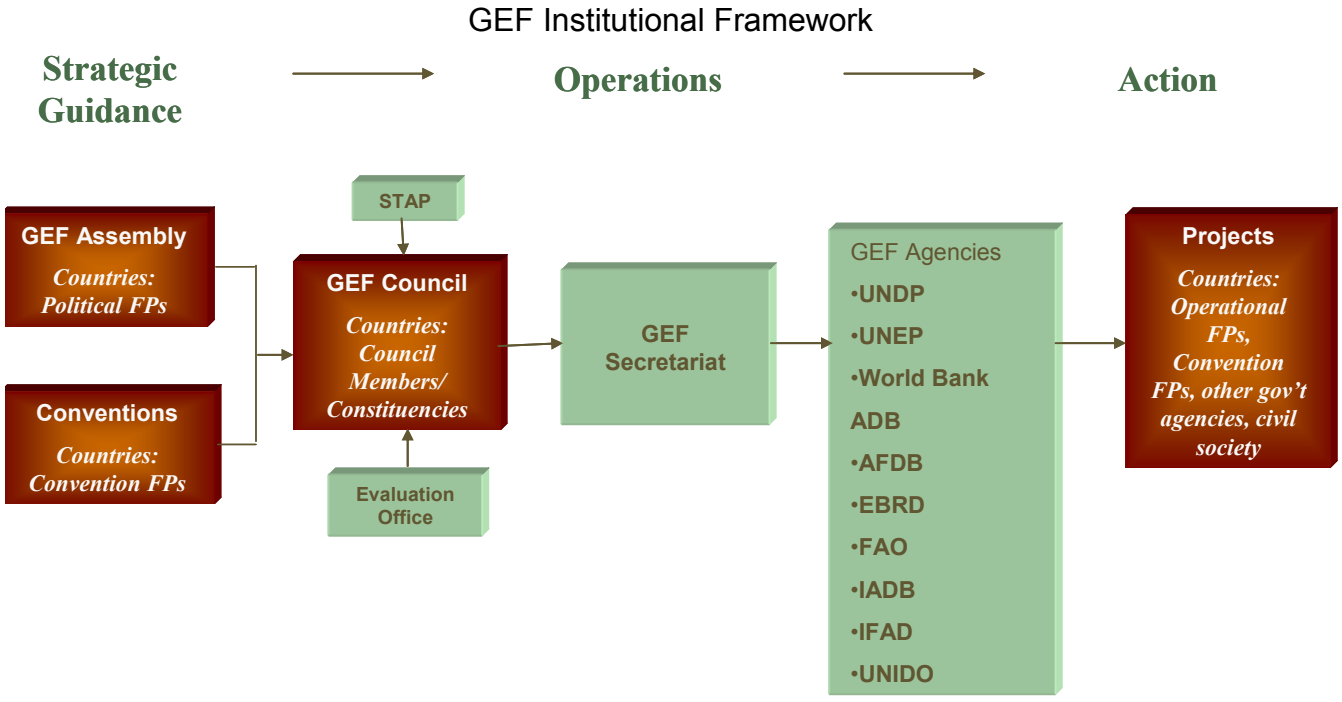
UNDP recognizes that the direction of the above suggested approaches may introduce apprehensions in governments that are not comfortable with a carbon market objective, and who would prefer other sources of co-financing, such as direct grants. However, it needs to be recognized that structures that are optimal for interaction with the carbon market may not be optimal for other forms of co-financing. Grant based co-financing will likely undermine any concurrent ERPA-based approach in the eyes of the carbon markets. A key challenge in the design of any project is in reconciling the interests of a number of disparate stakeholders simultaneously.

In view of that and due to its long engagement with the GEF as one of its Partner Agencies, UNDP looked at possibilities to engage the GEF as one of the solutions to the resource mobilization efforts to maximize climate co-benefits.

UNDP also looked at other bilateral partners as well funding from the Climate and Clean Air Coalition, CCAC.

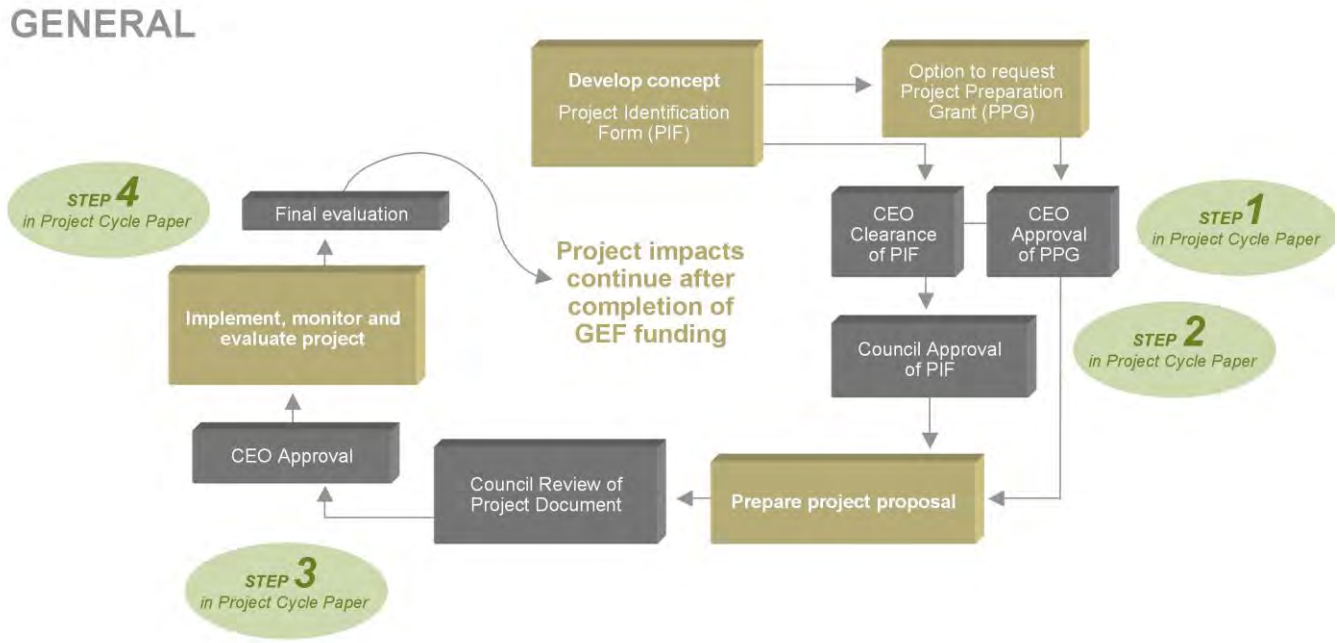
Global Environment Facility (GEF)

While the GEF is an important partner regarding the mobilization of additional resources for maximization of climate benefits, lessons learnt from Chillers submissions to the GEF indicated that it is necessary to have project cycles to be somehow synchronized as to avoid long delays in funding (with loss of co-financers and lack of interest of clients in developing countries). In average, GEF full size project development processes may take 3 to 8 years, depending on many factors, including but not limited to GEF availability of resource to respond to large pipeline of climate mitigation projects, including from previous replenishment cycles.



The GEF project approval cycle is defined in the GEF web page as the "stages that "a project must go through in order to be approved by the GEF and to receive allocation and/ or commitment of funding. There are 4 points in the project cycle where the GEF Secretariat and/or GEF Council play a role in reviewing and making decisions on providing funding for projects (referred to as Step 1, Step 2, Step 3 and Step 4 in the GEF Project Cycle Paper). These 4 decision points are depicted as gray boxes in the figure below. Olive colored boxes signify stages in the project cycle where the recipient country, together with its partner GEF Agency, takes the lead (www.theGEF.org)."

GEF Project Cycle



The new GEF Secretariat senior management is keen in looking into ways to remove barriers. Partner-implementing agencies have been in contact with the GEF Secretariat colleagues who are also eager to find good solutions. If synchronized and depending on the will of different partners including GEF Council members, the duration can be substantially reduced and MLF funds for HPMPs can be used as the source of co-finance required by GEF and GEF funds can be used to bring the additional climate benefits desired.

The resulting GEF VI Chemicals Strategy is a good example of this effort. It is proposed that HPMP links are dealt with outside Climate Mitigation focal area (outside STAR) and are part of Strategic Objective 2: reduce the prevalence of harmful chemicals and waste (complete de phaseout of ODS in CEITs and assist Article 5 countries under the Montreal Protocol to achieve climate mitigation benefits).

CCAC Trust Fund: The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants

Pollutants that are short-lived in the atmosphere such as black carbon, methane and hydrofluorocarbons (HFCs) are responsible for a substantial fraction of current global warming

with particularly large impacts in urban areas and sensitive regions of the world like the Arctic, and have harmful health and environmental impacts.

Addressing these short lived climate pollutants can have immediate, multiple benefits. Reducing them will protect human health and the environment now and slow the rate of climate change within the first half of this century.

Recognizing that mitigation of the impacts of short lived climate pollutants is critical in the near term for addressing climate change and that there are many cost effective options available , the governments of Bangladesh, Canada, Ghana, Mexico, Sweden and the United States and the United Nations Environment Programme (UNEP) have come together to initiate the first effort to treat these pollutants as a collective challenge.

Together, they have formed the Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants (CCAC), a unique initiative to support fast action and make a difference on several fronts at once: public health, food and energy security and climate. The Coalition is open to countries and non-state actors that are committed to taking action on short lived climate pollutants, and wish to join in this global effort.

The Coalition's initial focus is on methane, black carbon, and HFCs. At the same time, Partners recognize that action on Short lived climate pollutants must complement and supplement, not replace, global action to reduce carbon dioxide, in particular efforts under the UNFCCC. For more information please see http://www.unep.org/ccac/

One of the CCAC focal areas initiative focus on HFCs/standards. It calls to significantly reduce projected growth of high-GWP HFCs by mobilizing the private sector, civil society, international organizations, and governments to[5]:

- Promote development, commercialization, and adoption of climate-friendly alternatives;
- Encourage the uptake of climate-friendly alternatives that support national, regional, and global policies and approaches;
- Overcome barriers to technology deployment, including supporting revisions standards to allow for the uptake of climate-friendly alternatives;
- Encourage responsible refrigerant management and better equipment designs to minimize leaks and emissions;
- Share information and experience on policy options to reduce use and emissions;
- Focus on HFCs produced for use in air conditioning, refrigeration, foam products, aerosols, fire protection, and solvents.

The Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants is a partnership of governments, intergovernmental organizations, representatives of the private sector, the environmental community, and other members of civil society. The Coalition is government-led, but is highly cooperative and voluntary.

Since the Coalition's launch in February 2012, the partners have been working to identify quick-start actions that will ensure rapid delivery of scaled-up climate and clean air benefits by reducing key short-lived climate pollutants (SLCPs), including methane, black carbon and hydrofluorocarbons (HFCs).

[5] Reference: Newberg, C. and Thompson, J. presentation to the CCAC Working Group 24th July 2013 in Mexico City.

These initiatives or “focal areas” for action-oriented work seek to promote near-term reductions of SLCPs at a substantial scale worldwide and engage high level stakeholders.

At the first meeting of the CCAC High Level Assembly, on 24 April 2012 in Stockholm, an initial tranche of five initiatives was agreed upon for rapid implementation, as follows.

- Reducing Black Carbon Emissions from Heavy Duty Diesel Vehicles and Engines

The Coalition will work to reduce the climate and health impacts of black carbon and particulate matter (PM) emissions in the transport sector.

- Mitigating Black Carbon and Other Pollutants From Brick Production

This initiative will focus on addressing emissions of black carbon and other pollutants from brick production to reduce the harmful climate, air pollution, economic, and social impacts from this sector.

- Mitigating SLCPs from the Municipal Solid Waste Sector

The Coalition will work to address methane, black carbon, and other air pollutants emissions across the municipal solid waste sector by working with cities and national governments.

- Promoting HFC Alternative Technology and Standards

For this initiative, governments and the private sector will be targeted to address rapidly growing HFC emissions, which could account for as much as 19% of carbon dioxide (CO_2) emissions by 2050 if left unchecked.

- Accelerating Methane and Black Carbon Reductions from Oil and Natural Gas Production

The Coalition is seeking to work with key stakeholders to encourage cooperation and support the implementation of new and existing measures to substantially reduce methane emissions from natural gas venting, leakage, and flaring.

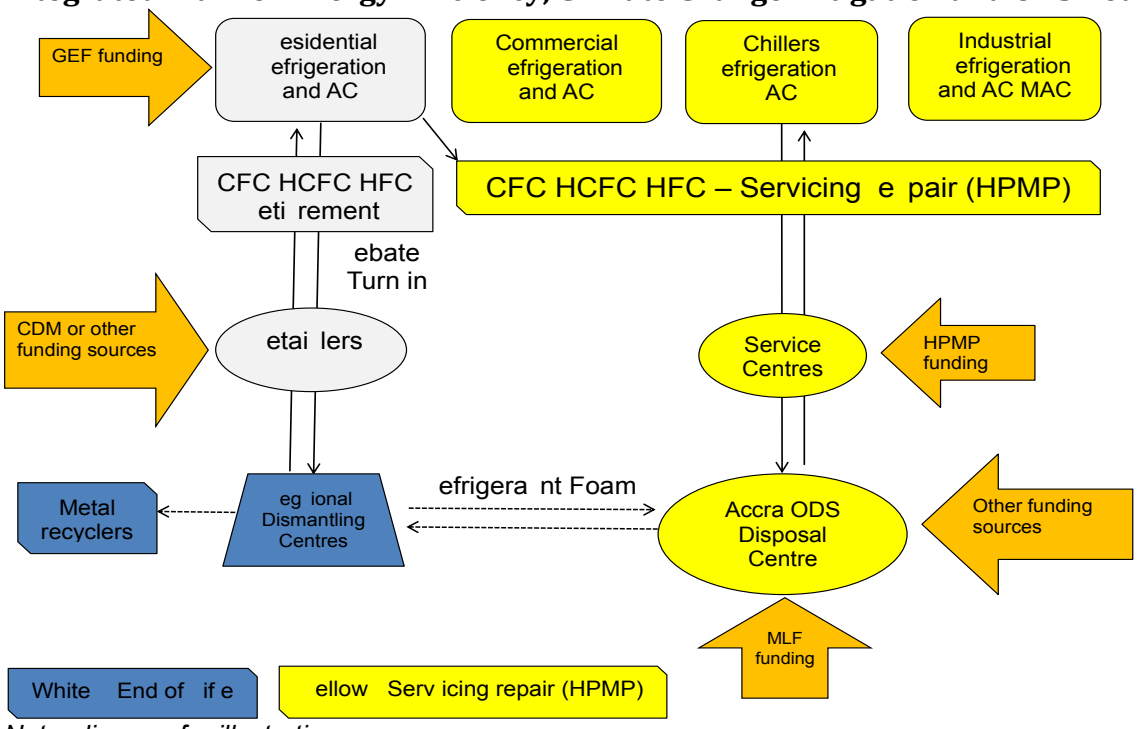
For more information please see http://www.unep.org/ccac/

Combining and Sequencing of Environment Finance Across Funding Sources – some examples

Some examples of integrated approaches used by UNDP, combining and sequencing sources of funds including multilateral, bilateral private sector and government contributions are shown below.

GHANA

Integrated Plan for Energy Efficiency, Climate Change Mitigation and ODS Reduction



Note: diagram for illustration purposes

Status of Ghana project regarding integrated plan:

July 2008	Approval of GHA/PHA/55/PRP/27 – PRP for HPMP, UNDP/Italy Bilateral cooperation
June 2009	Stakeholder meeting to finalize the HPMP further to which the "*Integrated Plan for Energy Efficiency, Climate Mitigation and ODS Reduction for the Refrigeration and Air Conditioning Sector in Ghana"* was presented to all stakeholders (including EPA, Energy Commission, …)
July 2010	Approval of GHA/PHA/61/INV/30 – HPMP First Tranche
April 2011	Approval of GHA/DES/63/DEM/33 -- Pilot demonstration project on ODS waste management and disposal
May 2011	GEF Secretariat CEO-Endorsement of "SPWA-CC Promoting of Appliance Energy Efficiency and Transformation of the Refrigerating Appliances Market in Ghana" (http://www.thegef.org/gef/node/4287)
July 2012	Approval of GHA/PHA/67/INV/34 – HPMP Second Tranche

Examples of Proposals Prepared Using Funds Under Approved MLF Resource Mobilization Budget

UNDP selected the air conditioning and refrigeration sector due to high potential of energy efficiency gains with corresponding decrease in carbon dioxide emissions. The refrigerant market is expected to grow at a compound annual growth rate of 5.2%, over the next five years and reach 1.6 million metric tons by 2018. During the implementation of HCFC phase-out in enterprises/sub-sectors/sectors involved in HPMP Stage-I, there is a unique window of opportunity to phase-in alternative technologies that are low-GWP, safe, cost-effective and energy-efficient, and thus maximize climate benefits of HCFC phase-out in HPMP Stage-I and beyond.

Asia-Pacific, with its thriving economies and rapidly expanding manufacturing bases, is expected to experience highest consumption during the next five years. Therefore the focus of the project was on the countries of Asia-Pacific. Small Island States in the region are also very impacted by the selection of alternatives larger countries have and the challenges to manage consumption in the servicing sector, especially if high GWP and energy inefficient technologies are coming to their countries.

Therefore, UNDP focused on countries, in which it was either the lead agency or was the agency responsible for implementing HCFC phase-out in the particular sector.

The understanding from the beginning is that funds approved in the resource mobilization project were akin to project preparation costs and have been utilized to cover the incremental costs of staff time and travel, over and above their normal MP duties. In addition, the funds also covered incremental direct costs, such as workshops and meetings. Since UNDP MPU is a self-sustaining unit financed by MLF, which does not receive core funding from UNDP management, there was no other way that such additional resources could have been funded, except through external sources such as MLF, with a clearly defined purpose.

INDONESIA

Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning (PENHRA)

Different country situations and priority needs were considered and in collaboration with UNDP's GEF-Climate Change Mitigation team, a proposal was developed and submitted to GEF, for energy-efficiency enhancements in the Refrigeration and Air Conditioning Sectors in Indonesia. The proposal, under GEF's climate change focal area, and within Indonesia's STA (System for Transparent Allocation of Resources) allocation, has a projected grant funding of US$ 5.020 million.

The objective of the PENHRA Project is to improve energy efficiency of refrigeration and air conditioning (RAC) equipment and appliances manufactured and sold in Indonesia – aligned with the HCFC Phase-out Management Plan (HPMP) for Indonesia.Therefore, the project ,

- Focuses on energy efficiency enhancements in coordination with Indonesia's HPMP project in refrigeration and air conditioning manufacturing and import.
- Help manufacturers develop a range of energy efficiency technology enhancements to align with their choice of low Global Warming Potential (GWP) alternatives under the HPMP.

Indonesia plans to phase-out HCFC consumption in manufacturing in these two sectors, as part of its HPMP Stage-I. This project includes technical and policy interventions, which would enable the Indonesian government and industry to enhance energy-efficiency of air conditioning and refrigeration equipment, contributing to Indonesia's voluntary CO_2 emission reduction targets by 2020. The key element of the proposal is that the same stakeholders who would participate in Indonesia's HPMP Stage-I, would receive additional assistance to achieve higher energy-efficiencies in their products. The HPMP Stage-I funding for these sectors, has been shown as concrete co-financing for the GEF proposal.

The proposal has been approved by GEF Council at its 44th meeting in June 2013. Detailed documentation of the proposal is available at http://www.thegef.org/gef/project_detail?projID=4899.

The project objective of improved energy efficiency of Refrigeration and Air conditioning (RAC) equipment and appliances manufactured and used in Indonesia will be achieved with the fulfillment of the following focal area outcomes:

Outcome 2.1- Appropriate policy, legal and regulatory frameworks adopted and enforced for both manufacturing of Refrigeration and Air Conditioning (RAC) equipment and appliances;

Outcome 2.2 - Sustainable financing and delivery mechanisms established and operational for OEM (manufacturers) to adapt to the change in policy and regulatory frameworks.

These are in line with the GEF-5 climate change mitigation focal area objectives CCM-2. The goal of the project is reduction of greenhouse gas (GHG) emissions during the use phase of air conditioners (ACs) and refrigeration equipment in Indonesia.

This project is a unique demonstration of the combining and sequencing different sources of funding that target specific goals. The Multilateral Fund (MLF) for implementation of the Montreal Protocol has provided grant funding to Indonesia for compliance with the phase-out schedule for Hydrochlorofluorocarbons (HCFCs), through implementation of a performance-based HCFC Phase-out Management Plan (HPMP).

HCFCs are used as refrigerants in the air conditioning and refrigeration industry segments. Under the HPMP, these industry segments in Indonesia will phase-out HCFCs by 2015, by converting to non-HCFC technologies. During this changeover process, the RAC manufacturing sector has a one-time window of opportunity for technology conversions in conjunction with the phasing out of HCFCs, involving potentially intensive capital investments considering the long economic life of such investments. During this changeover phase, enterprises will need to make significant additional investments to enhance product design to produce improved energy efficiency equipment. The required additional costs must be borne by the enterprise and may need additional financial assistance from bank or financial institutions, since these additional costs for energy-efficiency enhancements are not eligible for funding through MLF.

Thus, the basic requirements to meet the HCFC phase-out are met through the technical and financial assistance from MLF, while, GEF funding requested in the proposed project would facilitate the realization of energy efficiency benefits while transitioning to non-HCFC technologies. Modifications in the existing production lines will be done to accommodate the enhanced energy efficiency features of specific RAC components that will make use of the new non-HCFC refrigerants.

Collectively, this combination and sequencing of funding sources will enable the RAC industry in Indonesia to simultaneously adapt low carbon technologies that enhance system energy efficiency performance and lead to maximize environmental benefits of the changeover. While transitioning from HCFCs to non-ODS alternatives under the HPMP, technical interventions to introduce safe low-GWP alternatives (reduced impact of refrigerants to climate change) and to improve energy efficiency (reduced GHG emissions through reduced energy consumption) can be most suitably and cost-effectively accomplished if implemented simultaneously with HPMP implementation timeframe.

Timely interventions to introduce optimum low-GWP, safe and energy efficient alternative technologies, thus would lead to maximization of environmental benefits through significant direct and indirect CO_2 emission reductions in Indonesia in the context of proposed project, HPMP implementation and Indonesia's voluntary CO_2 emission reduction targets. Thus, the proposed project enables Indonesia's A C industry to transform towards low carbon green growth pathways and also demonstrates efficient use of different sources of funding that are available internationally.

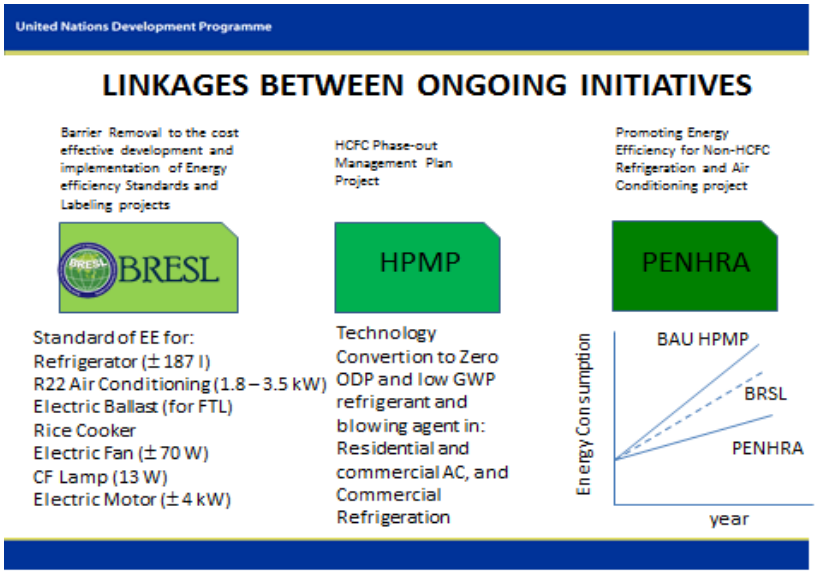
Project Components

- Policy and Institutional Frameworks for the RAC industry
- Public Awareness of Benefits of Energy Efficient RAC
- Promoting Investments for EE enhancement in the RAC Industry
- Technical Assistance for EE product design and training on EE RAC technologies

Technical Interventions

- Software for Heat-exchanger and RAC systems performance design
- Heat-exchanger fabrication for EE performance
- Fabrication facilities of improved shroud and mounting of fan
- Testing facilities improvements

The project will support investments on EE and other interventions, as explained earlier. The estimated GHG emission reduction impact : 4.35 million tons of CO_2e over 10 years.



The BRESL project- Barrier Removal to the cost effective development and implementation of Energy Efficiency Standards and Labeling is a regional project and has facilitated the revision of Indonesia's Ministerial Decree on EE Labeling and voluntary MEPS has been established.

Under this project the draft Technical Guidelines for 6 appliances developed and testing laboratories accreditation are in progress. Project implementation time frame – Jan09 – May14.

HPMP/MLF: Investments for conversion to HCFC free alternatives would be undertaken.

Mutually reinforcing goals – to contribute to sustainable adoption of lower-GWP technologies and Energy Efficient operations.

MALDIVES

Feasibility Study for District Cooling in Maldives to Avoid High-GWP HFCs

The Climate and Clean Air Coalition on Short Lived Climate Pollutants, CCAC has approved at its meeting in Mexico City, Mexico (July 2013), US$ 118,000, including agency fees to UNDP to conduct a feasibility study for replacing the existing population of HCFC/HFC based air conditioners in Malé, Maldives, with district cooling technology.

(a) Technical and economic feasibility of various alternative district cooling technologies and selection of optimum not-in-kind technology for elimination of HCFC/HFC use in the existing population of stationary air-conditioners in Malé, Maldives; and
(b) Establishment of cost estimates and financing plan.

Maldives is an archipelago of 1,192 coral islands, sizes ranging from 0.5 to 5 sq km, located in the Indian Ocean off the southwest coast of India. The islands are arranged in a necklace-shaped atoll chain about 860 km long and about 100 km wide, consisting of 20 administrative atolls. The population of Maldives is 350,000 persons (2012), of which the population located in Malé island is 150,000 (2012). Malé is the capital of Maldives and seat of the government. The key economic sectors in Maldives are Tourism and Fisheries.

The objective of the proposal is to conduct a feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives with a not-in-kind district cooling technology, featuring zero ODP, extremely low GWP, safe, and energy efficient refrigerants. This study, upon completion, would establish techno-economic feasibility for such a technology and also establish the related costs, financing and implementation plan. It is potentially relevant to technology choices being made in other countries with similar circumstances. This proposal will contribute to Maldives' national goals of carbon neutrality and HCFC phase-out by 2020. Therefore, the key expected results of this proposal are the review and selection of the optimum not-in-kind district cooling technology and establishment of costs and a financing plan for elimination of HCFC/HFC use in the existing population of air-conditioners in Malé, Maldives.

If the feasibility study and the recommendations therein are accepted and selected not-in-kind technology implemented, upon successful implementation, Maldives would eliminate the use of HCFCs/HFCs in stationary air-conditioners on Malé Island completely, allowing it to comply with its national targets of carbon neutrality and HCFC phase-out by 2020. It is expected that

the selected technology would also reduce the energy use in air conditioning by over 20% annually. This would be the first-of-its-kind demonstration project in the world, where national commitments and technological interventions coincide to produce a transformational change in Maldives.

One output of the feasibility study is the business model for operationalizing district cooling. This project would involve funding from various funding sources (e.g., Government, service utilities, international financial institutions, grant funds from international development finance institutions, special purpose funds like GEF, CCAC etc.). Exact structure of funding and management modalities would be available only after the study is completed and related consultations are concluded with different stakeholders. As in typical projects of this nature, in the next phase, equipment procurement, installation and commissioning and civil works (as required) would be undertaken at the implementation stage, possibly in a phased manner to cover target population, besides structuring the business operations. Specific details would be available once the feasibility study is completed.

The findings of this study can be utilized in other parts of Maldives which have residential islands and in resort islands, after assessment of feasibility. Further, other small island States and small nations facing similar challenges can adopt findings of this study. It may be noted here that findings of this study would be shared with other similar small island states that have started implementing the HCFC phase-out management plan. The outcomes of the study could be shared during the 3rd SIDS conference and during the MOP for other countries to opt for similar technologies to move away from growing HFC usage.

More details can be found in the project proposal in Annex 3.

Compliance with Other Provisions of ExCom Decision 63/20

Additionality of the proposed projects

During the development of proposed projects UNDP took into account the guidelines of different funding mechanisms such as M F and GEF with respect to 'additionality'.

The proposed projects specifically target outcomes that are additional to the HCFC phase-out objectives, either through use of further/emerging low-GWP alternatives or through achieving energy-efficiency enhancements or both, which are not normally eligible or funded by MLF. "Additionality" this context is intended to mean no double dipping (funding for the same outcomes again). It is very clear that MLF funds agreed eligible incremental costs of phasing out ODS and does not fund any other costs. The projects for which we mobilized funding, target either energy-efficiency improvements and/or introducing lower GWP alternatives than those that were funded by M F. There all these projects are clearly "additional" or incremental in terms of their outcomes.

In the case of the GEF project, Indonesia HPMP is considered as a baseline project and 'additional' GEF funding would facilitate the realization of energy efficiency benefits while transitioning to non-HCFC technologies. Modifications in the existing production lines will be done to accommodate the enhanced energy efficiency features of specific components of refrigeration and air conditioning that will make use of the new non-HCFC refrigerants. Collectively, this combination and sequencing of funding sources will enable the RAC industry in Indonesia to simultaneously adapt low carbon technologies that enhance system energy efficiency performance and lead to maximize environmental benefits of the changeover.

Transparency, good governance and covering cash flow

The United Nations Development Programme (UNDP) has a long-standing commitment to transparency, with UNDP country offices publishing financial, procurement and programme information on respective websites for more than four years. UNDP has developed and published an Information Disclosure Policy that makes clear our commitment to making information about our programmes and operations available to the public. The organization has also devoted considerable resources to adopting the International Public Sector Accounting Standards which are a significant step towards further enhancing UNDP's transparency and accountability.

UNDP implemented the transparency standard adopted by the International Aid Transparency Initiative (IATI) in a phased and cost-effective approach to provide better quality information to our partners and the public on UNDP's development work. The organization published the full IATI data set at open.undp.org in 2012 and is planning to move to automated reporting in 2013.

The funds mobilized would be managed and utilized in accordance with UNDP's rules and procedures and consistent with the agreements with the relevant donors. These funds would be accounted for and reported distinctly from MLF funds. It is not expected that the funding mobilized would be adequate to cover all costs, and therefore co-financing commitments from the participating enterprises to the extent necessary would be obtained.

The MLF funding provided to UNDP will be utilized for developing the proposals and for mobilization of additional financing, for covering costs and overheads that are additional to UNDP's normal work under the M F.

Avoiding perverse incentives

The technical and other outcomes for the sub-projects are clearly defined. The funds mobilized would be disbursed to the participating enterprises and/or other beneficiaries through performance-based agreements, with clear milestones, indicators and targets. The diligence as required in the agreements with donors will be duly carried out.

In UNDP's view, "Perverse incentives" is meant to clarify whether a project which receives funding in this manner, will revert back to the earlier technology after completion (since there is no legally binding international framework), and may be seek further funding for the same basic objective. The analogy is drawn from HFC-23 capture and destruction funding received by HCFC-22 producers under CDM, where there is a risk that after the end of the typical 10-year CDM contract, the producers might start releasing HFC-23 to the atmosphere again. Another example is to increase HCFC-22 production to increase release of HFC-23 to gain more CERs. From this perspective, projects being developed do not carry this risk, simply because increased energy-efficiency in products require plant modifications which are not reversible and market competition tends to make lower energy-efficiency products obsolete over time.

Profit-sharing and return of funds to MLF

The purpose of these resource mobilization efforts is to provide a guide/template on how such projects with multiple objectives and sources of financing can be developed and implemented. None of these projects envisage any revenue generation or profits. None of the external resources mobilized as a result of this effort, can be returned to the MLF. If there are any unutilized funds from the original US$ 200,000 provided by MLF, then these could be returned to MLF under the normal terms of agreement between UNDP and MLF.

Ensuring sustainability

Due diligence has been and will be carried out to ensure that the selected beneficiaries are technically and financially sound. It is also expected that co-financing from beneficiaries would be needed for most of the interventions planned. This will ensure sustainability. It may be also noted that preparing such proposals is meaningful only if the corresponding financing for the proposals is also mobilized, to ensure resources to successfully implement these proposals, and serve as an example of how such projects could be replicated in future. UNDP has completed all the required process to insure that the resource mobilization effort is a reality and projects can proceed.

A key commonality between past approaches and the current projects is to ensure that project beneficiaries are financially viable and sustainable. But this should be true for any project, whether MLF or outside MLF.

On the overall approach of resource mobilization, UNDP's views are that more institutional funding is critical to the continuation and wider scale of the approach. At the 21st MOP in Egypt and other meetings, including Executive Committee ones, UNDP has proposed "The Facility for Additional Income" (ODS Facility) as broader approach for the resource mobilization for

climate benefits. Document UNEP/OzL.Pro/ExCom/58/49, refers to UNDP proposal. Regarding its relevance today, we still believe the ODS Facility could be quite applicable. It would obviously require some adjustments to the current reality. The argument for the ODS Facility remaining relevant is in our view two-fold:

(i) Funds are a good modality now. With the carbon offset markets (e.g. CDM) currently struggling with very low prices, quite a few policymakers are looking at fund-based approaches to performance-based payments for emission reductions. So, for example, the TOR of the green climate fund has the ability to make performance based payments (to complement the carbon market doing so). Basically funds can act as a bridge during this difficult market period, until 2020, when a new global agreement comes into place and hopefully markets can pick things up. Funds also have the ability to more accurately pay the real incremental cost of the action.

(ii) Sectoral approaches. The other big development in carbon finance is that there is more of a move to sector-wide, rather than project by project, approaches to mitigation. So if something like the ODS Facility was to come about, it could sponsor sector wide initiatives.

Avoidance of duplication of similar projects

UNDP has taken care to ensure that the sub-projects and beneficiaries are selected where UNDP already has a clear mandate to work in the specific sectors/sub-sectors in context of the HPMP Stage-I in the relevant countries. UNDP will also ensure that overlaps with other similar initiatives from different sources of financing are avoided.

Further, Decision 63/20 is specific to UNDP and overlaps with other agencies in this regard, are not envisaged. UNDP will however be ready to coordinate with other agencies to avoid any duplication of efforts.

UNDP cannot control this element. If some other funding agency chooses, for whatever reasons, to fund our beneficiaries again, then the responsibility is of that funding agency. From our side, we only incorporate language in our agreements that the beneficiary will not seek funding for this objective again.

Information on transaction costs

Information on transaction costs would be available only upon completion of the sub-projects. The expected completion of these projects would be by end-2014.

The funds from the global project were/are being utilized for the following:

(a) Costs of MPU and UNDP staff time (from other teams) over and above their normal duties

(b) Costs of MPU and UNDP staff (from other teams) travel over and above the normal budgets/needs

(c) Costs of arranging meetings/workshops in several locations

(d) Costs of technical experts including time and travel, including internal cost recovery of time staff from other units have used to contribute/support the MPU effort.

The above costs are incremental to the “business-as-usual” scenario where only the core MP objectives of ODS phase-out are funded through agency fees and core unit costs. In most of the projects we have mentioned, energy-efficiency enhancements form bulk of the co-benefits

and are not eligible for funding under MLF. Thus the costs of preparing projects dealing with energy-efficiency enhancements are incremental to ODS phase-out alone.

In fact, this exercise does not differ much from the PRP exercise, except that instead of country specific PRPs as is the norm, this is a kind of global PRP.

Compliance with ExCom Decision 68/4 (ii)

At is 68th meeting the Executive Committee decided:

(ii) To request that UNDP, UNEP, UNIDO and the World Bank take into account the information provided in the desk study, where relevant, and incorporate such information in the final reports on resource mobilization for climate co-benefits to be presented to the 69th meeting in the context of the terms of reference set out in decisions 63/20, 63/22, 63/23 and 63/24;

It is important to note that the Executive Committee approved funds for UNDP "for the preparation of four pilot demonstration projects in the refrigeration and air-conditioning manufacturing sector to examine technical interventions to improve energy efficiency, national policy and regulatory measures to sustain such interventions in order to maximize the climate impact of HCFC phase-out.

The following lessons learnt applied to the kind of projects funded for UNDP, as follows:

1. The ability to mobilize external resources

The approach used to mobilize resources is in line with what was used for Chillers demonstration projects, where there was acceptance that (as per paragraph 95 ExCom 68/10) counterpart and ODA grant co-financing options should be pursued where quick results are needed".

In the case of UNDP projects, the approach used to mobilize resources was to engage with the following partners/mechanisms:

a. Private sector: HPMP implementation was already requiring substantive co-finance from private sector in developing countries, even for eligible components, due to agreed level of funding for the Stage I HPMP. Therefore it was of utmost importance we identified other sources of funding to cover of design changes in for instance conversion lines to cover for additional costs for climate related interventions.

b. GEF: While GEF has proven to be a key partner regarding the mobilization of additional resources for maximization of climate benefits, lessons learnt from Chillers submissions to the GEF indicated that it is necessary to have project cycles to be somehow synchronized as to avoid long delays in funding (with loss of co-financers and lack of interest of clients in developing countries). In average, GEF project cycle for a full size project, may take 3 to 8 years, depending on many factors, including but not limited to GEF availability of resource to respond to large pipeline of climate mitigation projects, including from previous replenishment cycles. If synchronized and depending on the will of different partners, the duration can be substantially reduced and MLF funds for HPMPs can be used as the source of co-finance required by GEF. More detail explanation can be found in the prior section of this report.

c. Climate and Clean Air Coalition, CCAC finance: UNDP agrees with the conclusion that "because of their short processing time, and relatively quick on-the–ground results, the counterpart and ODA grant co-finance options lend

themselves more easily to situations where early results are needed (for example meeting eminent phase-out deadlines)". While the size of the assistance required for pilot projects may be limited, the results of resource mobilization via CCAC grant funding can be a good path to have funds available quicker.

2. The potential to replicate the model used to other countries.

UNDP looked at the extent to what those projects can be replicated in the absence of additional resources from the Multilateral Fund. While there are common denominators, the interventions maybe quite different as the partners dealing with HCFC phase-out in sector plans in manufacturing sectors are quite different than companies and building owners dealing with chillers related demonstration projects.

The identification and sequencing of different sources of funds is something UNDP is experienced to do, with different funding sources in different areas. The challenge is to synergize among different funding mechanisms as to ensure funding is available when the country/company needs to make the necessary change. For that, the bilateral assistance and other funding sources such as CCAC, has proven faster, with fewer interventions from external bodies, and their decisions. The limitation is of course the volume of resources if replication is required at larger scale.

The option for co-finance through innovative funding arrangements indeed has a greater potential to generate a significant additional funding, but the complexity of such arrangements, while possible to generate as a model and replicate as such, have been proven difficult to implement on time for the required compliance of countries. Unless some bottlenecks are resolved at institutional level.

Any requests by the Executive Committee to continuously monitor and report on the implementation of projects approved by other funding mechanisms/sources (which fall out of the purview of the MLF), presents a big challenge to implementing agencies whose mandate falls outside those projects.

Results of UNDP's Efforts to Mobilize Additional Resources for Climate Co-Benefits

In the course of the preparation of the proposals UNDP progressed in different fronts, especially in cooperation with the GEF and CCAC in Indonesia (Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning) and Maldives (Feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives, with district cooling technology).This report will provide as attachments, both products. In addition, the report informs in business model pursued and lessons learned. In addition, the table below provides the budget breakdown showing the current situation of expenses incurred in the pursue of Decision 63/20, for consideration of the Executive Committee.

Table: Resource Mobilization related costs (amounts in US$)[6]

Project	*Total Budget (excluding fees)*	*Total Expenses*	*Budget Balance*	*Remarks*
Development of GEF project "Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning" in Indonesia	-	150,000	(150,000)	UNDP staff and experts time and travel related to be cost recovered from RM project
MLF Resource Mobilization project GLO/SEV/63/TAS/306	200,000	64,768	135,232	MPU staff time, travel technology workshops and participation in meetings related costs
Project proposal and related meetings with CCAC partners and Maldives	-	30,000	(30,000)	Staff time and travel related to be cost recovered from RM project
Total	**20,000**	**244,768**	**(44,768)**	

In view of the Decision 69/4, UNDP is seeking the approval by the Executive Committee of the two activities in Indonesia and Maldives, instead, which we believe fulfill the requirements under Decision 63/20.

The following table provides a summary of funds mobilized with UNDP's efforts to date:

Name of the project	*Source of Funds*	*Amount in US$*
Promoting Energy Efficiency for Non-HCFC e frigeration and Air Conditioning" in Indonesia	GEF Trust Fund	5,020,822
	Co-financing	25,000,000
Feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives, with district cooling technology	CCAC Trust Fund	118,800
TOTAL		30,139,622

Note: The US$ 1.7 million including agency fees mobilized from US Department of State under its Global Climate Change Initiative, is as requested, to be removed from the MLF funded resource mobilization activities.

[6] Please note that UNDP will have to fund the deficit of $45K above, not taking into consideration previous proposals for development of projects under bilateral cooperation (USA).

Annex 1. Issue paper: The Facility for Additional Income

ISSUES PAPER
5 October 2009

THE FACILITY FOR ADDITIONAL INCOME
UNDP INPUTS ON CARBON MARKETS AS A POTENTIAL FINANCING COURCE

INTRODUCTION

At the request of the Executive Committee to the Multilateral Fund, the Fund Secretariat has been exploring the possibility of a Facility for Additional Income ('FAI') to address the climate benefits related to the Montreal Protocol's activities. The Fund Secretariat has issued two papers on the FAI, for the 57th and 58th Meeting, and is preparing a revised paper for the 59th Meeting.

As set out in the most recent paper for the 58th meeting, the FAI's design is at a preliminary stage. Certain key components of the FAI currently proposed in the paper are as follows:

- The FAI will take the form of a voluntary fund to provide co-financing for climate benefits. A number of sources of co-financing are being explored, including the carbon markets and government loans or grants.
- In terms of activities, the FAI is currently focused mainly on financing of climate co-benefits of HCFC phase-out.
- The possibility of a self-sustaining fund is explored, financed by receiving carbon credits generated by HCFC phase-out, including energy efficiency credits under the CDM (CERs).

At the request of the Fund Secretariat, UNDP has prepared this Issues Paper on the role of carbon markets as a financing source for the FAI. UNDP recognizes the broader ongoing discussions on other sources of co-financing, however, in order to be focused, this paper specifically concentrates on the carbon markets.

Overall, given their current size and growth potential, UNDP believes the exploration of the global carbon markets as a source of co-financing for climate benefits is interesting for the Montreal Protocol community. The comments provided in this Issues Paper are given with the objective of identifying what steps would be necessary to successfully achieve co-financing by the carbon markets.

This Issues Paper is organized as follows:

- In Section 1, some key considerations on the carbon markets are set out with specific regard to the current proposed design of the FAI (as described in the report to the 58th Meeting).
- In Section 2, building on Section 1, an alternative approach to the FAI, the ODS Climate Facility, is described.
- In the Annex, for ease of reference, certain key terms in the carbon markets are explained.

As will be explained in this paper, UNDP believes that the design of the FAI is currently not well suited to successfully achieving the specific goal of co-financing in the carbon markets. As such, it is hoped that the subsequent detailed description of the ODS Climate Facility, which is expressly designed with carbon markets as a financing source, can be helpful.

1. CONSIDERATIONS ON THE CURRENT PROPOSED DESIGN OF THE FAI IN THE CONTEXT OF CARBON MARKETS

This section is not an exhaustive, point-by-point analysis of the design of FAI, but instead identifies a number of key themes for the FAI related to accessing the carbon markets to finance climate benefits.

1.1 Addressing the full scope of climate benefits through the carbon markets

There are potentially 3 forms of interactions with the carbon markets:

- Energy efficiency gains from HCFC phase-out (CDM)
- Direct emission avoidance from HCFC phase-out (voluntary carbon markets)
- Direct emission avoidance from ODS destruction (voluntary carbon markets)

The current design proposal of the FAI for carbon markets appears primarily targeted towards climate benefits from energy efficiency under the Kyoto Protocol's CDM. A focus on the CDM is understandable, as it is a well-established carbon mechanism and is underpinned by a defined oversight framework. At the same time, the contribution of energy efficiency climate benefits may be relatively minor in the key sectors in which HCFC phase-out will take place. This will likely result in small financial flows and make transactions costs a sensitive issue.

With these facts in mind, UNDP suggests that consideration is given to expanding the Facility's carbon market interactions to include direct emissions from both HCFC phase-out *and* ODS destruction activities (collectively, 'ODS Direct Emissions'). UNDP is aware that this may depart from the mandate given by the Executive Committee to focus the current work of the Facility on HCFC phase-out (Decision XIX/6). However, targeting ODS Direct Emissions in their entirety will address the full range of climate benefits, with the largest greenhouse gas (GHG) impacts, and will maximize the possible financial flows from the carbon markets.

It can be noted that the inclusion of ODS destruction activities can often be organized in association with early retirement programmes which provide major energy efficiency benefits, and where currently organizations such as GEF are taking the lead.

1.2 The need for further development of the nascent carbon markets for ODS Direct Emissions

Currently, ODS Direct Emissions are not recognized by the oversight frameworks which create and drive the compliance carbon markets. Rather, they are new and innovative areas of the voluntary carbon markets.

The fact that ODS Direct Emissions are a nascent part of the voluntary carbon markets raises a number of issues. The necessary oversight framework to ensure high quality, robust credits for ODS Direct Emissions is only now beginning to be developed by certain voluntary carbon market standards, and the quality of these standards is not yet assured. Equally importantly, demand for credits from ODS Direct Emissions under the voluntary market is uncertain and is likely to be low. This is because buyers in the voluntary market are often more discerning than those in the compliance market, requiring that the project type has a good story-line and track record. UNDP has some concern that ODS credits in the voluntary market may not be seen as attractive by many voluntary buyers who will not share the insights of the Montreal Protocol community itself.

To the extent that ODS Direct Emissions are included, the proposed design of the FAI appears to assume that mature voluntary markets for ODS credits exist, with the necessary market demand in place to both self-finance the FAI and to generate necessary co-financing. The required level of market maturity may never materialize, and as such may undermine the current FAI design as it relates to carbon markets.

UNDP suggests that consideration is given to redesigning the FAI to specifically assist in the development of the currently immature carbon markets for ODS Direct Emissions. In the long term, UNDP believes that the goal should be for ODS Direct Emissions to be part of the compliance markets. Such an approach is set out in Section 2, where one of the main purposes of UNDP's proposal for the ODS Climate Facility is to achieve this objective.

1.3 Form of investment by the Facility and alignment with carbon market practice

The carbon markets, such as the CDM, are market mechanisms with particular characteristics and practices. If the FAI is to effectively develop and harness the carbon markets to finance climate benefits in the short term, it is important that the FAI engages carbon market norms and is simply structured, thereby incentivizing private sector participation and earning widespread credibility.

With a view to maximizing the smooth integration of the FAI to the carbon markets, UNDP suggests consideration is given to two changes in approach in the current design of the FAI.

- First, that the Facility conforms with market practice and provides its carbon-based co-financing to projects through an Emission Reduction Purchase Agreement ('ERPA'). An ERPA is the established contractual approach for purchase of credits between buyer and seller.
- Secondly, that the Facility - at least in its initial form - does not seek to be self-financing through claiming a share of a project's credits in return for its co-financing investment. Such an approach can insert additional complexity, with the considerable risk of turning away private sector involvement.

UNDP recognizes that the direction of the above suggested approaches may introduce apprehensions in governments that are not comfortable with a carbon market objective, and who would prefer the FAI as a vehicle for other sources of co-financing, such as direct grants. However, it needs to be recognized that structures that are optimal for interaction with the carbon market may not be optimal for other forms of co-financing. Grant based co-financing will likely undermine any concurrent ERPA-based approach in the eyes of the carbon markets. A key challenge in the design of the FAI is in reconciling the interests of a number of disparate stakeholders simultaneously.

1.4 Near term delinking from HPMPs for practical purposes

With the advent of HPMPs, there is theoretically the possibility to link ozone and climate financing for all HPMPs through the FAI and the Multilateral Fund's existing activities, creating a one-stop-shop financing solution for Article 5 countries.

In the long term, UNDP would welcome the exploration of such a linkage. In the immediate term, for practical reasons, UNDP recommends that there is no obligation for the FAI to finance the climate benefits of HPMPs themselves, as this will avoid unnecessarily delaying HPMPs which are about to launch.

1.5 The possible impact on the carbon markets of the current proposal to amend the Montreal Protocol to include HFCs

It is worth noting that the current proposal for inclusion of HFCs under the Montreal Protocol, if adopted, will limit the scope of the carbon markets to provide co-financing for climate benefits related to HCFC phase-out.

Decision XIX/6 provides the opportunity to make strides in reducing greenhouse gas emissions of HCFCs which themselves have significant global warming potentials (e.g. HCFC-22 with a GWP of 2270). However, as there is currently no obligation to adopt the most climate beneficial solution, the cost of adopting technologies with lower climate impact is considered 'additional' in the carbon markets, hence qualifying for appropriate carbon credits.

The introduction of an HFC phase-down, depending on its specific timing, could drive a much stronger presumption against HFC-based projects and would make it more difficult to establish the "additionality" threshold. If so, HCFC-phase out could largely be ruled out of carbon markets co-financing, although early avoidance of HCFCs (i.e. ahead of the phase-down schedule) could be counted as an acceleration and still qualify.

1.6 Summary

UNDP believes that the current proposed design of the FAI faces a number of challenges with regard to co-financing from the carbon markets. Overall, the current design is ambitious in the complexity, scale and timing of its goals on co-financing. As set out above, a key challenge will be the currently immature carbon markets for ODS destruction, and the need to assist in their development. Another key challenge arises from reconciling the design needs of housing multiple sources of co-financing within the FAI.

If co-financing from the carbon markets is to be successfully achieved, UNDP believes a more simplified and targeted approach is necessary - an approach focused on developing and exploring carbon markets, delinked initially from the Montreal Protocol compliance, and which would conform in its practices with standard carbon market norms. This approach is taken with the ODS Climate Facility and is set out in the next section.

2. UNDP'S PROPOSAL TO ESTABLISH CARBON MARKETS AS A SOURCE OF CO-FINANCING FOR CLIMATE BENEFITS.

At a side-event at the 57th Meeting, UNDP put forward a proposal on carbon markets, including an ODS Climate Facility. This proposal has now been further refined. This section sets out key components of the proposal.

2.1. Objectives of UNDP's proposal

The objective behind UNDP's proposal is to explore a pathway to establishing the carbon markets as the source of financing for climate benefits. This objective can be split into 2 phases.

- ***Phase I: Setting up an interim ODS Climate Facility***, which would consist of a donor-led fund and an accompanying oversight framework to facilitate the purchase of credits from ODS Direct Emissions (HCFC phase-out and ODS destruction) projects. The purpose of the ODS Climate Facility would be to gain experiences across project types and to set an example, thereby helping establish credibility and develop the carbon markets. It is important to note that the ODS Climate Facility would not represent an irrevocable commitment by the Montreal Protocol community to the carbon markets, but is instead an exploratory and preparatory initial step, which may be terminated or followed by a subsequent Phase II.

- ***Phase II: Linkage of ODS Direct Emissions to the compliance carbon markets***. Should the ODS Climate Facility be regarded as successful, the objective can be to build on its experiences and to include the category of ODS Direct Emissions in a future compliance carbon markets regime – for example, a post 2020 international agreement. Once linked to the compliance carbon markets, the ODS Climate Facility's fund component would no longer be necessary to ensure demand for ODS credits, as this demand could come from the compliance market. The ODS Climate Facility's oversight framework would remain in place and be further developed as the oversight instrument for any compliance markets mechanism.

Overall, if the carbon markets are to be a source of financing for climate benefits, UNDP believes that the long term objective should be the compliance markets, with the voluntary markets only as an interim step. The ODS Climate Facility effectively acts as a 'controlled' or 'contained' instrument in the voluntary market, prior to the real objective of inclusion of ODS Direct Emissions in the compliance markets.

2.2 ODS Climate Facility: possible structure

Structurally, the ODS Climate Facility can be seen to have two key functional components: a fund and an oversight framework. These components could either be established within the Montreal Protocol Bodies (including the Multilateral Fund) or at the Implementing Agency level (for example UNDP, the World Bank).
Three possible structural configurations for the ODS Climate Facility can be envisaged:

Configuration	Fund	Oversight Framework
#1	Multilateral Fund	Montreal Protocol Bodies
#2	Implementing Agencies	Montreal Protocol Bodies
#3	Implementing Agencies	Implementing Agencies

The selection of an appropriate configuration can be a function of a number of factors. Considerations may include:

- The need for the Executive Committee, and/or the parties to the Montreal Protocol, to get involved with carbon market mechanisms directly.

- In respect of the management of the fund, the existing experience of the Implementing Agencies with the carbon markets may be a relative strength, for instance in contractual aspects such as entry into ERPAs to acquire credits.
- For the oversight framework, the Montreal Protocol bodies are particularly well suited, given their long-standing technical expertise with ODS banks and transition technologies, accounting of ODS trends and ODS project validation capabilities.

2.3 ODS Climate Facility: fund component

Within the ODS Climate Facility, the objective of the fund component is to provide financing for climate benefits, by purchasing and ensuring demand for ODS credits generated by projects under the ODS Climate Facility's oversight framework. The fund is necessary because in the current absence of compliance markets, demand in the voluntary market for ODS credits is uncertain and likely to be low.

2.3.1 Fund sponsors

The ODS Climate Facility's fund, or funds (if an Implementing Agency based funding model is taken), can be capitalized by sponsors, whether governments or private sector, that support the ODS Climate Facility's objective.

As a result of its purchases, the fund(s) would acquire ODS credits whose ownership would be pro-rated to sponsors according to their contribution to the fund(s). These ODS credits could either be held in the fund(s) or retired on behalf of donors.

2.3.2. Fund investment approach

ERPA Modality

The fund(s) would make financing investments in projects for the climate benefits, utilizing the standard carbon market contractual modality of an ERPA, where the unit of account is a credit representing 1 tonne of CO_2e. The Fund would enter into an ERPA with each ODS Direct Emission project at the beginning of its project cycle, according to which the Fund will agree to pay a set price per ODS credit, for an agreed volume of ODS credits to be delivered over an agreed period of time.

Pricing Mechanism under ERPA

A key aspect of the fund(s)' E P As would be to take a 'cost-plus' approach to pricing the ODS Credits under the E P A. This 'cost-plus' pricing would mean that the purchase price being offered will differ from one category of project to another, so that a more costly technology type for addressing ODS Direct Emissions, for example ODS recovery from foams, would receive a higher price per ODS credit.

This 'cost-plus' pricing will have a number of benefits:
- It will maximize the number of projects financed under the fund, as the fund will not overpay
- The fund(s) will not pay a high price per ODS credit for so called 'low-hanging fruit' project types which have a very low cost. In this way, this will avoid a re-occurrence under the ODS Climate Facility of the HFC-23 scenario under the CDM.

A further valuable role of the ODS Climate Facility would be to gather and publicly disseminate information on costs and pricing of different technology types. It is possible that there will be a certain level of other voluntary carbon market activity on ODS Direct Emissions outside the ODS Climate Facility. Information on pricing and real costs disseminated by the ODS Climate Facility can moderate any external prices being paid, again acting against a 'low-hanging fruit' scenario.

Advance Payment under ERPA

Some ODS Direct Emissions project types may have substantial up-front costs, and projects may have difficulty accessing financing to cover these up-front costs. Typically, carbon credit buyers make their payments under an

ERPA on an annual basis during the lifetime of the project, when the project delivers its annual credits to the buyer. However, for these projects types with substantial up-front costs, it can be possible for advance payments to be made under the ODS Climate Facility's E P As at the beginning of the project cycle, thereby addressing this issue.

2.4 ODS Climate Facility: oversight framework

Within the ODS Climate Facility, the objective of the oversight framework would be to ensure that the ODS credits generated by its projects, and purchased by its fund(s), are high quality and robust. The oversight framework will ensure high and uniform standards in quantifying the GHG benefits of ODS Direct Emissions, and tracking the use of ODS credits generated by these projects under appropriate registries. With the aim of developing the carbon markets, and in the absence of monitoring from the oversight bodies of compliance markets, the ODS Climate Facility's oversight framework can be key to raising the profile and credibility of ODS credits.

2.4.1 Approach to Oversight Framework.

There has recently been substantial activity in developing of protocols and methodologies for ODS destruction projects under two voluntary carbon market programmes, namely the Climate Action Reserve (CAR) and the Voluntary Carbon Standard (VCS). Both have the potential to be rigorous ODS protocols, with the CAR programme having slightly higher reputational value (and hence carbon price) while the VCS has the potential for wider geographic applicability than CAR – at least in the short-term.

The preferred oversight framework for the ODS Climate Facility is envisaged to combine complementary roles for the Montreal Protocol bodies and selected voluntary carbon market standards, maximizing existing expertise and sharing responsibilities. As such, it might be possible to see the content of the respective protocols reviewed by an Assessment Panel (most likely the TEAP) and the application of the protocol be addressed by the Fund Secretariat in a validation role at project level. This same oversight could also extend to the specific methodologies.

Similarly under the preferred oversight framework, since both voluntary carbon market programmes either already have, or are in the process of developing, registries that could be relied upon for tracking ODS Direct Emission projects, there appears to be no need to recreate these at Montreal Protocol level. However, it could be proposed that the Ozone Secretariat either directly, or via Parties, acts as a repository for ODS Direct Emission credit reports from the voluntary carbon market actors such as VCS and CAR. If such a reporting requirement could be enforced in some way, the Montreal Protocol community could keep an appropriate track on the credits being claimed.

As an alternative to the preferred oversight framework, it is possible that the Montreal Protocol community decides that it is not appropriate at this stage to be directly involved in the ODS Climate Facility, but rather that the ODS Climate Facility should be an Implementing Agency-led activity. In this scenario, the Implementing Agencies could establish an oversight framework in conjunction with selected reputable voluntary carbon market programmes.

2.5 ODS Climate Facility: projects and co-financing

2.5.1 Overview of projects

A key role of the Implementing Agencies, such as UNDP, would be to source and facilitate projects under the ODS Climate Facility. This role can involve identifying projects, assisting in preparation of project documentation, and assisting and overseeing the operation of the project activity.

Projects would be selected with the over-riding objective of the ODS Climate Facility acting to develop the carbon markets. The aim will be to gain a broad range of experiences, to understand the benefits and challenges of carbon markets as a financing source across different project types.

The project portfolio for the ODS Climate Facility would target the following general characteristics:

- It would be limited to (i) HCFC phase-out and (ii) ODS bank management

- It would encompass a range of geographies
- It would encompass a range of technology types, including refrigerants and foams, but needing to make case-by-case decisions on halon and CTC destruction
- It would include a range of project sizes, in order to better understand the impact of transaction costs
- The number of projects would be a function of the funding made available by sponsors and the size of the projects that are targeted

2.5.2 Co-financing of projects

The ODS Climate Facility, as envisaged, would have the specific focus of developing financing from carbon markets to address ODS Direct Emissions.

Where there are other sources of financing in addition to the carbon markets, either ozone (for instance, with a HCFC phase-out project), or climate (for instance, through energy efficiency either through the GEF or CDM), the Multilateral Fund and Implementing Agencies can act as one-stop-shop for projects, combining these financing sources.

As a practical matter in terms of co-financing, the ODS Climate Facility would not be automatically linked to HPMPs. This is because the Facility – with its objective of developing the carbon markets - is intentionally, at this stage, not exhaustive in its scope and will only address a subset of HPMPs. In the longer term, assuming ODS Direct Emissions are included in a compliance mechanism, full linkage with HPMPs can be pursued.

2.6 ODS Climate Facility: timing

2.6.1 Establishment and term of ODS Climate Facility

Should there be support for the ODS Climate Facility, there are benefits to an immediate launch. Although still in the early stages, activities in the voluntary carbon market for ODS Direct Emissions are progressing, and there is a closing window for the Montreal Protocol community to influence the carbon markets development in a positive manner. The risk of not moving quickly would be that the voluntary markets would take on the ODS Direct Emission projects in an uncontrolled way and that reputational damage could be done.

As to the lifetime of the ODS Climate Facility, this would be a function of a number of factors including:

- Sufficient experience and data on ODS Direct Emissions projects having been gained. This information will be necessary to design a well-functioning compliance approach.

- The timing of negotiations and the establishment of substantive compliance mechanisms which may include ODS Direct Emissions.

It may also be prudent for the design of the ODS Climate Facility to include a pre-defined term, should subsequent linkage to a compliance mechanism not be desired/possible.

2.6.2 Timing considerations related to HCFC phase-out and emissions from ODS bank management

There is clear evidence from the work of TEAP in response to Decision XX/7 that the opportunities for ODS Bank Management are at their greatest at this point in time because of the significant element of CFCs in the products currently entering their respective waste streams. This proportion will decline over the next fifteen years and it will be important that an optimal credit value is established during that period to support the maximization of bank management opportunities. That said, current TEAP estimates suggest that the opportunity for annual refrigerant recovery and destruction alone is likely to be above 200 Mt tonnes CO_2-eq in 2025 and 150 Mt tonnes CO_2-eq in 2030, based on the vast quantities of HCFC-22 still reaching the waste stream over that period.

In the case of technology transition projects related to the HCFC phase-out objectives of Decision XIX/6, the timescales for individual transitions will be spread across the overall phase-out period. However, since the

HPMPs need to identify and ideally maximize the climate benefits of their respective project portfolios at the start of the overall project cycle (i.e. during 2010), an early awareness of the likely climate incentives will be essential.

ANNEX: KEY CONCEPTS IN CARBON MARKETS

For ease of reference, this annex sets out some common concepts in the carbon markets.

"Carbon Credit" refers to a right, interest, benefit or allowance for the holder to emit greenhouse gases. The standard unit of measure of a Carbon Credit is one ton of carbon dioxide equivalent (CO_2e). There are two broad types of Carbon Credits:

- an "**offset**" is a carbon credit which is created in recognition of a reduction in greenhouse gas emissions below an accepted business-as-usual baseline.
- an "**allowance**" is a right or permit to emit greenhouse gas and is granted under a regulatory regime, like the EU ETS.

"Compliance Market" refers to Carbon Credit trading activities which are conducted by entities who are subject to regulatory requirements to limit or cap on their greenhouse gas emissions. The most common Compliance Markets are created by the Kyoto Protocol and the EU Emissions Trading Scheme. The value of trading in the Compliance Market in 2008 was US$125 billion (1).

"Clean Development Mechanism" or **"CDM"** is a flexibility mechanism created under the Kyoto Protocol under which emission reduction activities which occur in developing countries may be registered to create Carbon Credits. These CDM Carbon Credits can be acquired and utilized by developed nations, where the cost of reducing emissions is higher, to contribute to meeting their Kyoto Protocol compliance obligations. In 2008, the total value of CDM Carbon Credits transactions was US$32.8 billion (1).

"Emission Reduction Purchase Agreement" or **"ERPA"** means a legal contract between a buyer and a seller for the sale of Carbon Credits. An E P A is often signed to secure a "forward sale" of Carbon Credits, meaning that the terms of the contract are agreed at the date of signing for future dates of delivery of carbon credits.

"Methodology" is an approach to calculate either (i) the baseline, or business-as-usual, emissions that are forecast to occur if a particular project idea is not implemented, or (ii) the actual emission reductions that have occurred due to implementing a project idea. A methodology is an essential tool towards crediting a project's emission reductions (whether in the compliance or voluntary market).

"Protocol" means a governing framework for compliance or voluntary market carbon projects which is designed to ensure the environmental integrity and quality of Carbon Credits from those projects. A Protocol will generally set out a specific project cycle for accreditation of projects under the Protocol, including validation against a prescribed standard.

"Registry" is a central depository of accounts for the holding and trading of Carbon Credits. Each of the major Protocols has established a registry system for Carbon Credits which are created and verified pursuant to its protocol. The Voluntary Carbon Standard and Climate Action Reserve each have their own registry. In addition to holding and transferring, a registry can be used to cancel or "retire" a Carbon Credit. Once a Carbon Credit is cancelled or retired, it will cease to exist and thus cannot be traded or utilized for any future offsetting purposes.

"Voluntary Market" refers to trading in Carbon Credits which is conducted for any reason other than to meet a regulatory compliance obligation. Carbon Credits traded in the Voluntary Market are generally called "VE s ", meaning "Verified Emission ed uctions". Purchasers may buy VE s on the voluntary market for a number of reasons, including: (i) as a means to hedge against future compliance obligations, (ii) branding or public relations purposes, (iii) as an investment or asset to trade, or (iv) out of a sense of moral or ethical duty to offset one's emissions. In 2008, the value of transactions in the voluntary market was US$397 million (1).

(1) Source: State of the Carbon Markets, 2009.

Annex 2: Proposal funded by the GEF
Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning (PENHRA) in Indonesia

PROJECT IDENTIFICATION FORM (PIF) [1]
PROJECT TYPE: Full-sized Project
TYPE OF TRUST FUND:GEF Trust Fund

PART I: PROJECT IDENTIFICATION

Project Title:	Promoting Energy Efficiency for Non-HCFC Refrigeration and Air Conditioning (PENHRA)		
Country(ies):	Indonesia	GEF Project ID:[2]	4899
GEF Agency(ies):	UNDP	GEF Agency Project ID:	4945
Other Executing Partner(s):	Ministry of Energy and Mineral Resources (MEMR)	Submission Date: Resubmission Date: Resubmission Date:	19 March 2012 03 July 2012 16 January 2013
GEF Focal Area (s):	Climate Change	Project Duration (Months)	36
Name of parent program (if applicable): • For SFM/REDD+ ☐		Agency Fee ($):	476,978

A. FOCAL AREA STRATEGY FRAMEWORK[3]:

Focal Area Objectives	Expected FA Outcomes	Expected FA Outputs	Trust Fund	Indicative Grant Amount ($)	Indicative Co-financing ($)
CCM-2	Outcome 2.1: Appropriate policy, legal and regulatory frameworks adopted and enforced	Output 2.1: Energy efficiency policy and regulation in place	GEFTF	1,120,822	6,562,500
	Outcome 2.2: Sustainable financing and delivery mechanisms established and operational	Output 2.2: Investment mobilized Output 2.3: Energy savings achieved	GEFTF	3,650,000	18,000,000
		Sub-Total		4,770,822	24,562,500
		Project Management Cost[4]	GEFTF	250,000	437,500
		Total Project Cost		5,020,822	25,000,000

B. PROJECT FRAMEWORK

Project Objective: Significantly improved energy efficiency of refrigeration and air conditioning (RAC) equipment and appliances manufactured and used in Indonesia

Project Component	Grant Type	Expected Outcomes	Expected Outputs	Trust Fund	Indicative Grant Amount ($)	Indicative Co-financing ($)
1. Policy & Institutional Frameworks for the Refrigeration and AC (RAC) Industry	TA	1. Enforced policies, laws and regulatory support mechanism to ensure manufacturing and sale of certified quality energy efficient (EE) RACs in Indonesia	1.1: Developed policies and regulations on the local manufacturing and import of EE RACs 1.2: Established and effectively enforced mandatory national standards (MEPS) for RACs 1.3: Inspection and certification system established and	GEFTF	500,000	2,062,500

[1] It is very important to consult the PIF preparation guidelines when completing this template.
[2] Project ID number will be assigned by GEFSEC.
[3] Refer to the reference attached on the Focal Area Results Framework when filling up the table in item A.
[4] GEF will finance management cost that is solely linked to GEF financing of the project. PMC should be charged proportionately to focal areas based on focal area project grant amount.

1

GEF-5 PIF Template-November 2011

Detailed documentation of the proposal is available at
http://www.thegef.org/gef/project_detail?projID=4899

Annex 3: Proposal funded by CCAC Trust Fund
Feasibility Study for District Cooling in Maldives to Avoid High-GWP HFCs

PROJECT PROPOSAL FOR CCAC FOCAL AREA INITIATIVE (HFCS)

PROJECT TITLE:	To conduct a feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives, with district cooling technology.
IMPLEMENTING AGENCY:	UNDP (Montreal Protocol Unit, EEG/BDP)
COUNTRY(IES):	Maldives
PROJECT OUTCOME(S):	(a) Technical and economic feasibility of various alternative district cooling technologies and selection of optimum not-in-kind technology for elimination of HCFC/HFC use in the existing population of stationary air-conditioners in Malé, Maldives; (b) Establishment of cost estimates and financing plan
PROJECT DURATION:	15 months
ESTIMATED PROJECT COST:	US$ 118,800
PROPOSED FUNDING:	**US$ 118,800**
SOURCE OF FUNDING:	CCAC Trust Fund
AGENCY FEES:	Included in above
PROJECT MONITORING MILESTONES:	Included
COORDINATION:	The project will be implemented by UNDP in close coordination with the CCAC HFC focal area initiative Lead Partners and the respective target country governments and stakeholders

SUMMARY

This proposal is for conducting a feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives, with a not-in-kind district cooling technology, contributing

to Maldives' national goals of carbon neutrality and HCFC phase-out by 2020.
The results of the feasibility study will be used by Maldives to establish an appropriate vehicle and mechanism for implementation of the actual replacement of HCFC/HFC-based air-conditioners with zero-ODP, extremely low-GWP, safe and energy-efficient district cooling technology, to minimize the carbon footprint of air-conditioners in Malé, Maldives.
The key expected results of this proposal are the review and selection of the optimum not-in-kind district cooling technology and establishment of costs and a financing plan for elimination of HCFC/HFC use in the existing population of air-conditioners in Malé, Maldives.

PROJECT OBJECTIVE

The objective of the proposal is to conduct a feasibility study for replacing the existing population of HCFC/HFC based air-conditioners in Malé, Maldives with district cooling technology, featuring zero ODP, extremely low GWP, safe, and energy efficient refrigerants. This study, upon completion, would establish techno-economic feasibility for such a technology and also establish the related costs, financing and implementation plan. It is potentially relevant to technology choices being made in other countries with similar circumstances.

BACKGROUND

Maldives is an archipelago of 1,192 coral islands, sizes ranging from 0.5 to 5 sq km, located in the Indian Ocean off the southwest coast of India. The islands are arranged in a necklace-shaped atoll chain about 860 km long and about 100 km wide, consisting of 20 administrative atolls. The population of Maldives is 350,000 persons (2012), of which the population located in Malé island is 150,000 (2012). Malé is the capital of Maldives and seat of the government. The key economic sectors in Maldives are Tourism and Fisheries.

National Goals and Commitments

Carbon neutrality goal by 2020

The Government of Maldives has set the year 2020, as the goal for achieving neutrality of its CO_2 emissions. Achieving this goal is expected to be challenging and will require urgent mitigation actions in several sectors, including electricity generation and transportation, in addition to significant reductions in the use of greenhouse gases.

Complete Phase-out of HCFCs by 2020

Maldives is implementing its HCFC Phase-out Management Plan (HPMP) with funding from the Multilateral Fund for implementation of the Montreal Protocol. The plan targets complete elimination of HCFC use by 2020. HCFCs are widely used as refrigerants in Maldives in servicing of various refrigeration and air conditioning equipment, with significant majority use in air conditioners.
Maldives is considering a ban on imports of HCFC-containing air-conditioners from 2014. The concern though, is that in absence of commercial availability of zero-GWP, low-GWP, safe and energy-efficient refrigerants, there is almost a certainty that HFC-based air-conditioners will replace HCFC-based air-

conditioners, producing a negative environmental impact. This presents a challenge for achieving the national carbon neutrality goal.

Sector Profile

Domestic air conditioners and small commercial refrigeration equipment (HCFC-based)

- Imports ~20,249 (2008, Maldives customs)
- Population ~90,000 units (2008, UNEP)
- Annual growth ~10 to 15%

Note: The current (2012) population of air-conditioners in Malé is estimated to be about 150,000. The energy use by these air-conditioners is estimated to contribute about 35% of the total energy use in Malé.

Transport Refrigeration/Air Conditioning

- Population of air-conditioned vehicles ~2,500
- Annual growth ~9%

TECHNOLOGY

Current alternative technologies for air-conditioners

All currently manufactured air-conditioners work on the principle of the vapor compression cycle with refrigerants in closed loop. HCFCs have been traditionally used as the preferred refrigerants in air-conditioners for over 3-4 decades. HCFCs need to be phased out under the Montreal Protocol.

The current alternatives include HFCs and Hydrocarbons. However, these do not fundamentally alter the technology, only change the refrigerants. The annual growth in demand for air conditioning over the next few years is expected to nullify the marginal energy efficiency gains potentially expected from these technologies. Thus, there is an insignificant reduction in the overall carbon footprint with these technologies, and they are consequently considered to be inadequate to address Maldives' particular requirements of meeting the 2020 carbon neutrality target as well as the Montreal Protocol target of complete phase-out of HCFCs by 2020.

Not-in-kind alternative technologies

Not-in-kind alternatives include vapor absorption systems, deep seawater cooling systems, tidal and other cooling systems, etc. in a district/community cooling configuration. These systems do not use conventional refrigerants, such as HCFCs, HFCs and HCs. They can use multitude of energy sources such as waste heat, steam, direct heat, electricity, etc. These systems are potentially more energy efficient and have an overall low carbon footprint. They appear to be prima facie appropriate candidates for replacement of HCFC/HFC based air-conditioners; however, a detailed feasibility study will be required establish the commercial viability and costs. It may be noted that currently, HFC based equipment are increasingly entering the market and adoption of not-in-kind alternatives could reduce overall carbon foot print compared to the equipment entering the market.

PROJECT DESCRIPTION

The following is the overview of activities that would be carried out under the project:

- Identification and selection of suitable national and international expert entities
- Carrying detailed baseline surveys of the current population of HCFC/HFC-based air conditioners and growth trends.
- Carrying out detailed site surveys.
- Techno-economic review of current commercially available not-in-kind alternative technologies.
- Establishment of estimated costs, financing modalities and implementation and management modalities for each alternative.
- Recommend the optimum alternative technology.

The above activities would be carried out through engagement of suitable national and international expert entities, in close cooperation with the government and stakeholders and adopting suitable administrative process. Stakeholder consultation meetings would need to be carried out to ensure their engagement. Documentation and reporting will also be needed to present the results. Management and supervision by Maldives government at the appropriate level will be required to ensure timely delivery of the results envisaged in the proposal.

PROJECT COSTS AND FINANCING

The total project costs are **US$ 118,800**. The details are tabulated in the table below:

Breakdown of project budget

No	Item/Description	Total
1	Contractual services – national experts	15,000
2	Contractual services – international experts	43,000
3	Stakeholder consultation meetings	25,000
4	Documentation and reporting	5,000
5	Management and supervision	20,000
Sub-total		**108,000**
Agency fees		**10,800**
Funding Request		**118,800**

Note: *The budget breakdown is indicative. There may be revisions to line items based on the specific needs of the country. UNDP documents such budget revisions and reports them as needed.*

IMPLEMENTATION

Monitoring Milestones

MILESTONE/MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Start-up of project activities															
Award of contracts															
Data collection															
Data analysis															

Reporting															

Management

The overall management of the project will be carried out by Government of Maldives with the assistance of UNDP (Montreal Protocol Unit) following UNDP financial rules and procedures.

Coordination and Reporting

The project implementation will be closely coordinated with the CCAC HFC Focal Area Initiative Lead Partners. Brief progress reports on project implementation will be provided on a quarterly basis. A final report on the project shall be provided at the end of the project duration.

RESULTS

The key results of this proposal would be a technical and economic feasibility study of various not-in-kind district cooling alternative technologies, selection of optimum technology for elimination of HCFC/HFC use in the existing population of air-conditioners in Malé, Maldives and establishment of cost estimates and financing plan.

Overall outcome

If the feasibility study and the recommendations therein are accepted and selected not-in-kind technology implemented, upon successful implementation, Maldives would eliminate the use of HCFCs/HFCs in stationary air-conditioners on Malé Island completely, allowing it to comply with its national targets of carbon neutrality and HCFC phase-out by 2020. It is expected that the selected technology would also reduce the energy use in air conditioning by over 20% annually. This would be the first-of-its-kind demonstration project in the world, where national commitments and technological interventions coincide to produce a transformational change in Maldives.

The findings of this study can be utilized in other parts of Maldives which have residential islands and in resort islands, after assessment of feasibility. Further, other small island States and small nations facing similar challenges can adopt findings of this study. It may be noted here that findings of this study would be shared with other similar small island states that have started implementing the HCFC phase-out management plan. The outcomes of the study could be shared during the 3rd SIDS conference which is going to be held next year and during the MOP for other countries to opt for similar technologies to move away from growing HFC usage.

RESOURCE MOBILIZATION FOR HCFC PHASE-OUT AND CLIMATE MITIGATION CO–BENEFITS

A Study Prepared for the Executive Committee of the Multilateral Fund

The World Bank

4 November 2013

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KEY MESSAGES

This study seeks to identify potential investment opportunities and sources of co-financing to meet the additional costs of energy efficiency and climate mitigation benefits associated with HCFC phase-out projects supported by the Multilateral Fund of the Montreal Protocol. As it stands, the Multilateral Fund only supports eligible incremental costs related to ozone depleting substances, and does not fund the additional costs of additional energy efficiency related improvements. Currently therefore, the Multilateral Fund does not directly incentivize the uptake of the most energy efficient technology, leading to missed opportunities to invest in ozone depleting substances phase-out projects and maximize associated climate mitigation outcomes from these projects, and risking technology lock-in. The paper explores strategies that can maximize synergies with climate financing in general and in combination with the World Bank's energy efficiency and climate mitigation portfolios.

An analysis of impacts and benefits shows that savings related to electricity, whether at the individual consumer level or from avoided generation capacity, dominate. When comparing the direct climate benefit arising from reductions in emissions associated with the replacement of HCFCs (given the intrinsic global warming potential of the refrigerant) with the indirect benefit associated with energy savings from new equipment (from the lower electricity consumption), the value of the indirect benefit is larger. In any event however, from a country perspective, it is energy security benefits that drive policy making directed at the Ref/AC sector, with climate mitigation and ODS phase-out as secondary objectives only.

There are, in principle, a number of sources of financing that address energy efficiency in developing countries that could, potentially, be leveraged to finance the additional climate benefits associated with HCFC phase-out. Broadly speaking however, challenges arise with respect to timing, approach, and implementation:

- No sources of funds were identified that could provide the type of predictable funding that would allow countries to plan on securing funds in accordance with the timeframe of their compliance obligations under the Montreal Protocol.
- Climate financing traditionally takes a demand-side approach offering incentives to end-users to reduce their energy use, while the Montreal Protocol typically works with equipment manufacturers to replace ODS in production processes.
- Multisource financing can add to transaction costs and elevate governance and decision risks in interdependent financing operations.

A dedicated funding window for financing ozone-climate co-benefits, including HFC avoidance, could be explored. Existing funds such as the Climate Investment Funds or the GEF could be used or modified so that resources could be earmarked to ensure predictability and accountability of funding and timing so as to blend with Multilateral Fund funding as seamlessly as possible. In parallel and additionally, seed money could be made available through the Multilateral Fund or others to offer incentives for Parties to pursue energy efficiency / climate

mitigation linkages, for example to support energy audits in cases where there are good prospects for follow-up climate finance.

Generally, bringing together various sources of financing increases transaction costs. Any effort to promote multi-source financing should acknowledge the same and strive to streamline implementation and management procedures of such a blended operation in order to eliminate, or strongly limit additional project and financial management and reporting requirements and keep transaction costs low.

Good strategic planning and inter-sectoral coordination at the country level are crucial to ensure that policies are aligned and possibilities to leverage financing are optimized. Parties should be encouraged to ensure that their second phase HCFC Phase-out Management Plans include a broad and strategic overview of on-going and planned investments for climate mitigation and energy efficiency so that the Montreal Protocol interventions can be mainstreamed within these larger on-going programs. The overall domestic climate change and energy policy and regulatory environment, including Nationally Appropriate Mitigation Actions where relevant, should be providing the framework for the mainstreaming of HCFC phase-out. Linkages should be made with potential new sources of climate finance and greenhouse gas mitigation instruments, including the Green Climate Fund and potentially new carbon market-based instruments which the Partnership for Market Readiness supports. In many countries, this would require strong coordination and collaboration across sectors and ministries, as well as careful consideration of Agencies' comparative advantage.

World Bank investments for clean energy are growing, and their analysis shows that there is scope for inclusion of Montreal Protocol objectives in energy-related activities. World Bank Group commitments to finance energy efficiency have stood at approximately $1.5 billion per year for the past five years. In addition, a review of the overall World Bank portfolio reveals that projects representing approximately $3.5 billion, or 8.7% of the Bank's portfolio, across a variety of sectors offer opportunities for linkages with the Montreal Protocol agenda. Further analysis of these opportunities would allow key sectors with strong potential for synergies, such as energy but also health and agriculture, to be targeted through awareness-raising and distribution of appropriate information and guidelines. Green procurement practices could also actively be promoted in these sectors, even if that in and by itself will not mobilize resources. A principal challenge here would lie in aligning Multilateral Fund financing with Bank lending, even when directly related to energy efficiency financing, given the different business models at play; the challenge goes beyond mere alignment of procedures. Additional Montreal Protocol integration funds could be set aside to blend in with World Bank or other IFI funds as a way to magnify impact and help countries meet compliance targets.

A review of financial flows related to climate change underlines the fact that domestic private sector investment predominates. Indeed, in some key countries, this is the largest source of climate finance, pointing to the importance of interventions that target the domestic private sector. The World Bank could therefore explore with its client countries opportunities

for synergies between the Montreal Protocol agenda and Bank Development Policy Lending, which could help set the enabling policy environment with interventions targeting standards setting and awareness-raising. There may also be further scope and synergies with investments by the International Finance Corporation which should be explored.

The study provides an overview of the use of carbon finance in the past and outlines potential future opportunities for its use. The Kyoto Protocol's Clean Development Mechanism has had limited success in reducing investment barriers related to less mature technologies and large scale, long-term investments, and, in its current form, imposes significant transaction costs and risks on project developers. On the other hand, the CDM has been successful in dissemination of mature technologies and projects that offered short term large greenhouse gas reductions. In the near term in any event, carbon finance is not available to support energy efficiency, or other types of financing at the nexus of the Montreal Protocol/climate change agenda, given the severe downturn of the global carbon market, associated with the economic downturn in countries that had been the engines of demand for carbon credits, and carbon market mechanisms and systems as currently configured do not present a reliable financing option to support the phase out of HCFCs, especially in middle-income countries.

Nonetheless, we expect that market-based instruments will play a role in future GHG mitigation efforts at the international and domestic levels and that new climate finance instruments, such as the Green Climate Fund, will become accessible more broadly and, in the spirit of "green growth", could be tapped to support a broader co-benefits agenda. The international community and countries around the globe are looking at the next generation of carbon markets and the outlook is promising with respect to development of domestic carbon markets and frameworks that could support this agenda. The development of new climate finance instruments which could better support energy efficiency and related ODS phase-out efforts can be an opportunity for the Montreal Protocol community to align objectives and instruments and plan synergies in future operations. For example, Mexico's plan to develop and implement Nationally Appropriate Mitigation Actions targeted at the refrigeration sector may offer a useful model for others. Other domestic instruments, some supported by the World Bank's Partnership for Market Readiness, may become available over time, and, once mature, financial engineering tools and approaches outlined in this study should be applicable.

In conclusion, the current development of new GHG mitigation and financing instruments can be seen as an opportunity for early discussion and engagement towards more tailored tools that will make co-financing for co-benefits easier to achieve in the future.

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LIST OF ACRONYMS

A5:	[Parties] Operating Under Article 5 Paragraph 1 of the Montreal Protocol
AC:	Air Conditioning
AR4:	Fourth Assessment Report of the Intergovernmental Panel on Climate Change
BAU:	Business As Usual [scenario]
BFIs:	Bilateral Finance Institutions
CAR:	Climate Action Reserve
CCAC:	Climate and Clean Air Coalition
CCX:	Chicago Climate Exchange
CDM:	Clean Development Mechanism
CERs:	Certified Emission Reductions
CF:	Carbon Finance
CFCs:	Chlorofluorocarbons
CFLs:	Compact Fluorescent Lamps
CIF:	Climate Investment Funds
COP:	Conference of the Parties [to the Kyoto Protocol]
CPI:	Climate Policy Initiative
CTF:	Clean Technology Fund
DFIs:	Development Finance Institutions
DPL:	Development Policy Lending
DSM:	Demand Side Management
EE:	Energy Efficiency
ESCO:	Energy Services Companies
ESMAP:	World Bank Energy Sector Management Assistance Program
ERPA:	Emission Reductions Purchase Agreement
ETS:	Emission Trading Scheme
EU:	European Union
GCF:	Green Climate Fund
GEF:	Global Environment Facility
GHG:	Greenhouse Gas
GPP:	Green Public Purchasing
GWP:	Global Warming Potential
HCFCs:	Hydrochlorofluorocarbons
HFCs:	Hydrofluorocarbons
IBRD:	International Bank for Reconstruction and Development
IDA:	International Development Association
IEA:	International Energy Agency
IFC:	International Finance Corporation
IFIs:	International Financial Institutions
IPCC:	Intergovernmental Panel on Climate Change
ISO:	International Organization for Standardization
JI:	Joint Implementation

KP:	Kyoto Protocol
LDCs:	Least Developed Countries
MDBs:	Multilateral Development Banks
MEPs:	Minimum Energy Performance Standards
MICs:	Middle Income Countries
MFIs:	Multilateral Finance Institutions
MLF:	Multilateral Fund for the Implementation of the Montreal Protocol
MP:	Montreal Protocol
NAMA:	Nationally Appropriate Mitigation Action
NFIs:	National Finance Institutions
NMM:	New Market Mechanism
ODS:	Ozone Depleting Substance(s)
ODP:	Ozone Depleting Potential
OECD:	The Organization for Economic Co-operation and Development
PAD:	Project Appraisal Document
PID:	Project Information Document
PMR:	Partnership for Market Readiness
PPP:	Public-Private Partnership
RECs:	Renewable Emission Certificates
Ref:	Refrigeration
RTOC:	Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee
SLCPs:	Short-Lived Climate Pollutants
SMEs:	Small and Medium-Size Enterprises
tCO_2eq:	Tonnes of Carbon Dioxide Equivalent
TEAP:	Technology and Economic Assessment Panel
UNFCCC:	United Nations Framework Convention on Climate Change
VCM:	Voluntary Carbon Market
VCS:	Verified Carbon Standard
VER:	Verified Emission Reduction
WMO:	World Meteorological Organization

1. INTRODUCTION

1. This study[1] seeks to identify potential sources of co-financing to meet the additional costs of energy efficiency (EE) and climate mitigation benefits associated with the HCFC phase-out supported by the Multilateral Fund of the Montreal Protocol (MLF). As it stands, the policy of the Multilateral Fund is to support only the eligible incremental costs related to the phase-out of ozone depleting substances, and not to support the additional costs of additional energy efficiency related improvements of the equipment. Currently therefore, while the Multilateral Fund encourages exploring co-financing opportunities for improving energy efficiency, the Fund does not directly support the uptake of the most energy efficient technology. This can lead to missed opportunities to invest in ozone depleting substances phase-out projects and therefore missed opportunities to maximize the associated climate mitigation outcomes from these projects, as well as risking technology lock-in. Strategies to maximize synergies with climate financing in general, and in combination with the World Bank's energy efficiency and climate mitigation portfolios, are explored with the aim to outline how finance may best be leveraged in support of climate co-benefits generation in MLF-funded operations.

2. The Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (MP) decided in 2007 to accelerate the phase-out of hydrochlorofluorocarbons (HCFCs) in accordance with the schedule shown in the Table 1, below. The decision XIX/6 also required that the Parties take into account potential climate benefits associated with HCFC phase-out, which are influenced by the selection of HCFC alternatives and the energy efficiency of refrigeration and air conditioning (Ref/AC) equipment.

3. HCFC phase-out management plans (HPMPs) approved by the MLF seek to facilitate the conversion of Ref/AC manufacturing and foam manufacturing away from the use of HCFCs to non-ODS alternatives. These processes entail structural redesign of equipment that allows for enhanced energy efficiency, and certification testing of equipment. Specifically in the Ref/AC sector, this provides an opportunity to build upon MLF funding to upgrade equipment energy efficiency performance as part of the HCFC phase out, though the process is not cost neutral given that the components required for energy efficient Ref/AC equipment and refrigerants with low global warming potential (GWP) tend, at present, to be more costly. Conversely, there is a risk of lock-in with less than optimum technology if financing towards the cost of energy efficiency upgrade cannot be made available in a timely manner.

4. While blending of financial resources is applied in many World Bank operations, it is also a source of added complexity, transaction costs and risk in project preparation and implementation, to an extent which often discourages project teams and clients from seeking

[1] The Study for Resource Mobilization Activities Related to the Phase-out of HCFCs was approved by the Executive Committee of the MLF by Decision 63/24. The original concept proposed by the World Bank envisaged addressing the resource mobilization question from two complementary perspectives: harnessing market mechanisms to accelerate donor commitment and overall resources available to the MLF; and, using market mechanisms at the project level. Ultimately, the Committee agreed to proceed by focusing solely on the second approach.

out opportunities for blended finance. The World Bank has recognized this and repeatedly attempted to harmonize project cycle and approval requirements, most recently through on-going efforts to streamline GEF and Bank lending project preparation milestones. Yet it is still difficult to overcome the rules and governance interests of the source funds and financing mechanisms. This is problematic because – other than in a private sector setting – alternative financing arrangements rarely exist, which can lead to suboptimal project (re)design or even halting project preparation entirely.

Table 1. *Montreal Protocol HCFC consumption control measures*

Non-Article 5 Parties: Consumption		*Article 5 Parties (developing countries): Consumption*	
Base level:	1989 HCFC consumption + 2.8 per cent of 1989 CFC consumption.	**Base level:**	Average 2009–10.
Freeze:	1996.	**Freeze:**	January 1, 2013.
35 per cent: reduction	January 1, 2004.	**10 per cent: reduction**	January 1, 2015.
75 per cent: reduction	January 1, 2010.	**35 per cent: reduction**	January 1, 2020.
90 per cent: reduction	January 1, 2015.	**67.5 per cent reduction**	January 1, 2025.
99.5 per cent: reduction	January 1, 2020, and thereafter, consumption restricted to the servicing of refrigeration and air-conditioning equipment existing at that date.	**97.5 per cent: reduction (averaged over ten years 2030–40)**	January 1, 2030, and thereafter, consumption restricted to the servicing of refrigeration and air-conditioning equipment existing at that date.
100 per cent: reduction	January 1, 2030.	**100 per cent: reduction**	January 1, 2040.

Source: Montreal Protocol Handbook, UNEP (2012)

5. Whilst this aspect is not addressed here, it should be noted that the study is nested in the broader public policy challenge of the compartmentalization in addressing (global) environmental issues and consequently of funding sources. Given increasing interdependency of environmental concerns and solutions and the resulting scope for synergies and savings, such compartmentalization can be seen as a failure of public policy coordination. Addressing this failure appears a particular challenge in the international context with its complex negotiated arrangements and governance arrangements. Yet, alternatives could be considered, such as addressing sound environmental conduct holistically, perhaps on a sector or industry basis, and aligning financial support mechanisms accordingly.

6. This study explores pathways that may encourage the uptake of ozone- and climate-friendly technologies through synergies between the MP, policies to promote energy efficiency and climate finance instruments in support of the spirit of Decision XIX/6 of the Meeting of the Parties to the MP, and thereby leading also to cost-effectiveness of public financing and economic efficiency, where synergies exist and can be exploited. The study underscores the fact that feasible, strategically designed opportunities, based on practical experiences, exist to

encourage harmonization between the phase-out of the HCFCs and HCFC-using technologies with efforts to promote energy efficiency and reduce greenhouse gas emissions (GHG).

7. The study recognizes that carbon markets and carbon finance, in general, are in a state of flux and will likely remain so in the mid-term, and carbon prices are highly depressed and could remain so for years. Regardless of the specific design of any mechanism, the current problem is lack of demand – associated with the economic downturn in many countries (especially in Europe), leading to historical (too) low prices that make the mechanism ineffective , and insufficient visibility on sources of future demand and the regulatory context. Consideration of carbon finance as an option for financing of climate co-benefits will require a more robust market with greater clarity and predictability of demand - essentially, this study assumes this will happen and thus seeks to extrapolate the lessons from the CDM experience to be ready.

8. Therefore, the avenues explored present options for consideration, irrespective of the exact future configuration of the climate financing landscape, and of how the scope and roles of the various climate financing instruments may evolve. The study is also relevant[2] to the work of the Climate and Clean Air Coalition to address Short Lived Climate Pollutants, as the paradigms that are explored are broadly applicable to efforts to minimize HFCs.

2. SECTOR BACKGROUND

9. The objective of the MP is to eliminate the consumption and production of substances that deplete the ozone layer. The MP has achieved recognized success in phasing out the consumption and production of chlorofluorocarbons (CFCs) and other ODS through adoption of lower ozone depleting potential (ODP)[3] alternatives, including HCFCs (see Annex I, Table 1 for the range of lifetimes, ODP and GWP of principal ODS and alternatives). The agreement to accelerate phase-out of HCFCs has generated a further shift towards other alternatives, including an upswing in the use of hydrofluorocarbons (HFCs), which have no ODP but do however, have high global warming potential (GWP). Although the MP does not regulate or have a formal role in control of HFCs, its decision XIX/6 establishes a clear desire to minimize climate impacts. Where feasible therefore, conversion to substances with no ODP and low GWP such as, ammonia, CO_2 or hydrocarbons, is promoted. New HFCs with low to very low GWP are under development[4] but at present, viable low- and no-GWP alternatives are not commercially

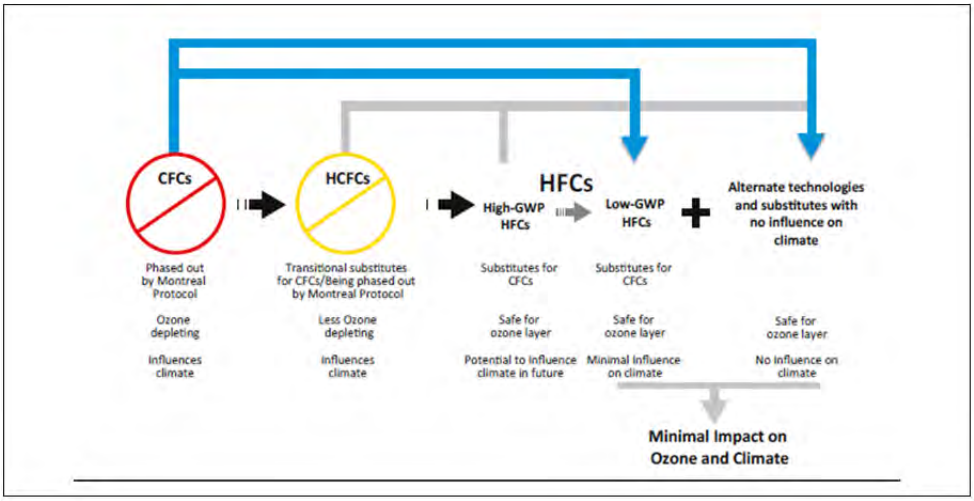
[2] The growth of HFCs which are increasingly replacing ODS phased out by the MP, and also increasing with rising demand for air conditioning is cause for concern. The threat from HFCs stems not from their current global contribution to climate forcing which is relatively limited, but from the potential for exponential growth if left unabated, particularly in developing countries, and the risk to cancel the climate benefits that accrued from CFC and now HCFC phase-out (see UNEP's HFCs Synthesis Report). Whilst this report is not primarily concerned with HFCs, some of the tools and lessons learned can apply to efforts to minimize HFC growth, notably the section that seeks to map out opportunities for linkages with the Bank's portfolio.

[3] ODP is the ratio of the impact on ozone of a chemical compared to the impact of a similar mass of CFC-11. The ODP of CFC-11 is defined to be 1.0. Other ODS have ODPs that range from 0.01 to 12.0

[4] At least one producer has announced commercial production and market availability in early 2013, for HFO blends for air conditioning and heat pumps application, while HFO-1234yf is being adopted for mobile air conditioning (in cars) in Europe and North America.

available for all applications and/or circumstances (see Figure 1 for a depiction of ODS and related GHG control measures over time).

Figure 1. *ODS and related GHG control measures and policies*



Source: HFCs Synthesis Report, UNEP (2011)

10. While HCFCs are used in both the foam manufacturing and Refrigeration/Air Conditioning sectors, the greatest potential energy efficiency gains through HCFC conversion and technology upgrade can be achieved in the latter due to recent technological advances. One sub-sector which offers interesting potential climate benefits is the residential AC sector which currently uses HCFC-22[5]. This section provides some broad estimates of the climate benefits and energy savings that are associated with the sector. Table 2 provides a rough "back-of-the-envelope" analysis of the relative benefits that could drive a technology upgrade program linked to room air conditioning equipment.

11. These analyses provide rough estimates of the potential climate benefits and energy savings associated with the HCFC transition, and point to where these savings can be found. The Montreal Protocol's TEAP estimates[6] that, in 2008, there were 553 million units of HCFC-22 air conditioners in service, containing 1 million tons of HCFC-22. Therefore, each year it can be estimated that at least 50 million new units reach the market, containing roughly 100,000 tons of HCFC-22.

[5] HFC-23, a by-product in the manufacture of HCFC-22, is a potent greenhouse gas regulated under the United Nations Framework Convention on Climate Change (UNFCCC). Therefore, the harmonization of efforts to phase out HCFC-22 and eliminate HFC-23 is critical to both protecting the ozone layer and for climate change mitigation efforts.
[6] TEAP, RTOC (2010)

12. Based on a hypothetical conversion / replacement scheme targeting 1 million of these units, one can see that the main drivers related to co-benefits would be, by far, energy savings for the individual consumer and avoided economic cost of building new power generation capacity. Based on the analysis in Table 2 below, a scheme could be developed for example to provide a rebate on any working air conditioner that is scrapped and replaced for a new energy efficient one. Such a rebate if it were to include the first year of energy savings and avoided cost of constructing a new power plant could amount to at least $126 per unit. The analysis also indicates that, should a viable carbon market be available, carbon finance revenues would more than cover the cost of managing such a scheme through intermediation of retailers and manufacturers or with energy services companies (ESCO) as driving agents.

Table 2. *Back-of-the-envelope estimate of the energy efficiency and climate mitigation related impacts of a program addressing 1 million energy efficient room air conditioners*.

Personal savings from one room AC

- Electricity savings = $117 per year
- Carbon "value" equivalent = $3.4 per air conditioner per year

Impact on power generation

- Avoided cost of new power plant construction: $95- $216 million
- Equivalent to $9.5- $21.6 per air conditioner, excluding operating costs

Program carbon finance income

- Net income from carbon finance: $3.2 - $3.3 per air conditioner per year (assuming $5 per ton CO_2 - which is not supported by the market today)

Possible (theoretical) impact from high GWP refrigerant replacement

- $0.6 per air conditioner per year

→ Main impact / driver is energy savings for the individual consumer and avoided investment in generation capacity. In contrast the savings from displacement of HCFCs, even if eligible for earning carbon credits (which it is not), is much smaller.

Source: this report – see Annex I, Table 2, for assumptions and details

13. This pro-forma example demonstrates that climate benefits stemming from the refrigerant control is often only a small fraction of the potential for GHG reduction (15% in our example). On the other hand, climate benefits from energy efficiency improvement, generally leading to reduced GHG emissions depending on the source of power, are more critical from a climate change perspective. These rough estimates are for illustration purposes only, and different equipment and situations would lead to different results, including with possibly less energy efficiency gains.

14. It should be noted that while reliance on the CDM in the energy efficiency sector has been problematic in part because of complex and high transaction-cost monitoring and

verification requirements, by contrast the baseline assessments and monitoring and verification tasks associated with MP compliance should be less onerous since, contrary to energy efficiency aspects, there are less opportunities for the baseline or the target to deviate from a theoretical value (that is, whether a particular ODS or non-ODS refrigerant is being used).

15. Finally, with economic growth and rapid urbanization trends, increase in refrigeration and air-conditioning energy use have become one of the largest and fastest growing contributors of energy (electricity) demand in developing countries. Air-conditioning, in particular, also coincides with electricity peak loads in most countries and therefore energy efficiency in air-conditioning also provides a significant opportunity to address electricity sector supply-demand gaps which many countries face resulting in power system blackouts and brownouts. In this context, the main public driver behind replacing the existing stock of Ref/AC or shifting the new stock of Ref/AC to new technologies is energy security, with climate change mitigation as a co-benefit and reduction of ODS even further down the line.

3. FINANCING INSTRUMENTS FOR CLIMATE CHANGE MITIGATION, ENERGY SAVINGS AND EMISSIONS REDUCTION

3.1 Overview of Climate Finance Instruments

16. Climate finance refers to public or private sector finance that supports climate adaptation and mitigation activities. This includes a number of policy and finance instruments that may be used to incentivize mitigation actions and influence change in behavior amongst stakeholders.

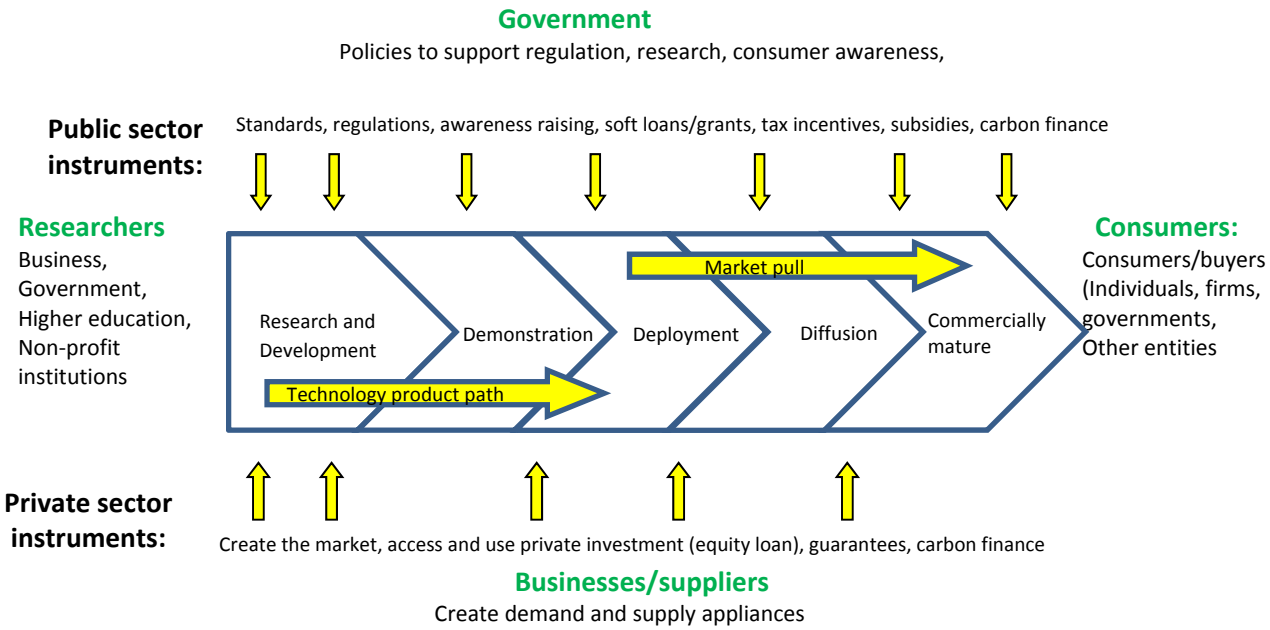
17. Four broad categories of stakeholders are involved in the energy efficiency process and product life cycle continuum (see Figure 2):

- Governments, economic unions and global treaties, such as the MP and Kyoto Protocol that use a variety of tools – of which regulation, fiscal and financing instruments, and capacity development are key - to drive behavioral change in the product development cycle, involving product design researchers, manufacturers and consumers of energy efficient appliances and services;
- Businesses, including suppliers, retailers and energy services companies (ESCOs) who sell products/appliances and services to enhance energy efficiency and maximize profits and returns for investors;
- Consumers, who purchase energy efficient appliances and services depending on their needs, income level, level of awareness and exposure to marketing; and
- Researchers and innovators, looking to develop new appliances and services in response to changes in the regulatory environment and business and consumer demand.

18. Numerous financing instruments are available from a variety of potential partners to address policy, fiscal and financing needs related to energy efficient product and services development and uptake. A non-exhaustive list of various financing partners who may support

such efforts is presented in Table 3, with a more detailed overview of specific source of funding outlined in Annex II. Table 4, then maps the types of perceived public and private sector energy efficiency financing needs against available financing instruments and the agents from whom support may be solicited.

Figure 2. *Product development cycle showing role of key stakeholders and available instruments to support energy efficiency*



Source: "Beyond the sum of the parts", WB (2010)

3.2. Overview of Climate Finance Flows

19. The Climate Policy Initiative's (CPI) Landscape of Climate Finance 2012 [7] estimates that annual global climate finance flows reached approximately $364 billion in 2010/2011, approximately half of which went to investments in developing countries ($171 billion). Figure 3 presents CPI's graphical depiction of these overall flows. Additional complex interactions exist that are not depicted, for example households' behavior (private) reacting to government incentives (public).

20. Mapping climate finance to date has proven challenging with no precise internationally agreed definition. Current efforts to track such financial flows struggle with issues regarding specificity (e.g., tagging of adaptation or mitigation investments), consistency (e.g.,

[7] See http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2012
This is the most comprehensive treatment of the subject and is the source for all the figures in this section.

comparability across existing reporting systems), and comprehensiveness (e.g., extensive data gaps).[8] It is worth noting that estimating financing for energy efficiency in general, which is most relevant to both ODS and climate change benefits, is further complicated by underreporting, given a tendency to classify investments by the sector targeted versus the energy efficiency or climate benefits sought: investment for equipment upgrade is more likely to be recorded, if at all, under the specific equipment category (e.g., AC, refrigerator, appliance, etc.) than under energy efficient action. This may partially explain why energy efficiency accounts for only 4% of global flows in the finance landscape.

21. Given the current shortcomings in reporting of climate-related flows it remains difficult to identify, beyond dedicated instruments like the MLF or carbon finance, which flows fall at the intersection of ODS mitigation and low emissions development. The World Bank is actively working on systems, as are others, to improve such reporting and increase the reliability of data in this domain. Based on information available at this time, this section outlines evidence of flows, as yet largely untapped for HCFC projects, that could be used to support opportunities for synergistic ODS and climate co-benefits. Realizing this potential will require targeted outreach, awareness-raising and capacity building.

22. Public flows. Governments and public financial intermediaries have invested slightly more than $80 billion in mitigation activities, with energy efficiency representing 18% of this amount. A significant percentage of mitigation finance comes from development finance institutions, including bi-, multi- and national development banks that together have provided $32.3 billion in climate finance, or about 30% of North-South climate-related flows, highlighting the pivotal role that these institutions play in leveraging and mobilizing finance for climate-smart development.

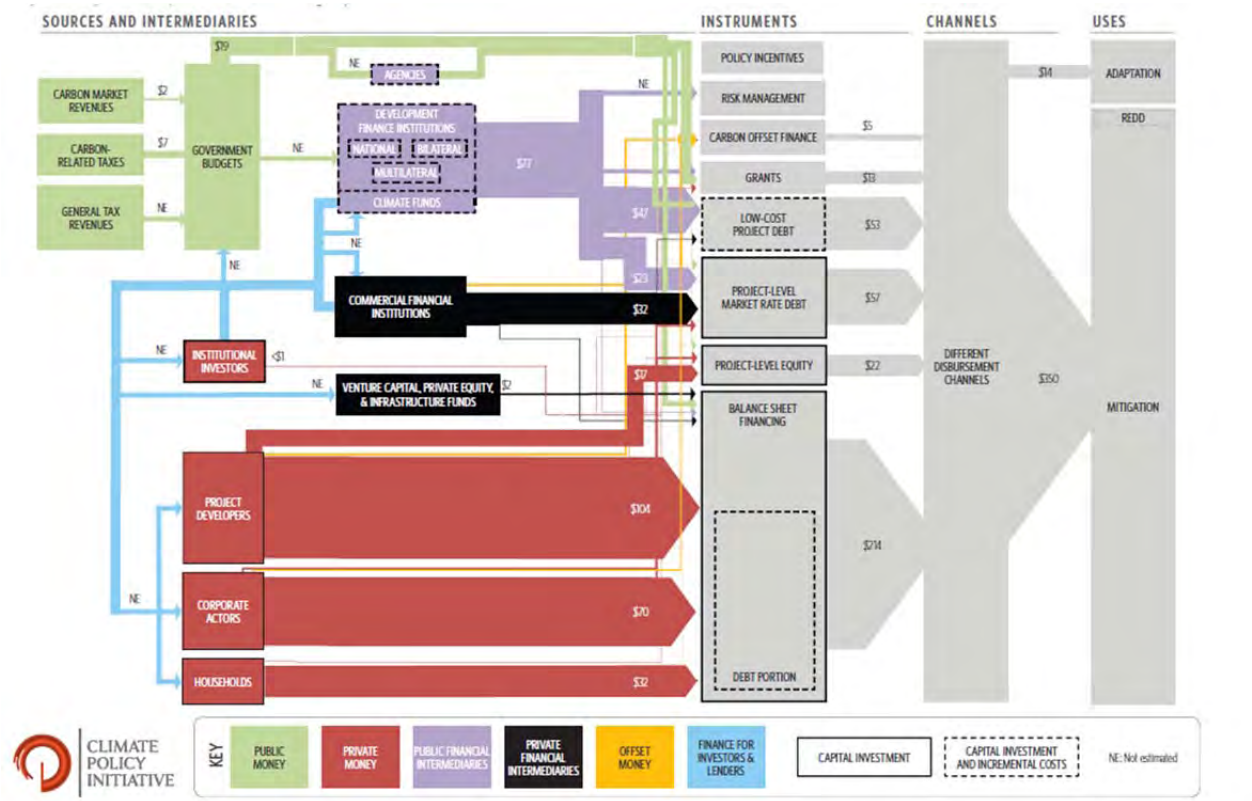
23. Development Finance Institutions (DFIs)[9] support energy efficiency for energy security, climate change priorities or other purposes, and this financing is on the rise. DFI energy efficiency portfolios include a wide range of activities including, technical assistance and policy incentives, financial intermediation, direct investment in projects and programs, as well as piloting new financing models and combining and leveraging various streams of finance. According to the Climate Policy Initiative, governments and public financial intermediaries provided the following amounts in support of renewable energy and energy efficiency in 2010/11:

- National Finance Institutions (NFI): $28.9 billion (67.7% of NFI climate financing), with strong concentration in two countries, Brazil and China;
- Bilateral Finance Institutions (BFI): $3.6 billion (29.2% of BFI climate financing for renewable energy and 13% for energy efficiency);
- Multilateral Finance Institutions (MFI): $13 billion (61.45% of MFI climate financing).

[8] For a more detailed discussion see Buchner, Barbara, Jessica Brown and Jan Corfee-Morlot. (2011). *Monitoring and Tracking Long-Term Finance to Support Climate Action*. May 2011. OECD/IEA Project for the Climate Change Expert Group on the UNFCCC.

[9] DFIs are defined in the CPI report as comprising 4 Bilateral Finance Organizations, 9 Multilateral Finance Organizations including the World Bank, and 19 National Finance Organizations.

Figure 3. *Climate flows 2012*



Source: Climate Policy Initiative (2012)

24. Overall, as outlined in Table 4, a number of financing tools exist that can address the various needs related to EE financing, from the policy/regulatory enabling environment, to investments and risk guaranties.

25. In 2012, multilateral development banks (MDBs) collectively committed more than $25 billion for climate action, of which approximately 80% was dedicated to mitigation activities. In the order of $12 billion is considered to have been allocated to sustainable energy, which includes energy efficiency, but the exact collective amount for energy efficiency has not yet been calculated.

Table 3. *Possible financing partners – a non-exhaustive list*

SOURCE OF FINANCING	DESCRIPTION
Investor capital formation	Investor capital is generated by bank, private and corporate investors responding to perceived investment opportunities offered by the market for an expanding range of EE appliances driven by technology improvement, growing consumer demand, increasing costs of energy, and increasing EE standards.
Multilateral Development Banks (MDBs)	MDBs and donors manage various loan facilities that seek to help developing countries eradicate poverty and achieve global development targets, under which EE is gaining importance as a financing/development priority.
Global Climate Change Alliance (GCCA)	Initiative of the European Union to build a new climate change alliance with developing countries, working through established channels for cooperation.
Global Energy Efficiency and Renewable Energy Fund (GEEREF)	A Public-Private Partnership designed to maximize private finance leveraged through European Commission public funds, managed by the European Investment Bank with a focus on financing SMEs.
Clean Technology Fund (CTF)	The CTF is one of the funding windows under the Climate Investment Funds (CIF), partnership of the MDBs that provides incentives to middle income and developing countries to scale up the demonstration, deployment, and transfer of technologies with a high potential for long-term GHG emissions savings, including EE.
Global Environment Facility (GEF)	The financial mechanism for a number of Multilateral Environmental Agreements (MEAs), including the United Nations Framework Convention on Climate Change (UNFCCC) and for CEITs under the MP. The GEF finances the incremental costs of project activities, i.e. only those that are being undertaken to meet the objectives of the MEA (global benefits). By 2011, GEF funding had supported over US $140 million for EE projects.
German International Climate Initiative (ICI)	The ICI finances climate projects focused on, inter alia, promotion of a climate-friendly economy.
Indonesia Climate Change Trust Fund (ICCTF)	A national funding entity established by the Government of Indonesia, the ICCTF acts as a catalyst to attract investment and implement a range of alternative financing mechanisms for climate change mitigation and adaptation programs.
UK International Climate Fund (ICF)	Operational since 2011, the ICF is the primary channel for UK climate change finance, through which developing countries may receive funding to embark on low carbon growth.
Japanese Fast-Start Financing	Fast-Start Financing (or Hatoyama Initiative) makes available up to USD$15 billion in public and private financial assistance to help developing countries address climate change.
Green Climate Fund (GCF)	Mandated by the parties to the UNFCCC, once operational the GCF is intended to provide funds to developing countries to finance climate change adaptation and mitigation activities, including for EE.
World Bank Carbon Finance Unit (WB CFU)	The WB CFU enters into transactions as Trustee of various carbon funds. Whilst originally the focus was on “project-based” transaction, using financing contributed by public and private sector entities from OECD countries to purchase project-based GHG emission reductions in developing countries and CEITs, the scope of its activities now includes programs as well broader considerations.

Source: this report; based on various sources

Table 4. *Energy efficiency financing needs, tools and examples; financing instruments available*

Financing needs, tools, and examples	Available financing instruments
Creation of enabling environment, including capacity building • *EE regulations:* energy efficiency appliance standards and labeling, building codes, industry performance targets, fuel efficiency standards • *Regulatory reforms:* removal of subsidies (power and heating pricing reform), decoupling sales from revenues • *Technical assistance:* to ESCOs and other EE project developers to build an ESCO industry and prepare financing deals; to financial institutions to develop financial products; to government agencies on public procurement rules; to utilities on EE/DSM program; programs for cooling and heating design • *Government tax reform and incentives*	MDB resources are available to meet these costs. Grants from the GEF, Bank Trust Funds (ESMAP, ASTAE, PPIAF, PHRD, etc.), foundations, or other donors
Investment resources *Private financing:* EE projects may be profitable and have short payback periods, but they suffer from other barriers such as inertia, principal-agent problems, or managerial challenges	International or national investment capital may be used if investment meets risk-reward requirements
Long-term financing can be provided to governments on a sovereign guarantee basis for the following: • *Lending for energy efficiency:* Lending to municipalities or power utilities • *Lending to local financial institutions:* Lending stimulates on-lending for EE investments • *Public procurement:* Bulk procurement of energy-efficient retrofits for government buildings • *Green/Climate bonds:* support low carbon development/finance energy efficiency	Government resources and development banks may also be used Mobilized from private sector
Concessional element in financing: • *Financial incentives:* Providing consumer rebates • *ESCOs:* Providing initial capital to set up ESCO industry • *Dedicated revolving EE fund:* Operating like a dedicated investment fund • *Utility EE/DSM fund:* Paying costs of utility-based efficiency programs	CTF, IDA (in low-income countries) Concessional financing from other donors (AFD, KfW, or JBIC) or GEF resources (for piloting or demonstration only), Govt may also provide this Carbon finance may assist with energy efficiency programs and provide additional revenue based on project generating emission reductions
Risk mitigation Partial risk guarantees for investments or technology (can also be supported with concessional finance)	The Multilateral Investment Guarantee Agency (MIGA), part of the World Bank Group, provides partial guarantees; The Global Environment Facility (GEF) has, in the past, provided limited risk guarantees on first-loss positions; Commercial bank & other risk guarantees are also available

Source: Research undertaken for this report

26. *Private flows*, which are broadly defined as financial institutions and investors, corporate actors and households, represent the lion's share of climate investment. In 2010/11, private flow investments amounted to approximately $217-243 billion globally, or 63% of the total. Contributions from private intermediaries, commercial banks and infrastructure funds, are considered to be in the order of $33.1-42.8 billion. Here, even more so than for public sources, the information behind private flows for climate action is tenuous. Important data

gaps exist and assumptions are often required given the multiplicity of sources and endpoints, confidentiality issues and lack of data. Flows are not only difficult to quantify, but it is difficult to estimate to what extent they may have been stimulated by specific policy and regulatory actions.

27. Overall, without differentiating between mitigation and adaptation inputs, private actors contributed approximately $85 billion to financing in developing countries, with 80% financed from their balance sheet. CPI (2012) further estimates that this contribution is largely internal to developing countries; that is, domestic private actors contributed up to 83% of the private investments in developing countries – making them a critical target for awareness raising and capacity building. In China for example, 79% of energy efficiency financing is estimated to stem from domestic private sources.

3.3. Carbon Finance

28. There are several types of carbon market instruments which developing countries could use to help finance the introduction of low GHG, ozone friendly, equipment:

- The Clean Development Mechanism (CDM);
- International and domestic voluntary carbon markets;
- Emerging domestic cap and trade systems; and
- New Market Mechanisms currently under development (NAMAs[10], sectoral crediting, new types of offset instruments, e.g. the Japanese "Joint Crediting Mechanism").

Carbon finance concepts

29. The United Nations Framework Convention on Climate Change (UNFCCC) governs climate change negotiations. The UNFCCC's Kyoto Protocol (KP) in turn contains the targets and timeline to which so-called Annex I Parties[11] agreed to reduce their GHG emissions as well as the flexible mechanisms they may use in meeting their targets. Parties who ratified the Protocol can either meet their emission cap through domestic action, or they may purchase emission quotas ("Assigned Amount Units") from other Annex I Parties or project-based carbon offsets ("Certified Emission Reductions") from developing countries through the Protocol's Clean Development Mechanism (CDM). Outside the Kyoto Protocol and the demand generated by Parties needing to meet legally-binding emissions targets, a (smaller) voluntary carbon

[10] Nationally Appropriate Mitigation Action (NAMA) refers to a set of policies and actions a country commits to undertake to address its climate change challenges and low carbon development goal. These may include scaling up of renewable energy development, energy efficiency measures, forest management, solid waste management, public transportation etc. As of September 2012, about 50 countries had submitted information regarding their NAMA to the UNFCCC and one of the mechanisms to support the framing and implementation of NAMAs is through the Partnership for Market Readiness. Resources from both public and private sectors at domestic and international levels need to be mobilized for countries to take actions.

[11] Countries with legally binding emissions objectives under the KP those that were member of the OECD in 1997 (when the Protocol was negotiated and adopted) and the countries with economies in transition. While most Annex I Parties observed the Protocol's first Commitment Period (2008-12), the USA never ratified the Protocol and Canada withdrew after having ratified it. The Protocol's agreed second Commitment Period is supported by even fewer countries (essentially only the European Union). A new climate treaty with broader participation is currently being negotiated and planned to come into force in 2020.

market has also emerged consisting of voluntary demand for emissions offsets not required for regulatory compliance.

30. CDM projects are activities that can demonstrate that they will reduce GHG emissions (measured in tons of CO_2 equivalent - tCO_2-eq) compared to a baseline, usually the business-as-usual (BAU) scenario. For example, a project which proposes to install energy efficient air conditioners compared to the baseline equipment and which can demonstrate that this activity results in reduced consumption of energy and hence lowered CO_2 emissions (from power generation, based on the GHG intensity of the power grid) may qualify as a CDM project[12]. CDM projects must also contribute to meeting the sustainable development of the host country. The same principle is typically applied by standards and emission registries that facilitate carbon offset projects and the generation of carbon credits for the voluntary market. Carbon finance concepts are described in detail in Annex III.

31. Carbon finance projects and the emission reductions they generate are normally registered, either with the UNFCCC (for CDM projects) or with a registry in the voluntary market, after they have been verified to meet the required standards. Registration will usually enable the project developer to sell the expected or the verified and registered actual emission reductions (certified emission reductions - CERs - under the CDM) to another party wishing to offset its own CO_2 emissions. The sale of emission reductions from a carbon offset project will usually generate an income stream that will support the project over time, but which may also be used to raise project finance. That is, at least initially, the CDM – and carbon finance in general – were also thought of as a financing mechanism for investments in energy efficiency and cleaner technologies in developing countries. However, carbon finance was not in fact designed to address investment barriers in underlying projects as most carbon purchasing contracts (e.g., emission reductions purchase agreements - ERPAs) consider payments for credits upon delivery. Therefore, project developers have found this form of project finance difficult to access, since commercial banks were reluctant to accept ERPAs as collateral for their loans. It should be noted, however, that this touches on a more general issue of financing of demand-side energy efficiency with future energy savings, and that this difficulty is not inherent to the CDM only.

32. Project-based carbon finance instruments are structured as performance-based payment schemes with internationally defined overarching principles and methodologies for assessing project eligibility and quantifying, monitoring, reporting and verifying GHG impacts of project activities. Project-based carbon finance has been instrumental in reducing emissions of short-lived climate pollutants (SLCPs), such as methane, from waste management operations, and HFCs, from chemical plants, which are covered by the mandate of the Kyoto Protocol.

Targeting HFC-23 incineration with the Kyoto project-based mechanisms

[12] A similar Kyoto Protocol mechanism, known as “Joint Implementation”, exists for emission reduction projects in Annex I countries.

33. Some CDM projects were developed to support the incineration of HFC-23, which is generated as a by-product in the production of HCFC-22, a Montreal Protocol-regulated chemical, either for refrigerant or as input ('feedstock') for the further production of synthetic polymers. This is described in more detail in Annex IV. Given the high GWP of HFC-23, plant operators were, until recently, able to earn significant revenue through the carbon offset market, far exceeding the cost of purchasing, installing and operating HFC-23 incinerators and the transaction costs linked to the carbon market. However, concerns over the abundance of HFC-23 credits and with the risk/perception for perverse incentives, and questions regarding their additionality and contribution of these activities to host country sustainable development, all led to a decision in 2012 by the EU to no longer allow the use of carbon credits from such projects for compliance within the EU Trading Scheme (ETS), thereby effectively halting most carbon finance flows to HFC-23 destruction projects.

34. Therefore, while carbon finance proved extremely effective in early years at catalyzing investments for mitigation of HFC-23 releases, eligibility restrictions on CERs associated with GHG reductions from the destruction of HFC-23 in the EU-ETS is having a big impact and raises doubts that this mechanism could be expanded to help finance future ODS mitigation efforts.

Destroying ODS Banks with the voluntary carbon markets

35. At a much smaller scale, voluntary carbon markets are creating incentives for the recovery and destruction of ODS, as described in more details in Annex IV. While the MP regulates the production and consumption of ODS, a significant amount of ODS still remains contained in equipment, products, and stockpiles, and risks being released into the atmosphere in the absence of appropriate regulatory or financial incentives. Activity has, thus far, been limited, except in California where transactions have increased in number and volume from 2010 to 2012. The level of interest expressed remains low however in comparison to the volume of ODS potentially eligible for destruction, as provided by some estimates[13]. Moreover, the voluntary markets today are suffering from the same uncertainties and depressed prices as the CDM, though they appear less affected.

Assessment of carbon market experience and risks based on 12 years of operation

36. The main suppliers of CERs have been China, India, Brazil and Mexico, accounting for over 95% of all CERs issued to date. Over 62% of CERs issued derive from industrial gases projects including HFC-23, N_2O, and PFC projects which have been attractive targets for CDM projects in the early stages of the carbon market, taking into account their high GWP, high concentration and the relative robust financial and technical nature of their industrial emission sources. Conversely, end use energy efficiency projects including, in the Ref/AC and chiller

[13] See "*Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market*", ICF International (2010).

replacement sectors, have made negligible progress, with fewer than 10 projects issuing CERs, each in small amounts.

37. Overall, while carbon finance instruments have established very detailed procedures for accounting of, and banking on, GHG emission reductions, they are not without risk, for the following reasons:

(i) carbon finance instruments pose risk for both project developers and buyers of carbon credits. For the former, carbon finance procedures are burdensome, projects are time consuming to develop, and they present risk with regard to the possibility of non-registration, or, if registered, with regard to the possibility that expected volumes of emission reductions may not be issued – the CDM board is looking at measures to improve the efficiency and effectiveness of the CDM. From the perspective of the buyer, if the expected income from a carbon finance project is critical to the success of a project (related to the additionality criteria), such risks may be perceived to be too high to proceed with carbon financing;

(ii) program design and successful delivery: there are transaction costs associated with dealing with multiple dispersed sources of financing, but also associated with programs involving smaller interventions - how to bundle these and coordinate activities to generate an attractive package has been a key challenge. In this regard, significant progress has been made under the CDM's programmatic approach[14];

(iii) carbon finance rules do change from time to time and while some simplifications have been introduced, revisions of rules and modalities often lead to greater stringency;

(iv) the recent severe downturn in prices of emission reductions resulting from a lower demand associated with economic downturn does not encourage the use of carbon finance at this time. Nonetheless, a number of actors, including the European Union and the World Bank, are exploring measures and means to revitalize the market; and a new round of carbon finance is expected to emerge, linked to a new climate treaty entering into force – none of this in the short term.

38. Despite its complexity, the CDM was quite successful in terms of number of projects and capacity built in developing countries – upon which the new generation of carbon finance instruments builds. Carbon finance programs however can take anywhere from 3 – 6 years to deliver an actual revenue stream associated with the value of the carbon credits, and given the current market situation, they do so at very low rates of return. As a result, this serves as a disincentive for any project that would be dependent on carbon finance income.

[14] Small-scale methodologies, programs of activities and micro-projects have been promoted, leading to several CDM projects addressing efficient lighting, micro-hydro etc.

3.4. Current Status of Carbon Markets

39. Glut of carbon assets from CDM at time of severely contracted demand. In the order of 2.4 billion tons of CO_2eq carbon credits were contracted during the 2002-2011 period from both developing countries and countries with economies in transition. These contracts reached a cumulative total worth of US$28 billion in carbon credits and supported underlying investments of more than US$150 billion in developing countries, principally from the private sector.[15] Since 2011, the market has contracted in reaction to the end of the first Kyoto Commitment Period and EU restrictions on the use of CDM credits from new projects (except in LDCs) in the third phase of the EU ETS. Whereas in 2007, 636 million primary[16] CERs were traded for $8.2 billion, by 2011 this had declined to just 263 million primary CERs at a value of $2.9 billion.[17] And though November 2012 saw the registration of the 5000th[18] project by the CDM Executive Board, at the same time the price of primary CERs dropped to under $1 compared to the $20+ value they commanded in 2008. The voluntary market has been somewhat less impacted, but has also seen a drop in prices.

40. Carbon market outlook for 2013 to 2020: It is projected that approximately 2.5 to 3 billion CERs[19] will be issued from projects registered before the end of 2012 against a demand of no more than 1.5 billion CERs, largely due to restrictions following the economic downturn in the world's largest market, the EU ETS, which has historically driven demand for CERs. The voluntary carbon market, which is smaller, may face similar difficulties. Therefore, CER prices are expected to remain depressed, which provides little incentive to the market to develop new CDM projects.

41. Decisions emanating from UNFCCC Conference of the Parties, Doha post 2012: The flexible mechanisms of the Kyoto Protocol (CDM, JI and emissions trading through Assigned Amount Units) continue to exist as compliance instruments for the Parties[20] to the second commitment period from 2013-2020. However, no additional compliance demand for carbon assets will result, given that a review of commitments will not take place until 2014, and no significant actions were taken to address the current position of the carbon market as outlined above.[21]

[15] Bloomberg New Energy Finance, 2012. Reference to investments in 2010 and 2011.
[16] "Primary" CERs are purchased from the original party that makes the reduction.
[17] This represents a 2011 monetary value of forward (primary) project-based transactions for generation of pre-2012 and post-2012 CERs, ERUs and voluntary market (see State and trends of the carbon market, 2012, WB).
[18] As of May 13, 2013, 6,830 projects have been registered. http://cdm.unfccc.int/
[19] Undiscounted and risk adjusted values are over double this figure.
[20] Excluding Japan, New Zealand and Russia, but including Belarus and Kazakhstan with emission caps.
[21] The following actions which are expected to provide results in the medium term were agreed to :

- The Green Climate Fund which is intended to be operational in 2014 – though progress has been slow in setting this up;
- Germany, the UK, France, Denmark, Sweden and the EU Commission announced concrete finance pledges in Doha for the period up to 2015, totaling approximately 6 billion USD;
- A work programme has been agreed to further elaborate the new market-based mechanism under the UNFCCC, and also sets out possible elements for its operation. A work programme to develop a framework for recognizing

42. The European Union (EU) policy changes: Carbon credits which are generated from projects in non-LDCs registered before end of 2012 will remain eligible under the European Emissions Trading Scheme, while those registered after 2012, or from industrial gasses projects, including from HCFC-22/HFC-23 projects, have become ineligible under the EU ETS post-2012.

43. Implications of current CDM and joint implementation[22] (JI) market for phasing out HCFCs: Given the lack of demand for emission reductions, which is projected to last through the mid-term, coupled with the continued projected low price of emission reductions and the EU position, carbon finance as currently configured does not present a reliable financing option to support the phase out of HCFCs, especially for MICs.

44. In the post-Kyoto area, the CDM will likely lose its dominant role and be supplemented by new generations of international and domestic carbon market instruments (e.g. NAMAs, Bilateral Crediting Mechanism (Japan), policy and sector-based crediting). This is relevant since the concept of synergies may most effectively be introduced at the formative stage of these new mechanisms. Examples exist in the international and increasingly domestic voluntary carbon markets, where for instance the "Gold Standard" enhances its carbon credit offerings by certifying (and monetizing) additional sustainable development benefits. It should, for instance, be possible to define a carbon asset class that certifies energy efficiency and GHG reductions, or ozone and climate benefits.

45. The focus in climate finance circles is now turning towards developing a new and wider array of climate finance instruments which could, amongst other things, better support energy efficiency and related ODS phase-out efforts.

3.5. Emerging Domestic and International Schemes

46. Despite the challenges facing the global CDM-based market, many countries have learnt from the experience and now are exploring innovative and cost-effective ways to scale up emissions reductions and foster financial flows, including through carbon market instruments. Much of the current focus of the international community is towards the next generation of carbon mechanisms, including new international mechanisms that aim to target "broad segments of the economy" (as opposed to project-by-project) and deeper GHG reductions, and international framework for domestic carbon markets that are starting to emerge. Under the Partnership for Market Readiness (PMR), a grant-based, global partnership, the World Bank is working with a number of developed and developing partners, representing some of the world's largest economies, to build readiness for market-based instruments for GHG emissions

mechanisms established outside the UNFCCC, such as nationally-administered or bilateral offset programs, and to consider their role in helping countries to meet their mitigation targets, has also been agreed.

[22] The "joint implementation" mechanism defined in the Kyoto Protocol allows a so-called Annex B Party (industrialized countries, roughly equivalent to non-A5 countries under the MP) to earn emission reduction units from a project in another Annex B Party. This is therefore relevant for the Countries in Economies in Transition, and not directly relevant to MLF supported activities.

reduction. To date, nearly $30 million in grant funding has been allocated to 16 nations to support the design and development of market approaches to greenhouse gas emission reductions. This includes development of monitoring, reporting and verification systems and consideration of scaled-up crediting mechanisms and domestic cap and trade schemes to meet given emissions caps cost effectively and meet national mitigation objectives, and to promote energy efficiency in response to rising power costs and demand, growing supply bottlenecks, and energy security issues. Some examples, including support for developing Nationally Appropriate Mitigation Actions[23] (NAMAs), are outlined in Table 5 below. Moreover, PMR participants have recently agreed to explore opportunities to pilot emission reductions transactions in connection with a payment facility to purchase emissions credits generated as part of the Partnership's activities[24].

Pay-for-Performance mechanisms

47. Pay-for-performance mechanisms (also known as results-based finance) are also being developed that build on the experiences of the international community with carbon finance, and with output-based aid. Such schemes disburse cash on the delivery of pre-determined and independently verified results. Compared to traditional funding mechanisms, pay-for-performance provides increased transparency and accountability along with greater scope for innovation that can also be a powerful catalyst for private investment and maximize public value for money. Pay-for-performance mechanisms present opportunities for short-term climate mitigation interventions and can serve as stop-gap measures to breathe new life into carbon markets.

48. Following the request of the G8, the World Bank convened a group of experts, the Methane Finance Study Group, which released its report in April, 2013, that evaluates new approaches to financing methane reduction activities. An innovative recommendation from the Group is to establish a climate finance facility that would use payment for performance against independently verified emission reductions to provide incentives for methane abatement projects, and rely on an auction mechanism to ensure the lowest possible cost to the funder. There is a great deal of interest in this initiative, and the partners in the Climate and Clean Air Coalition subsequently agreed in September 2013 to establish a similar Study Group to review potential strategies for supporting financial flows towards projects that can significantly reduce black carbon emissions.

[23] Nationally appropriate mitigation actions (NAMAs) are domestically developed voluntary initiatives adopted by developing countries to mitigate their GHG emissions. Countries develop NAMAs for those sectors which most interest them, for example renewable energy (e.g., geothermal) or energy efficiency (e.g., energy efficient buildings or equipment). The financing of NAMAs will use domestic resources or resources provided by donor countries ("supported NAMAs") including through carbon markets ("credited NAMAs"). The UNFCCC has established a website for the submission of information on NAMAS and for donors to review and decide if they wish to support a particular NAMA.

[24] Strategic orientation for the future of the Partnership for Market Readiness, PMR Secretariat, October 2013 http://www.thepmr.org/system/files/documents/PMR_Draft_Strategic%20Note_October2013.pdf

Table 5. *Examples of relevant country undertakings under the Partnership for Market Readiness*

COUNTRY	PMR ACTIVITIES
Brazil	Brazil has a voluntary commitment to reduce emissions by 36.1%-38.9% below business-as-usual by 2020. The country is currently considering mitigation plans that cover the forestry, agriculture, energy, iron, steel, transportation, mining and building sectors. As part of its proposed PMR activities, Brazil is analyzing different carbon pricing instruments suitable for given sectors.
China *	China aims to reduce emissions intensity by 40-45% compared with 2005 levels by 2020. In order to achieve this objective—and as included in its 12th Five-Year Plan—China looks to create statistical and verification systems for GHG emissions and to pursue pilot emissions trading schemes (ETS) in five cities and two provinces. The country aims to set up a national scheme by 2015. China's market readiness plan, supported by financing from the PMR focusses on the design of China's national emissions trading scheme, including (i) core technical, institutional and regulatory market readiness components; (ii) design elements of main ETS components; and (iii) specific consideration and research on issues facing State-owned enterprises and the power sector in a carbon emissions trading scheme.
India *	India aims to reduce its GHG carbon intensity by 20-25% compared with 2005 levels by 2020 as a voluntary commitment. Energy efficiency measures are being promoted and scaled up to permit these significant reductions in energy intensity. India's Perform Achieve and Trade Scheme (PAT) is an existing market-based mechanism that covers 8 industrial sectors, that was developed to enhance the cost effectiveness of improving energy efficiency through certification of energy savings that may be traded using energy savings certificates (ESCerts). The PAT aims to accelerate a shift to energy efficient appliances in designated sectors through the use of innovative measures to make products more affordable, and creating mechanisms that would help finance demand side management programs in all sectors by capturing future energy savings. To further intensify these efforts, India is working through the PMR to develop reporting guidelines for EE and expand sectoral coverage of the PAT. This scheme is particularly interesting due to its innovative nature and potential for replication in other countries.
Indonesia*	Indonesia plans to reduce its national GHG emissions by 26 percent from its BAU scenario by 2020 and by an additional 15 percent with international support. With assistance from the PMR, Indonesia plans to build MRV systems for the power sector and its cement industry as well as conduct research and consensus building activities on the future use of market-based instruments.
Jordan *	The PMR is helping Jordan explore the potential for scale-up of crediting for NAMAs in renewable energy, water (energy efficiency in pumping, waste water treatment) and/or solid waste management sectors.
Mexico	Mexico pledges to reduce up to 30% of its emissions by 2020 compared to its baseline scenario, dependent on international support and participation in external markets. As part of its PMR Activities, Mexico is focusing on the development of three crediting NAMAs in the following target areas: (i) urban services; (ii) appliance/refrigerators; and (iii) urban transport, as well as on the elaboration of a national registry/tracking tool for emissions data collection, management and reporting system.
Thailand *	Thailand seeks to lay the groundwork for a low carbon society, as outlined in its 11th National Economic, Social, and Development Plan, and to reduce energy intensity by 25% by 2030 as compared to 2005 levels and to increase the share of alternative energy to 25% of final energy consumption by 2021. PMR support in Thailand will help create an Energy Performance Certificate scheme (EPC) and a pilot Low Carbon City Program (LCC).
Vietnam *	PMR support in Vietnam will, inter alia, help design and pilot market instruments in the steel, solid waste, and power (energy efficiency) sectors. Vietnam's emissions reduction strategy focuses on energy efficiency and large-scale renewable energy production. The country aims to reduce energy consumption per unit of GDP by 2.5-3% per year by 2020 and to reduce greenhouse gas emissions relative to its BAU scenario by 2-3% per year from 2020 to 2030. Vietnam is also developing a Green Growth Strategy that envisions emission reductions from the energy sector by 10% relative to BAU (and 20% with international support) by 2020.

* Indicates countries with whom the World Bank is working on HCFC consumption and production projects.

Source: this report, based on http://www.thepmr.org/

4. OPPORTUNITIES FOR SYNERGY: BUILDING ON EXPERIENCE

4.1. Experience with Multi-Source Financing: the "Chillers Replacement" Cohort of Projects

49. A cluster of projects that targeted the conversion of building chillers, with the explicit intent to address servicing uses of CFCs, potential climate co-benefits and identification of additional financing from other sources offers useful insight and lessons learned regarding securing and implementing multi-source financing .

50. The analysis reviews the achievements and on-going challenges associated with five projects: India, Indonesia, the Philippines, Thailand and Turkey. This analysis does not constitute a formal evaluation, nor is it comprehensive. Rather, it provides a qualitative overview of some of the difficulties encountered at the various stages of implementation, and reflects upon the lessons that may be extracted and serve as possible guidance for such future work. The details for each project are presented under Annex V.

51. Overall experience with this cohort of projects has been mixed, and this even though chiller replacement allowed unusually large energy efficiency gains (30% and more), thereby providing a rapid return on investment. While they represent a clear effort to acknowledge synergies inherent amongst the different global environmental conventions and their financing mechanisms, they also speak to the complexities that can arise as additional financing partners become involved, as well as when a "blended" approach applies in name only. Such challenges have ranged from an inability to synchronize the timing of financing approvals, the collapse of the carbon market, the impact of the 2008 financial crisis, competing institutional, governance, and implementation arrangements (e.g. dual reporting), namely under the MLF and GEF, and issues regarding the acceptability, suitability and commercial availability of alternatives.

52. In general and as noted earlier in the report, the difficulty of truly leveraging underlying investment with carbon finance revenues has been a challenge for the carbon finance experience thus far. Here, carbon finance in and of itself has not driven the financing of chiller projects largely due to doubts associated with the status of the CDM in light of the political uncertainty regarding the post-Kyoto timeframe, as well as the current depleted state of the carbon market. Where the integration of carbon finance has been tested, it has tended to overburden projects with heavy monitoring procedures and, in general, higher transaction costs. Moreover, within the context of chiller replacement, one barrier lies in the opportunity cost of access to up-front financing for the investment, a challenge that can also be compounded by low energy tariffs. The India experience, in particular, shows that as a result of this barrier (and a lack of trust in carbon markets), participants will choose up-front compensation over greater compensation in future – the CER price level being a factor of course.

53. Lessons drawn from an extensive study on chiller replacement in India formed the basis of the World Bank's design to secure MLF financing for the global chiller demonstration program. Based on the recognition that carbon finance would not address the opportunity cost barriers, the strategy adopted was for MLF and GEF funding to cover the upfront costs for the first round of chiller replacement and, once carbon finance returns started to flow, these could in turn be utilized for upfront financing to bring additional chiller owners onboard. Unfortunately, this premise could never be effectively tested given the global economic downturn and subsequent collapse of the carbon market.

54. Experience with these projects has also demonstrated that multi-source financing tends to lead to heavy implementation structures and procedures. There is a need to simplify procedures and processes not only to streamline obtaining financing from multiple sources, but also with respect to reporting requirements imposed during implementation. At present, for example, it is a requirement to maintain strictly separate progress reporting and accounting of relatively small amounts of MLF and GEF financing for 'blended' projects, despite the similarities between the instruments and their quasi identical shareholder base. The design of similar future projects should strive to substantially simplify procedures and minimize additional administrative requirements, and should consider exploring the potential for joint project design, approval and oversight functions in order to enhance efficiency and reduce transaction costs.

55. The experience gained in Turkey demonstrates how positive results may be derived through application of a simple and targeted project design can rapidly deliver the desired market transformation. Here, non-grant instruments were used to overcome the opportunity cost, low energy tariffs and lack of fiscal incentive barriers that were faced. The Turkish counterparts who managed the project on the ground offered an attractive financing package (zero interest loans with three year payback periods) and also actively promoted chiller replacement, which ultimately led to the project achieving a high success rate.

56. One broad lesson that can be drawn from this suite of projects is that concessional financing is important for this type of projects, and is particularly relevant as it also benefits and can leverage funds for climate mitigation. In particular, where, as in this instance, there are multiple barriers to be addressed, from operational complexity, with multiple project cycles of different institutions and funding mechanisms (including GEF and MLF), regulatory/policy uncertainty (state of the CDM) and technical difficulties (choice of refrigerant).

57. As noted above, the market for primary CDM has dropped to its lowest level since 2004, linked to declining demand for offsets resulting from economic turbulence, a growing long-term oversupply of carbon offsets in the EU ETS and plummeting carbon prices. This has impacted the vision behind the strategy governing the more recent group of projects, requiring that they be restructured to adapt to the new context, and deliver the best possible outcomes in terms of chillers replacement in that context.

Box 1. *The "chillers replacement" cohort of projects – Key lessons*

- Five "chillers" projects were implemented or prepared by the World Bank; four envisaged multi-source financing with GEF co-financing, including three of those that also envisaged a carbon finance (CDM) revenue stream.
- The most successful of the five projects, based on the number of chillers replaced, is the oldest one (for Turkey) which, whilst it promoted an innovative revolving fund for chillers replacement, relied on a single source (MLF) of international financing.
- The projects that had envisaged relying on a CDM revenue stream had to drop that component. It is difficult however to tease out intrinsic project design /CDM delivery issues from the overall collapse of the CDM – in other words, these projects might have been fully successful had the CDM not collapsed (and more countries ratified the Kyoto Protocol).
- There is some evidence however that carbon finance led to overburdening the projects with monitoring and verification procedures which were unattractive to chillers owners.
- Technical issues (i.e. choice of refrigerant) were the source of irreconcilable differences, ultimately leading to the cancellation of one of the projects (Indonesia).
- Blending MLF and GEF resources has been a source of delay related to different project cycles and approval procedures, despite similarities in instruments and quasi identical shareholder base.
- Blending MLF and GEF resources has also lead to heavy implementation structures and procedures, with requirements for separate progress reporting and accounting of relatively small amounts of grant financing – these procedures should be streamlined and simplified.

These lessons derive from a qualitative and non-exhaustive analysis of experiences with the cohort of "chillers" project implemented by the World Bank, rather than from a formal evaluation. These lessons in general are relatively nuanced, and the more detailed overview provided in Annex 5 of this report should be read to gain a more thorough understanding of the challenges faced, and opportunities.

58. Taking this experience and looking more broadly, some options might be explored to avoid compartmentalization and facilitate "multi-benefit" or synergetic approaches. Financial resources could be pooled upfront from different sources and funds (e.g. GEF and MLF) and under a specific mandate to address synergies more systematically to effectively create a seamless single-window for project proponents and implementers. In the longer term, a single funding mechanism that would address environmental benefits on a broad basis (e.g. including national and local benefits) could also be envisaged. With a more robust carbon market, benefits generated could be converted into assets to be monetized in emerging environmental markets (such as the carbon market) and/or sold to (or reimbursed by) specialized funds or interested parties. Although such an approach is not without governance and administrative complexities and risks (political and market related), the Green Infrastructure Investment Fund[25] (GIIF) that is being developed in the East Asia Pacific Region, for example, is exploring comparable avenues.

[25] The recent World Bank study on a Green Infrastructure Investment Finance framework to stimulate greater flow of funds for green investments in EAP countries is primarily oriented toward promoting private investments, but can also serve to accelerate public-private partnerships as well as purely public engagements. The framework consists of an analytical

4.2. Some Relevant Models for Phasing out HCFC-22 in the Residential Sector

59. Two main approaches have been adopted by developing countries in promoting new Ref/AC technologies from the energy standpoint. First is the set of policy-based approaches using appliance energy efficiency standards (along with appliance energy efficiency labeling systems), and often in conjunction with building energy efficiency codes. This approach is primarily focused on new stock and works well in countries where energy (electricity) pricing is rational and where the compliance regime is robust with infrastructure available (testing laboratories, etc). However, as a short-term measure, often the second approach of financial incentives is adopted especially where there are limited incentives for consumers to adopt new energy efficient appliances or replace existing appliances with new ones as these are more expensive, and neither are manufacturers willing to promote these into the market in the absence of binding regulations and consumer demand. The choice between mandatory regulation (efficiency standards), incentives (subsidies in various forms), and purely voluntary programs (e.g., labeling and disclosure of efficiency ratings) is of relevance to appliances and therefore refrigerants. Most of the World Bank's interventions in the areas of appliances, including refrigeration and air-conditioning, are in the second category – that is based on financial incentives - as relying on standards and labeling enforcement, only, is often found difficult by governments.

60. The following section explores examples that have been developed recently or that are under development, and that offer promising models for addressing climate co-benefits, particularly in the residential sector.

<u>The Mexico Efficient Lighting and Appliances Project (ELAP)</u>

61. The Mexico ELAP paradigm highlights a number of key relevant characteristics that can serve to inform the design of a cross-cutting ozone-climate co-benefits model. The project was approved in November 2010, with a development objective to promote Mexico's efficient use of energy and mitigate climate change through the increased use of energy efficient technologies at the residential level. The vehicle by which to achieve these objectives is to promote the development of a sustainable market for energy efficient equipment among the large and fast growing energy end-use sectors for lighting and Ref/AC.

62. The project has three components including, the replacement of 45 million incandescent bulbs with compact fluorescent lamps (CFLs) in the low to medium-income residential sector and targeted technical assistance and institutional strengthening. Its Component 2, in particular, is designed to provide incentives to encourage the replacement of

methodology to assist policy makers in deriving the financial "viability gap" of green investments, and a country assessment framework to allow a better understanding of a country's investment climate in general and green investments climate specifically. (http://documents.worldbank.org/curated/en/2012/04/16253049/green-infrastructure-finance-framework-report)

old and inefficient appliances, namely refrigerators and air-conditioners in the residential sector.

63. The value of the project is estimated to be $714 million and its financing structure includes a blending of World Bank financing, composed of loans from the IBRD and the CTF, as well as a GEF grant. This is complemented by financing from the Government of Mexico, the National Development Bank (NAFIN) and Mexican consumers (see Figure 1 in Annex VI).

64. The second component is of particular interest to this study, given its focus on phasing out CFC-12 based appliances in the residential sector, and its support for the Appliances Replacement Program under the Government's national program on energy efficiency, which targets the replacement, including collection and scrapping, of approximately 1.7 million old (more than 10 years) and inefficient REF/AC appliances over a four-year period.

65. Component 2 proposes two types of incentives: 1) the provision of vouchers as instant discounts to low-income consumers; and 2) the provision by NAFIN of credits, at favorable interest rates, to middle-income and other qualifying consumers. Resources from the IBRD loan to the Government co-finance the vouchers; those from the CTF loan to NAFIN support the credits; and resources from the GEF grant capitalize the guarantee facility that protects NAFIN from credit defaults by consumers.

66. Carbon finance is also considered in connection with the appliance replacement program and Ref/AC disposal activities under Component 2, where MLF resources have supported an assessment of opportunities for financing the destruction of ODS through the voluntary carbon markets[26].

67. *Qualification of Efficient Appliances by Consumption Level*. In order to qualify as an eligible appliance under the program, refrigerators and air conditioners must meet specific EE requirements above the Minimum Efficiency Performance Standards approved by the Government. In addition, appliances must also meet certain size requirements, which vary by consumption level, reflecting limitations on size for consumers who benefit from the larger subsidies provided by the vouchers as compared to the credits.

68. *Integration with Mexico's Domestic Refrigerator Nationally Appropriate Mitigation Action*. This NAMA proposal is being developed as a potential crediting NAMA and will be elaborated during the implementation of Mexico's Market Readiness Proposal with funding from the Partnership for Market Readiness. A description[27] is included on the PMR website. The Domestic Refrigerator NAMA is an initiative driven by the National Association of Appliances Manufacturers (ANFAD), whose intention it is to introduce, on a nationwide scale, more EE technologies that use refrigerants with significantly lower or zero GWP. The domestic refrigeration technology currently sold in Mexico is based on HFCs, predominantly R-134a,

[26] "Disposal of ODS in Mexico", World Bank (2012)
[27] http://www.thepmr.org/system/files/documents/Mexico_MRP_Final_Refg_19-02-2013.pdf

which has a high GWP of 1300. The move away from the use of HFCs, combined with enhanced energy savings, will contribute doubly to the country's climate change mitigation efforts.

69. The NAMA proposal scales up the World Bank efficient appliances project described above. Although older, inefficient refrigerators and air-conditioners are still in use, the market has been steadily moving towards adoption of HFC-134a appliances. Based on imports and domestic production capacity data, the Mexican market share for refrigerant fluid currently shows 98 % HFC-134a and 2 % hydrocarbon[28].

70. The NAMA aims to phase in HFC-free energy efficient technology to cover 100% of the domestic market in Mexico (2.4 million units per year in 2012) within a 5-year timeframe. The estimated mitigation potential from the electricity to be saved is in the order of 4.6 million tCO_2-eq accumulated over a 15 year period. Piloting the NAMA with the introduction of 100,000 new refrigerators is estimated to cost around $770,000 for operational costs and $3,250,000 for the coverage of the incremental cost of the new technology ($30/unit), plus $21,160,000 for loans to the end users, which will be paid back through household electricity bills. A visual representation of the NAMA's implementation arrangement is presented in Annex VI, Figure 2.

71. The design of this initiative still needs to be elaborated and operationalized, along with identifying funding sources. While a number of key elements will need to be in place to ensure success, financing will be key. If successful, the design of both initiatives - vouchers and low-interest loans for consumers, and financial incentives for manufacturers - could be adapted and replicated to HCFC appliance phase-out in other developing countries. This would demonstrate that energy saved in the Ref/AC sector can be associated to quantifiable emission reductions, and that carbon finance holds the potential to play an important role in harnessing additional resources to incentivize consumers and/or appliances manufacturers.

The India Super-Efficient Equipment Program (SEEP)

72. A program developed and under preparation by India's Bureau of Energy Efficiency (BEE), supported by the World Bank administered Clean Technology Fund (CTF), to introduce super-efficient equipment offers another interesting model that could apply. While not currently targeting Ref/AC equipment, it is envisaged that it could in future, and the model is potentially directly applicable to support climate co-benefits in parallel with MP funding towards an ODS-free transition. SEEP was designed as a national program by the BEE. In the first phase, the introduction of super energy efficient fans is targeted. Ceiling fans are the second biggest consumer of domestic electricity after household lighting in India. The super-efficient fans will consume 35W of electricity compared to the current market average of 70W, i.e. bringing 50% energy savings on average.

[28] World Bank Project Appraisal Document

73. The transformational program will be implemented in two phases. The first phase will be funded through the CTF which will provide $50 million to the Government of India. The second phase will be funded through Government budget. The program will be voluntary for manufacturers. Phase 1 will incentivize the sale of 5 million super-efficient fans over a three year period out of a market of approximately 30 million sales. Because the incremental manufacturing cost of the super-efficient fans would initially be about $5 more than inefficient fans, the program will provide financial incentives to manufacturers to create price parity.

74. The design of the financing mechanism involves an innovative approach: manufacturers will bid for an amount of financial incentive as well as the total production quota through a reverse bidding mechanism with a pre-specified cap. The bidding mechanism will allow multiple winners. The incentive will be paid per fan unit to the manufacturer after the product leaves the factory to market.

75. The program includes a strong monitoring and verification aspect. The number of super-efficient fans produced will be checked and their quality will be tested according to the Bureau of Indian Standards. Two types of testing will be conducted: an initial one-time test to check the conformity of the product with the agreed specifications; and, a periodic random test on products picked from manufacturers' assembly lines and retail shops.

76. What makes this model particularly relevant and attractive is that it is a relatively rare example of supply-side intervention in the climate change/ energy efficiency domain, which can readily match the types of conversions that are typical of MP interventions. If successful, the model could easily be replicated to other countries and/or expanded to Ref/AC equipment, as well as to include MLF funding targeting the refrigerant.

Model Scenario for the Residential Sector

77. Many residential energy efficiency equipment programs have been developed and implemented in developed and developing countries; ODS phase-out activities can be included in the design of these activities. Based on this experience, some complementary features of an energy efficiency equipment transformation programs could be as follows: (i) strong regulation and enforcement including inspection at import points, manufacturers, retailers or the installation points for larger equipment to ensure compliance with standards; (ii) standards and labeling to demonstrate to inspectors and consumers compliance with regulations; and (iii) financial incentives to overcome initial financial barriers/higher costs until the new standards become common practice. Incentives can take the form of loans, grants, tax incentives or initial subsidies to the power sector, suppliers/ retailers or consumers depending on where the financial barrier is found and can be most efficiently overcome. The Mexico example which may serve as model addresses these key points by providing the consumer with information about the efficiency of the new technology against the minimum energy performance standards supported by a labeling program and financial incentives for manufacturers and/or consumers.

78. In the case of regulatory approaches/policy tools to promote energy efficiency of Ref/AC equipment such as appliance Minimum Energy Performance Standards (MEPs) and appliance energy efficiency labeling, elements related to MP requirements (that is, if the refrigerant used is ODS free or not) could be integrated into the standard MEPs and also provided as information through the EE label design. For example the California Appliance Efficiency Regulations[29] refer to ODS. In the case of financial incentive-based approaches to promote energy efficient appliances through traditional utility demand-side management or innovative market mechanisms like ESCOs, it would be important to establish the relative additional (incremental) purchase cost of complying with MP requirements over the BAU cost of the appliance with regular efficiency levels, and over the cost of appliance with higher efficiency – with additional incentives to target the most environmentally friendly refrigerant.

79. A typical household level equipment energy efficiency program may target air-conditioning units (windows or split systems) used in the residential sector or small buildings (split systems or rooftop units) that are currently using HCFC-22 as the coolant. Depending on the country concerned, the key stakeholders to involve in an energy efficiency program are, therefore: (i) the power sector, whose interests are to reduce the gap between power demand and supply (including reducing peak load), promote energy security and independence and, in some instances, to mitigate climate change; (ii) consumers (commercial, public, households) for whom energy efficient equipment provide energy savings and thus, monetary savings; (iii) manufacturers and retailers, who must comply with regulations and respond to demand from consumers.

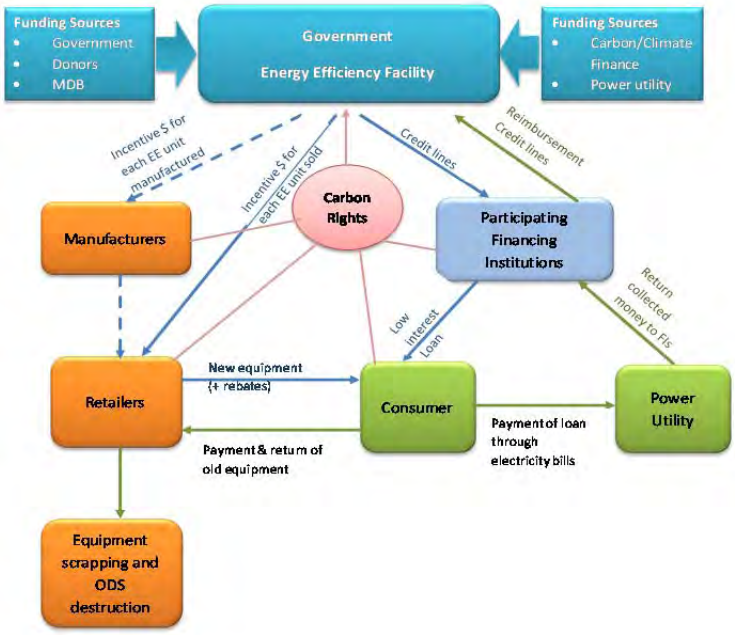
80. Compelling this set of stakeholders to test and label equipment correctly, both with regard to EE standards and the ODS potential of equipment, allows consumers to make more informed decisions. However, the higher upfront costs of upgrades are often strong barriers to the deployment of EE technologies. Therefore, market transformation may only be achieved when adequate financial incentives are offered to the parties facing the financial barriers, usually the consumers or suppliers. Based on the Mexico ELA project example, a potential HCFC-free energy efficient air-conditioning program could be structured as per Figure 4 below.

4.3. Driving ODS Phase-out Through Energy Efficiency in the Non-residential Sector

81. The non-residential sector includes buildings (public and commercial: air-conditioning, chillers, rooftop units), and industrial facilities where refrigeration plays a key role in the process (textile, foods and beverages, chemicals, etc).

[29] http://www.energy.ca.gov/2012publications/CEC-400-2012-019/CEC-400-2012-019-CMF.pdf

Figure 4. *Model structure for a potential HCFC-free energy efficient AC program*



Source: this report

82. Many of the points discussed above under residential models also apply to the non-residential sector including approaches to regulation and enforcement, standards and labeling and financing mechanisms to support phase-in. A key difference in the non-residential sector as compared to the residential sector is the size of the equipment, its cost and the volume of ODS involved. It therefore needs to align with corporate and public sector financing models, some of which are as follows:

- Leasing and loan facilities need to be available through equipment suppliers/ commercial banks (i.e. where corporate loan financing schemes are required);
- Innovative financing approaches, such as those involving third party ESCOs where, for example, a utility or supplier finances and installs the new equipment and recovers the cost from the corporate consumers electricity based on the value of actual or averaged projected energy savings as managed by the ESCO;
- Public sector financing of energy efficiency projects in public buildings, which has become increasingly favored as a means to reduce operating costs; and
- The use of official development assistance (ODA) can also play an important part in demonstrating pilot programs in either corporate or public settings.

The GEF – Supporting Energy Efficiency Finance

83. GEF concessional funding has been a strong catalyst for introducing innovative ideas and supporting institutional development to build successful energy efficiency programs. A number of World Bank Group GEF-supported energy efficiency projects in different regions have successfully institutionalized ways to achieve energy efficiency gains that promise strong returns on investment. The most sustainable uses of GEF resources have been achieved when the GEF contribution formed part of broader, longer-term energy efficiency initiatives - such as blended packages of concessional and non-concessional energy efficiency finance (including helping local financing institutions develop their own EE lending products and business lines). Other good examples include projects focused on market transformation, heating reform and building EE, industry/utility level EE, or ESCO development - supported by strong government commitment and program financing from other sources.

84. For example, the Bank's International Finance Corporation's (IFC)-implemented *China Utility-Based Energy Efficiency Finance Program (CHUEE)* used the GEF contribution to provide credit enhancement tools and technical assistance to local banks to develop their energy efficiency and renewable energy financing business. Financial institutions, utility companies, and suppliers of energy efficient equipment were brought together to establish new financing models for energy efficiency, with a focus on expanding lending to small and medium enterprises. The concessional element focus on provision of public training, green credit, international standards such as the Equator Principles, and completion of five industrial and regional energy efficiency opportunity studies, helped the China Banking Regulatory Commission, the Chinese banking sector other potential investors, as well as ESCOs and equipment suppliers better understand the Chinese national EE market. A $16.5 million GEF investment in CHUEE helped three partner banks disburse $540 million in energy efficiency loans to 107 projects, mobilizing nearly $1 billion of additional financing and resulting in a global reduction of millions of tons of CO_2 equivalent.

Building Energy Efficiency Codes

85. Building energy efficiency codes and standards offer a powerful tool to promote energy efficiency measures, including consideration of the substances used as refrigerant. A recent World Bank ESMAP publication "Mainstreaming Building Energy Efficiency Codes in Developing Countries" (2010) asserts that mandatory and enforced building EE codes are an essential and effective tool to promote energy savings related to heating and cooling that may otherwise be overlooked[30]. The report also notes that no country, industrialized or developing, has reaped the benefits of energy conservation measures in buildings without enforcing compliance with such mandatory codes.

[30] Pierre Langlois and Shirley J. Hansen, PhD., authors of 'The World ESCO Outlook, 2012', further cite energy performance contracting (EPC) and shared savings contracting (SSC) models, adapted to local needs, as key tools for self-funding energy efficiency, based on their practical experiences gained working with developed and developing countries around the world.

86. The report also find that promotion and enforcement of building energy efficiency codes in a country can also both complement and promote the technical and engineering capacity of the national supply chain, such that local materials and equipment are available and compatible. In other words, promoting and facilitating the availability and uptake of ODS-free low-GWP/GHG solutions.

87. With respect to financing, in medium-income countries, building energy efficiency codes can be mainstreamed such that compliance becomes the norm and additional costs are effectively internalized in regular building costs. For lower income countries however, external financing to meet the up-front additional costs of energy conservation measures must be addressed, which could include participation in carbon markets to encourage market-driven energy efficiency innovations.

4.4. Using Carbon Assets to Enhance Investments in Montreal Protocol Projects

88. The possibility of using future carbon assets generated through MP projects to increase their level and/or lower their cost of financing remains worthy of consideration given that the general economic principles behind the global carbon market are broadly applicable to market-based mechanisms in the medium term.

89. If MP projects that aim to reduce ODS in refrigeration applications through the replacement of older HFCF-using cooling units with more modern and efficient technology are able to generate interesting energy saving benefits, and such projects are also registered under one of the various Carbon Finance mechanisms, then any energy savings achieved could be converted into carbon assets (at the power grid emission factor).

90. In principle, monetization of future carbons assets can offer two main benefits in addition to the immediate energy savings gained by consumers, provided carbon markets are solid: 1) from an environmental perspective, it could accelerate the implementation of HCFC - reducing projects. From a financial perspective, providing more capital and/or lowering its cost at the onset of a project, rather than relying on an additional future revenue stream from carbon finance, could improve a project's overall financial viability and encourage more rapid scale-up up of ODS-reducing projects.

Carbon Assets as a Credit Enhancement Tool for Lending

91. Carbon assets generated by MP projects could further potentially be used as collateral against lending[31]. For most sponsors, the collateral would be used to reduce the risk profile of the borrower, which would enable the lender to decrease the cost of funding for collateralized operations. Alternatively, for borrowers facing credit exposure headroom limitations, the

[31] The lending could be done by multilateral agencies, banks or other financial institutions.

credit enhancing effect of such collateral could be used to increase exposure limits, resulting in the release of additional funding sources. This proposal could utilize a range of carbon assets, such as CERs and verified, or voluntary, emission reductions (VERs).

92. Depending on the type of asset to be utilized, MP projects generating energy efficiency gains would need to register under the CDM or JI schemes. Post registration, carbon assets would be transferred by means of an Emissions Reduction Purchase Agreement (ERPA) or other arrangement, into the custody of a third party, which could use these assets as collateral to extend a loan to the country/project originating the assets at the project design phase. The collateral could be held on the balance sheets of the lender or in a separate facility that could be set up as a debt service facility with binding instructions to pay off pre-determined debts. Note however that this would require a mature and sophisticated market.

93. The introduction of carbon assets to the MLF financial structure would necessarily induce the management of additional risk. Determining which parties bear what risks, and how these risks can be mitigated are crucial elements of this proposal (see Figure 5):

- *Project Company*: holds the delivery risk, or the risk of generating fewer carbon assets than expected;
- *Carbon Credit Trustee*: holds (and manages) carbon asset price risk once an ERPA is signed. Otherwise, it would remain with the Project Company.
- *Lender*: holds the Borrower's credit risk in case of default by the project companies, though this risk would be reduced by the collateral. The Lender would also assume carbon asset delivery risk indirectly, as the quality of the collateral is linked to the ability of the project company to deliver as planned. Of all the risks, delivery risk remains the most difficult to mitigate or transfer.

94. Once carbon assets are verified, they may be sold at spot market prices or settled through the ERPA at a pre-agreed price. Depending on the arrangement, proceeds may be paid to the lender as debt service, or to the project entity. The host government may stand as a guarantor and/or consolidator (see Figure 6).

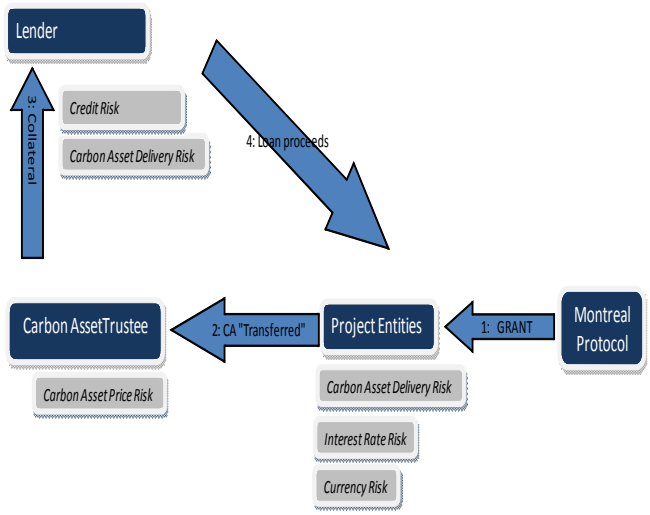
95. To enhance the collateralized lending concept, guarantee mechanisms could be used to mitigate certain risks. For instance, it may be possible to strip out the credit and delivery risk components of the carbon assets by using new or existing mechanisms (ie., IFC's Carbon Delivery Guarantee Mechanism[32]), thereby enhancing the monetization potential of the assets[33].

96. Effectively, such an approach allows a buyer of carbon credits to provide an advance, or lend money, against the projected value of the emission reductions to be purchased. This

[32] The IFC has two conditions for offering this financial product: a mature carbon market and with a clear and long-term price signal.
[33] See IFC Carbon Finance information page: http://ifcnet.ifc.org/intranet/carbonfinance.nsf/.

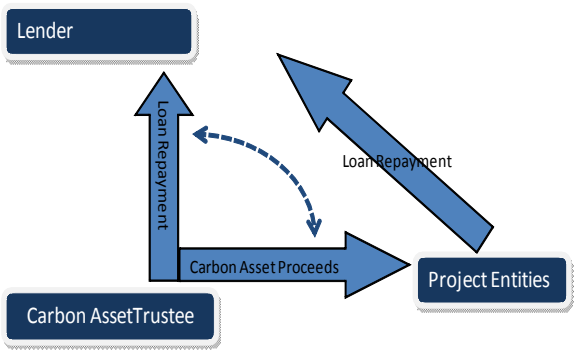
necessitates that a guarantee be established to allow the lender to recover its advance should the emission reductions not be delivered. In the past the World Bank carbon funds have offered such advances to some projects in their portfolio – other lenders could if they felt their risks were reduced by the existence of an ERPA with an institution such as the World Bank.

Figure 5. *Project's process flow*



Source: this report

Figure 6. *Illustration of flows as carbon assets are verified*



Source: this report

5. ADDITIONALITY AND OPTIONS FOR PROFIT SHARING

97. When approving the terms of this study, the Executive Committee highlighted a number of elements important for consideration including, the "additionality of the projects proposed" and "assurance that these projects would avoid perverse incentives for countries". Within the context of the MLF, "additionality" can be understood as assurance that the set of activities to be promoted would generate environmental benefits beyond the baseline of MLF-supported interventions, which would not happen without the additional effort.

98. This can also be understood, together with the reference to perverse incentives, as a desire to see that any grant or concessional element that is introduced with private sector beneficiaries does not distort existing markets. This is particularly important today when, contrary to the early days of CFC phase-out, the market is much more fragmented, with large volumes of chemicals of interest produced in developing (Article 5) countries in either wholly domestic, foreign owned, or joint venture-types of enterprises. The World Bank, including the IFC, possesses rich experience in project economic analysis to ensure that any grant element or concessional loan is set to an appropriate level for barrier removal but does not interfere with the market.

99. The Executive Committee, in approving this study, also requested that it "explore possibilities of profit-sharing, including return of funds to the MLF". This is in part an issue of how proceeds may be distributed and can be challenging to analyze in the absence of concrete parameters. Conceptually, "Profit sharing" with the Executive Committee can take three forms: (i) a lower MLF contribution (grant) to projects with synergies (and other funding sources), (ii) a greater scope or faster HCFC phase-out, (iii) monetary reflows to the MLF. Participation of the MLF in any monetary returns (e.g. from carbon credits) seems difficult to justify, unless a specific service was provided that may enhance the carbon market instruments. To create value, such services would best address weaknesses in carbon markets and related instruments, for instance upfront investment funding, financial risk management (through insurance or guarantees), funding / grant flexibility to fill unexpected funding gaps.

100. The concept of carbon or related revenues flowing back to the MLF could be explored through a model in which, for example, MLF support provided to manufacturers of HCFC-using Ref/AC equipment to convert to alternatives, as well as to introduce energy efficient and low GHG equipment which would generate energy and/or GHG savings. In return for the MLF providing funds[34] to manufacturers, the MLF could share in the income earned from the sale of the energy or GHG savings. From a theoretical perspective, the concept is feasible. Some generic design features of such a program could include:

- MLF funds would be provided as a grant to Ref/AC manufacturers to change production lines to produce low ODS, low GHG and more energy efficient appliances;
- All manufacturers benefitting from the MLF funds would be required to also take part in a program which would recognize or register the projected reduction in energy or GHG emissions – through more energy efficient appliances and appliances making use of low GHG coolants;
- A legal agreement would be required between the Implementing Agency of the MLF, equipment manufacturers and the overall entity managing the energy savings and GHG reduction program to apportion the income derived from the program – spelling out what percentage the MLF would receive;
- Once the program was registered or recognized, each year an annual audit would need to be undertaken to determine the number of equipment sold and the resulting energy or GHG savings and verify the resulting emission reductions; and
- Once the energy or GHG savings were sold, the income derived from the sales would then be apportioned between manufacturers, the Implementing Agency/MLF as per the legal agreement.

101. Some key factors related to the applicability of such a concept would include:

[34] As noted, this assumes that the MLF is also providing support directly for EE related improvements or other valuable services to the carbon market, such as price risk management, some form of guarantee or insurance , as otherwise it would be difficult to justify reflows to the Fund, since the "profits" that would involve private sector actors would then derive from energy savings and reduced GHG emissions, rather than being directly linked to the ODS reduction or financing arrangement that is supported by the MLF.

- When this concept was first considered, a robust carbon market existed with the price of emission reductions trading at over $10. The current price is under $0.5. Until the price of carbon recovers, such schemes will not be viable;
- The main target for such a program would be the larger manufacturers of AC and refrigeration equipment. However, they are typically located in middle-income countries which are now excluded from selling emission reductions to the European Union market from 2013;
- With domestic carbon and energy efficiency markets developing in many of the large equipment manufacturing countries, Mexico is the first one (and only one so far) to have demonstrated interest in AC and refrigeration fitting into the thinking and elaboration of its new generation of carbon finance architecture. In the years to come, other countries however could be inspired by the Mexico example; and
- Would large manufacturers find participation sufficiently attractive in a scheme as described above if they are required to share the income with the MLF? A recognized barrier to multiple-source financing generally is that this comes often with an increase in transaction costs which decreases the attractiveness of participation to investors. As noted above, even with the robust carbon price of the past, there was only limited use of the potential of a carbon finance program to generate energy savings.

102. The idea that the MLF could benefit from the reflows of a market mechanism/climate finance scheme tied to conversion to low ODS, low GHG and higher EE equipment manufacturing production lines is theoretically possible, and experience with the operation of similar funds is that reflows can be managed transparently when this is planned from the start. Although, as discussed, no such profitable opportunities exist in the short-term, the Bank is working with clients to monitor this space. The design and piloting of domestic climate finance markets that include energy efficiency improvements in the Ref/AC sector may provide an option in future.

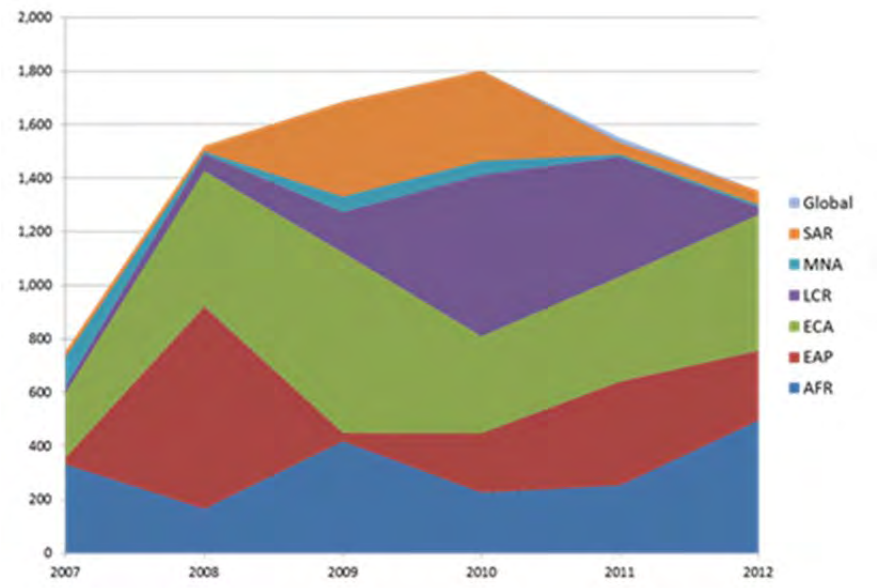
6. INVESTMENT OPPORTUNITIES

6.1 Energy Efficiency Financing at the World Bank

103. World Bank investments for clean energy are growing at rapid pace. World Bank Group commitments[35] for EE have been around $1.5 billion per year for the past five years. This offers opportunity to explore the possible linkages between Bank clean energy operations and the MP agenda, and to understand the potential scope and scale of energy sector activities that could be tapped into if incentives were aligned and transaction costs kept to a minimum.

104. Energy efficiency[36] has emerged as a growing investment focus of the WBG given the recognition that it is one of the most effective means to enhance energy security and achieve better supply/demand balance in the face of mounting power shortages, as well as to mitigate climate change. Energy efficiency can offer an interesting point of entry as it taps the least-cost domestic source of energy while reducing the need for investment in energy generation infrastructure required to power economic growth. In so doing, it can enhance private and macro competitiveness and creates fiscal space for other development priorities, while avoiding negative environmental impacts associated with energy generation including, but not limited to, global climate change.

Figure 7. *World Bank energy efficiency investments by region, 2007 – 2012*



Source: Jas Singh, ECA Energy Unit, WB (2013)

[35] Energy Anchor Database, data as of September 7, 2012; personal communication, Ashok Sarkar, 5 Oct 2012.
[36] This section "Energy Efficiency Community of Practice Progress Report for Fiscal Year 2012", SEGEN, World Bank, June 2012, and "Delivery Mechanisms for Energy Efficiency in Bank Operations" presentation by Jas Singh, Energy & Extractive Industries Learning Days, March 8, 2013.

105. Nevertheless, energy efficiency improvements, particularly on the demand side, are complex to implement as the opportunities are diverse, dispersed and spread across a range of different end-use sectors who face various technical, institutional, financial, market and regulatory barriers (see Table 6). In addition, converting potential opportunities into investments in order to scale up energy efficiency implementation requires working across sector boundaries – for instance, energy savings in the water, agriculture or transport sectors. Furthermore, transfer of knowledge in the areas of energy efficiency policy and finance – key to effective replication and scale up – is more complex than the transfer of technology, and the transferability of the relatively successful energy efficiency policy and finance approaches from OECD countries is not direct, requiring significant adaptation prior to replication in developing countries, given the different barriers and institutional contexts. World Bank GEF co-financed energy efficiency financing projects, such as CHUEE for example referenced earlier, have worked precisely to address these obstacles/barriers.

Table 6. *Main barriers to investments in energy efficiency*

Policy / Regulatory	Equipment/ Service Providers	End Users	Financiers
- Energy pricing and collection - Procurement policies favor lower cost - Import duties on EE equipment - Unclear or underdeveloped EE institutional framework - Lack of appliance standards and building EE codes, lack of testing, poor enforcement - Limited and poor data	- High project development costs - Limited demand for EE goods/services - Diffuse/diverse markets - New contractual mechanisms (ESCOs) - Limited technical, business, risk mgmt. skills - Limited financing/ equity	- Lack of awareness, high discount rates - High upfront and project development costs - Ability/willingness to pay incremental costs - Low EE benefits relative to other costs - Perceived risks of new technologies/ systems - Concept of EE is "virtual" – cannot see - Mixed incentives - Behavioral biases - Lack of credible data	- New technologies and contractual mechanisms - Small sizes/widely dispersed→ high transaction costs - High perceived risks – not traditional asset-based financing - Other higher return, lower risk projects - Over-collateralization - Behavioral biases

Source: Jas Singh, ECA Energy Unit, WB (2013)

106. Energy efficiency projects can generate interesting and multiple benefits but it must be acknowledged that they are work intensive at the design and implementation stages, given the barriers noted above, their lending volumes are, in general, much lower than renewable energy projects, and they offer less visibility than projects in the renewable energy sector. The Bank therefore, works with client countries to build the capacity necessary to ensure that energy efficiency projects are not systematically down-graded compared to large infrastructure projects (i.e., in the case of energy, transport and water sectors), and/or to sector-specific

strategies and guidelines that do not account for efficiency as a viable path to achieve development objectives (i.e., in the case of agriculture, sanitation, and urban sectors).

107. In addressing energy efficiency, the Bank uses a number of delivery models that target the industrial, commercial, public or residential sectors (see Table 7) including, development policy lending (DPLs), utility demand side management (DSM) programs, ESCOs, commercial energy efficiency financing, public EE financing, actions to stimulate market transformation, incentives subsidies and grants, and capacity building, awareness-raising and education. The experience[37] with these various mechanisms is described below, including pointers to existing or potential linkages and synergies with Montreal Protocol issues.

Table 7. *Delivery models for energy efficiency financing that have been used in World Bank projects*

Model / Sector	Industrial	Commercial	Public	Residential
DPLs	✓	✓	✓	✓
Utility DSM	✓	✓	✓	✓
ESCOs	✓	✓	✓	
Commercial EE financing	✓	✓	✓	✓
Public EE financing			✓	
Market transformation				✓
Incentives, subsidies, grants			✓	✓
Capacity building, awareness raising, education	✓	✓	✓	✓

Source: Jas Singh, ECA Energy Unit, WB (2013)

108. Climate/Energy DPLs with energy efficiency Policy Conditions. The demand from governments for DPL support has grown in recent years and several of these have targeted energy efficiency directly through: support to development of EE laws/acts, secondary legislation/decrees, national climate change/EE strategies, and EE Action Plans; changes in tariff structures to incentivize EE; upgrading or adoption of regulations to support white certificates[38], smart metering, codes and standards, and auditor/energy manager certifications; initiation/funding of appropriate EE programs; and, enactment of favorable tolls, taxes, and incentives. Key success factors identified for this delivery model include proper regulatory and financial incentives, adequate and dedicated funding sources, utility management commitment,

[37] From "*Delivery Mechanisms for Energy Efficiency in Bank Operations*", presentation by Jas Singh, Energy & Extractive Industries Learning Days, World Bank, March 8, 2013

[38] An instrument awarded by an authorizing body to guarantee that a specific amount of energy savings has been achieved; usually tradable.

strong program planning, implementation and evaluation functions, and strong customer outreach.

109. Utility Demand Side Management (DSM). On the demand side, the Bank has worked directly with electric utilities on their DSM approaches, addressing lighting or EE appliances, as it the case of the Mexico ELAP. There are many advantages for utilities to pursue DSM, but also mixed incentives which require that the incentives be well aligned. Recent examples include a number of utility-run CFL programs, as well as "post DSM" models such as DSM bidding, standard offer, EE power plant, and white certificates.

110. Energy Service Companies. ESCOs represent an approach that was developed in the industrialized world and adapted, with some success, to developing country circumstances. ESCOs configuration vary widely including, bundling projects, mobilizing financing, offering turn-key services, and assuming performance risks. ESCOs are complex mechanisms that require strong legal, financial, accounting, and business infrastructure and experience has shown that often the ESCO structure must be vastly simplified to be launched in Bank client countries. In these situations, "public" ESCOs are utilized to develop the market, which itself necessitates the development of a sustainable exit strategy for transition to a fully market-based structures.

111. Key success factors that have been identified include supportive policies and enabling environment; the introduction of simpler business models; appropriate financing schemes; early market development through public sector projects; and development of PPP models (e.g. public ESCO, super ESCO, ESCO agents, ESCO financing windows) to build capacity and develop the business model to kick-start the market.

112. Energy Efficiency Financing through Financial Intermediaries. A number of these delivery models have involved investments through "Financial Intermediaries" that then on-lend to others. Financial intermediaries can be commercial banks, ESCOs, or dedicated investment funds, and a variety of tools can be involved including, credit lines, revolving funds, special purpose funds, credit guarantees, special purpose vehicles, or equity funds. This type of intervention is commonly used to support energy efficiency with building owners, small industries, etc. It is therefore highly likely that such projects offer synergies related to the phase-out of HCFCs or HFCs, yet at the initial stage their design does not offer sufficient portfolio composition breakdown, or detailed activity lists. To maximize ozone-climate co-benefits using this modality, specific, up-front criteria would need to be integrated into investment support documents.

113. One of the on-going challenges of this work is to bring commercial banks into the market. Key success factors have included: conducting a holistic upfront market assessment; careful design of financing schemes and products; careful selection of financing partners with relevant prior experience and interest; intensive marketing to ensure a strong project pipeline; and, flexible schemes that can evolve with markets. Special incentives potentially supported

with concessional finance may be necessary to steer end-user refrigerant choice, where the lowest ODP/GWP option might incur additional costs not balanced by additional energy efficiency savings.

114. Direct Public Energy Efficiency Financing. This modality is typically used by public/municipal clients whose investments have a strong social dimension (e.g., schools, hospitals), and where commercial financing is not a viable option due to factors such as reliance on a central budget for maintenance and operations. In some cases, some repayment and/or co-financing obligations have resulted. In the interest of sustainability and scalability, this modality can only be applied where funds are available on an on-going basis. A number of examples of successful operations, namely in Central and Eastern Europe, have been undertaken.

115. Key success factors have included strong political commitment, transparent building selection criteria, realistic project performance indicators, use of bundled procurements to reduce administrative costs, strong technical baseline data, and competent contractors/suppliers. Introducing concomitant pricing reforms has also helped ensure sustainability of savings and proper operations and maintenance.

116. "Market transformation", refers to targeting the products rather than the end users. Many tools have been used, including utility DSM, standards & labeling, market aggregation, public procurement, marketing, technology transfer, financing, rebates, and manufacturer negotiations. Challenges include overcoming higher costs and changing purchasing behaviors, while in some projects, still under preparation, the Bank and its clients are also developing approaches to provide incentives directly to manufacturers.

117. Key success factors that have been identified include strong upfront market research, effective public campaigns, incentive schemes that have preceded introduction of mandatory requirements, careful selection of financing partners, judicious use of subsidies, effective and efficient enforcement, and economies-of-scale to help incentivize suppliers and bring down costs.

118. Incentives, Subsidies and Grants. The use of public funds has been justified to demonstrate new technologies or models, overcome initial high costs, lower perceived risks, and jumpstart nascent markets. This can be used where credit barriers are too high, banks are unwilling to lend, and to help address low priority of energy efficiency among consumers. Care has to be taken to design such initiatives such that subsidies can be used alongside market-based approaches without undermining them. Key success factors include effective administration, targeted use, sunset provisions, and intensive dissemination.

119. Most recently, "green" procurement has been used to support energy efficiency at the municipal level, in schools and hospitals. In this case, an incentive is provided to encourage purchase decisions based not only on least cost considerations, but also on life cycle benefit

considerations. Where alternatives are readily available, this can be a powerful instrument (see below).

6.2. Identification of Opportunities for Linkages with the Montreal Protocol Agenda and Points of Entry in the World Bank Program

Background

120. The World Bank's portfolio of projects in various sectors, including but not limited to energy efficiency, has the potential to strongly overlap with the MP agenda through the procurement of appliances, equipment, and/or insulation materials, as well as through elaboration of policy and regulatory frameworks that could consequently affect the choice of chemicals used. Overlap between these kinds of projects and the MP agenda can be made more explicit in order to maximize synergies and the MP related impact of Bank activities overall. Such opportunities for linkages are not however, readily apparent from basic project documentation used in Bank operations. Table 8 lists the World Bank sectors/activities with potential MP linkages.

121. A portfolio review has highlighted areas of opportunities for linkages and identified points of entry in the portfolio where communication of recommended practices regarding the choice of more desirable low-GWP and zero-ODP technologies could be targeted. This preliminary review, which has not been fine-tuned, nevertheless comprises all World Bank projects approved in fiscal years 2011 and 2012, including IBRD/IDA, GEF, and CIF projects, and serves as a first step to uncover the common patterns and trends in the Bank's regular programming where HCFC/HFC-related issues may be pinpointed.

Methodology

122. Within these two fiscal years, 447 projects were World Bank Board approved in FY-11 and 327 projects in FY-12, with an overall commitment of more than $80 billion from IBRD/IDA funding and trust funds. The review involved screening of project concept notes and project appraisal documents (PADs), based on the development of a typology to identify sectors and key activities that could impact the consumption/emission of HCFCs or HFCs. The broad approach followed cannot attribute funding specifically to directly relevant MP issues, but rather attributes funding for the full component if there is an overlap between that component and MP issues.

123. The 774 projects were rated based on the strength of their relational links to the HCFC agenda. A list of keywords was used to search project documents for overlap, excluding the Montreal Protocol projects, and each project was then classified according to one of four categories: full, strong, potential, or nil. Of the 774 projects, 16 projects qualified as 'full' based on the following selection of relational keywords: cold chain/ equipment/ room/ storage/ box,

cooling, freezer, refrigerator/ refrigeration, HVAC, AC, MAC (mobile air conditioning system), air con(ditioner).

124. The limited number of projects with 'full', explicit, overlap does not signify that there are no additional relevant projects. Many activities have strong potential relevance to the MP agenda, particularly given that Ref/AC systems are used virtually everywhere, and span many sectors. A further 62 projects were identified as having 'strong' overlap when the project documentation described activities strongly suggesting links with the HCFC agenda, in the following sectors: i) agriculture: food storage, milk and meat, preservation, packaging, distribution; ii) aquaculture; iii) development policy lending: energy efficiency, renewable energy, green growth, infrastructure, housing, low carbon, urban transport; iv) energy efficiency; v) health: medical supplies, distribution, vaccines, health care facilities; vi) transport: green freight/truck, train; and, vii) urban: green building (space heating and cooling). Together, projects with 'full' and 'strong' relational overlap, where targeted interventions could support MP objectives, represent 8.7% of the total FY11/FY12 portfolio of projects and have a cumulative committed value of $7 billion for these 2 years.

Table 8. *Examples of sectors and World Bank interventions potentially relevant to the Montreal Protocol agenda*

WB Sectors	MP- Relevant World Bank Interventions	Main MP Sectors
Agriculture	food banks/ storage and preservation packaging and distribution livestock, meat, milk productivity and technology climate smart agriculture	Residential/commercial and industrial air conditioning Commercial refrigeration Industrial refrigeration Car/truck/train (mobile) AC Foam manufacturing (blowing agent) Solvent use Firefighting (fire extinguishers)
Aquaculture	handling practices, hygiene capacity building, alliance for responsible fisheries	
Development policy lending	energy efficiency and renewable energy green/ low carbon growth infrastructure and housing urban transport	
Education	construction of schools, classrooms and kindergarten	
Energy Efficiency	lighting and appliances financing, investment, scaling up regulation	
Emergency recovery	construction of housing and road health and education services	
Health	medical supplies and vaccines incl. distribution construction of health centers, health care facilities, hospitals, ambulatories and laboratories	
Rural	basic infrastructure transitional housing	
Transport	green freight, truck and train	

	public transport smart/ intelligent transport management system transport efficiency	
Urban	green building municipal development informal settlement, low income housing development infrastructure investment	

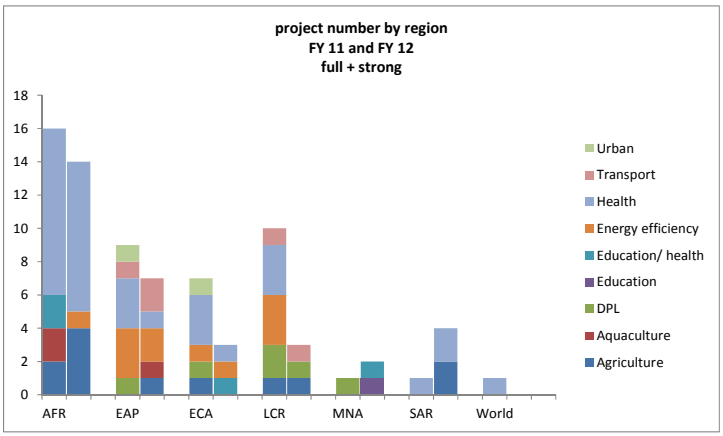
125. Furthermore, additional projects can be characterized as having 'potential' overlap, where the overlap could not be readily inferred from project documentation, but where the type of activities/sectors might in principle involve relevant aspects related to Ref/AC. Identifying which among these projects really overlap with the HCFC agenda would require a much more detailed analysis, including interview with the project teams. An additional 53 'potential' projects, worth another $7 billion in World Bank commitments have been identified associated in sectors and activities covering: i) agriculture: productivity/technologies, food safety; ii) aquaculture: alliance for responsible fisheries, capacity building; iii) development policy lending: health and education sectors, health reform; education: school construction, basic education services, early child education; iv) emergency recovery: housing construction, health, education, transport; v) health: maternal and child health services, capacity building, nutrition/ school meals, health care system; vi) rural: basic infrastructure, transitional housing, vulnerability reduction, food security/ nutrition; vii) transport: transport efficiency, smart/ intelligent transport management system, construction of railway, public transport; and, viii) urban: municipal development, historical building/ cultural heritage, informal settlement, infrastructure investment, low income housing development.

Potential Points of Entry

126. Analysis of the 181 projects classified as having full, strong or potential overlap with the MP agenda, shows that consideration of the 'potential' category did not appear to drastically alter the data trends that emerge and therefore, those projects with 'full' and 'strong' overlap only were identified as the first tier of projects/sectors that would be analyzed in greater detail.

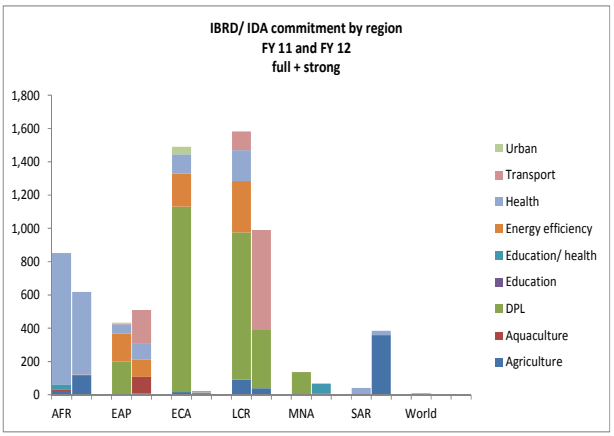
127. *Regional trends and opportunities*. The distribution of the number of projects (Figure 8) reflects the high volume of activities in the Africa region, of the majority in the health sector. In East Asia and the Latin American regions, EE and transport projects compose a larger share. Overall, the regional distribution pattern is consistent from one year to the other. From a dollar commitment by region perspective (Figure 9), the trend is skewed by a few large DPL operations in the Europe and Central Asia and the Latin America and Caribbean regions.

Figure 8. *Number of projects with full or strong overlap with the MP agenda, by region*



Source: this report

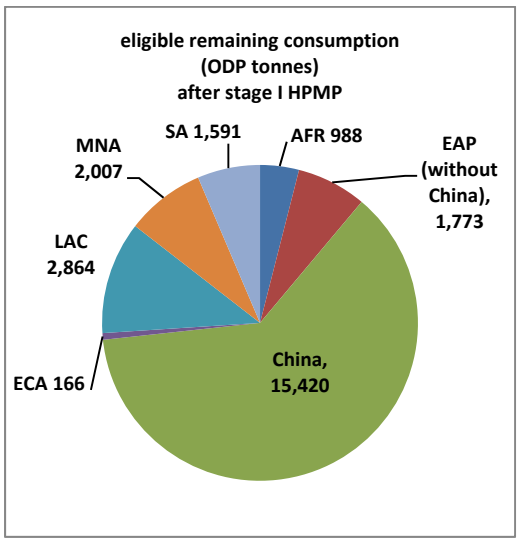
Figure 9. *$ commitment for projects with full or strong overlap with the MP agenda*



Source: this report

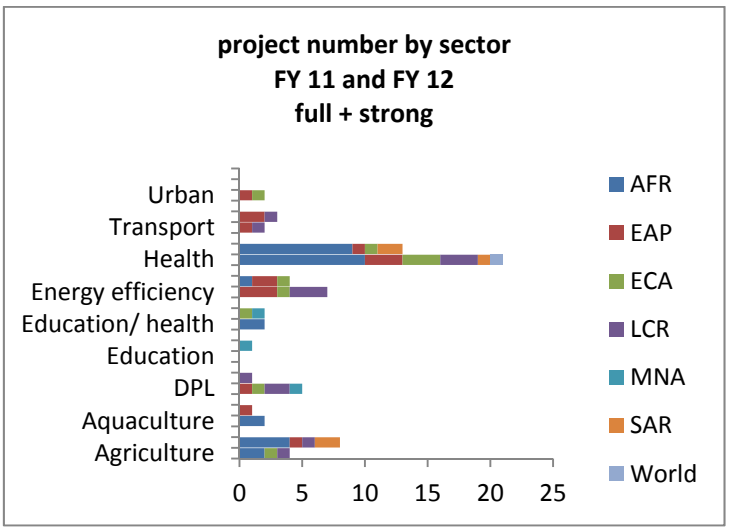
128. *"Needs".* Figure 10 highlights remaining eligible consumption of HCFCs, by region, following approval and implementation of the stage I HCFC Phase-out Management Plans in all eligible developing countries. A few things stand out, China's consumption notwithstanding. When compared to the types and volumes of World Bank investments, by sector and region, with overlap to the MP agenda highlighted in Figures 11 and 12, in general it may be surmised that the LAC region appears to be the one where the greatest opportunities exist that are matched with the greatest "need" in terms of HCFC phase-out.

Figure 10. *Eligible HCFC consumption remaining after HPMP phase I implementation in eligible Art 5 countries (ODP tons)*



Source: this report

Figure 11. *Number of projects with full or strong overlap with the MP agenda, by sector*



Source: this report

129. *Sectoral trends and opportunities*. Health sector projects make up the majority of the "full" + "strong" overlap pool, which is not surprising given the use of cold storage equipment in the medical supply and vaccine distribution chains (see Figure 11). Energy efficiency and agriculture come second. Air conditioning and refrigeration equipment are major consumers of energy, and therefore must be targeted for energy efficiency improvement. For the agriculture and aquaculture sector, food preservation and distribution, where cold storage and freezers are needed, are key concerns. Emergency recovery, transport, and education take a greater importance when looking also at the "potential" projects.

Due Diligence - Green Public Purchasing (GPP)

130. One key tool that may be used in World Bank projects to promote energy efficient equipment and/or technology that uses low GWP/ low ODP is by "greening" procurement. A recent internal guidance note[39] from the World Bank's Operations Procurement Unit outlines how Bank operational procurement policies and practices can have significant environmental and social impact through the goods and services that countries procure under Bank-financed projects and through those the Bank itself procures. Procurement is considered "environmentally responsible" when environmental aspects are incorporated into purchasing choices, along with economic factors such as price, quality, and performance. The note clarifies

[39] "Green public purchasing (GPP): An introduction and methods to include environmental aspects in technical specifications and bid evaluation criteria", OPCPR, WB, June 2007, updated November 2011.

that Bank Clients have the option to incorporate environmental requirements in the technical specifications of the goods and equipment procured under Bank Guidelines, and as part of bid evaluation.

131. In particular, the guidelines state that, "for goods and equipment, other factors may be taken into consideration including, among others, payment schedule, delivery time, operating costs, efficiency and compatibility of the equipment, availability of service and spare parts, and related training, safety and environmental benefits." This makes it possible to refer to "internationally accepted standards such as those issued by the International Standards Organization with which the equipment or materials or workmanship shall comply. When such international standards are unavailable or are inappropriate, national standards may be specified."

132. In addition, the Standard Bidding Document for Procurement of Goods (May 2004, revised May 2010) provides the possibility for introducing environmental aspects into the process of Evaluation and Comparison of Bids through the "Projected Operating and maintenance cost" and the "Performance and productivity of the equipment." The evaluation criteria in the Bidding Documents would specify a component of the good's operating and maintenance costs, which represent the corresponding environmental concern, such as energy consumption, emissions, waste management or disposal cost at end of useful life. The Bidding Documents would also specify a satisfactory method for calculating these costs over the operational life of the good in question. This "life cycle cost" becomes part of the bid-evaluated costs, and is defined as such in the Bid Data Sheet. For example, bidding documents could require bidders to demonstrate the annual electricity consumption cost for a computer or office photocopier over its useful life, using a standard formula that specifies units for calculation, the number of operating hours per day and/or other relevant operational characteristics.

133. The note also provides that a price advantage could be given to bidders demonstrating that environmental benefits are taken into consideration, as this could be clearly stated in the Technical Specifications in a manner similar to the Bank's current domestic preference allowance.

134. While "green procurement" is presented as an 'option' open to Bank clients, it is a tool that is available for immediate use within the context of existing guidelines and procedures, and allows Bank clients express preference for goods or companies with desirable environmental "qualities". If GPP were to be more effectively used to address MP considerations, clients and Bank task teams would require up-to-date technical guidance in order to effectively conduct bid specification and evaluation processes.

135. The portfolio review for FY 11 and FY 12, although preliminary in nature, raises a number of interesting trends and yields interesting opportunities for further analysis, as follows:

- Each year, approximately $3.5 billion, equivalent to 8.7% of the Bank's portfolio, appears to have significant overlap with the MP agenda.
- Taking into account regional distribution of potential and needs, good complementarity exists to explore MP-investment synergies across most regions, with the LAC region standing out as a region with particularly high potential.
- Taking into account sectoral distribution potential, priority sectors that could be targeted include, EE, health and agriculture.
- If consumption of ODS (HCFCs) can be seen as a proxy of needs, the EAP region, in particular, is one where efforts related to EE could be increased.

6.3 Potential Linkages with the International Finance Corporation (IFC)

136. IFC, a member of the World Bank Group, is the largest global development institution focused exclusively on the private sector in developing countries. Through Investment Services, IFC provides a broad suite of financial products and services—including loans, equity, trade finance, structured finance, and syndications—designed to promote development in emerging economies and help reduce poverty. Through Advisory Services, IFC offers advice, problem solving, and training to companies, industries, and governments, all aimed at helping private sector enterprises overcome obstacles to growth. Advisory services do not rely upon IFC capital for funding but are supported by donor Trust Funds.

137. IFC has helped develop and deploy tools for estimating project GHG emissions. The Carbon Emissions Estimator Tool (CEET) builds upon a tool developed by the Agence Française de Développement (AFD) and expanded to cover IFC investment sectors. The CEET provides investment departments with a simple way to estimate actual project emissions based on information commonly collected during project appraisal, as well as enabling the calculation of changes in GHG emissions by comparing project emissions to a no-project or reference scenario.

138. In FY13, IFC invested over $2.5 billion in climate related investments, or 14% of total FY13 net commitments. A corporate goal is to commit $3 billion to climate-related investments by FY15. Climate related investment volumes have been tracked since 2005 and, going forward, IFC intends to also report on the impact of its climate-related investments in terms of GHG emissions reduction. All new investment projects (excluding through financial intermediaries) are required to report GHG emissions prior to project approval as an additional form of business risk analysis.

139. Aligned with goals to scale up climate-related activities, IFC's guiding principles and typology for climate-related investment and advisory projects include various project types that are directly related to Montreal Protocol sectors: 1) Energy Efficiency, including Green Buildings, 2) Cleaner Production, 3) Retrofits or replacement of existing heating and cooling systems with reduced global warming potential refrigerants, and 4) Decrease in fugitive GHG

emissions in existing operations. There are however currently no projects explicitly addressing HCFCs. More information on IFC climate-related investments are described in IFC Definitions and Metrics for Climate-Related Activities.

140. IFC Advisory Services works with companies to adopt environmental, social and governance practices and technologies, as well as to seek broad adoption of these practices to transform markets and scale-up climate-change solutions. This represented 16% of total client-advisory spend in FY2012, with the goal to increase this to 23% in FY15.

141. Financial intermediaries represent nearly half of IFC's climate-related investments: IFC has supported 125 financial partners through 135 sustainability and climate projects in 35 countries since 1997. Engaging financial intermediary partners to overcome investment barriers and share IFC experience and standards also presents opportunities to engage a broader range of stakeholders around Montreal Protocol related issues.

142. The building sector is one area which holds great potential for enhancing linkages of relevance to the Montreal Protocol. Continued growth in the green building sector is expected to scale up improvements in energy efficiency in residential and commercial cooling and refrigeration. IFC's investments in new green buildings grew from $2 million in FY09 to over $400 million in FY13, representing 16% of IFC's climate commitments. For example, IFC is providing $10 million in financing to complete construction of an energy-efficient 50-bed hospital in Mexico's Monterrey city that will improve access to health services for low and middle-income communities. IFC is also supporting the buildings sector in emerging markets through its EDGE Green Building Market Transformation Program. Buildings certified by EDGE will have lower emissions than their peers and also require less energy, water and building materials. IFC is engaging with builders, developers and financial institutions to make these buildings more accessible to households and commercial enterprises.[40]

7. OVERALL CONCLUSIONS AND RECOMMENDATIONS

143. This study highlights the fact that, in principle, many sources of financing available to address energy efficiency considerations in developing countries could potentially be used to finance the additional climate benefits associated with HCFC phase out. The status of the global carbon market into the mid-term, however, limits the availability of funding sources that could provide predictable resource mobilization options against which developing country Parties to the MP could plan for compliance purposes. The report recognizes therefore that there are at present no silver bullets in light of the current uncertainty surrounding climate negotiations and climate finance: some new ideas are being explored but have not yet been tested. The report notes however that there are numerous efforts currently underway to shape the future of climate finance, including efforts under the Partnership for Market Readiness supported by the World Bank. There is, internationally, a strong recognition that it is vital for climate change

[40] For more information, please visit http://www.ifc.org/greenbuildings.

mitigation efforts to utilize market-based approaches including carbon markets, and that this requires that there be a "right" price set for Carbon in order to generate investments.

144. A number of opportunities for linkages exist between MP activities and the World Bank's portfolio. Every year, multi-billion dollar investments are sourced by the World Bank towards energy efficiency. Although not all these investments overlap with Montreal Protocol sectors, it is a safe assumption that a significant portion of these investments are in fact relevant. The initial analysis conducted has shown that a variety of sectors, across several Bank regions, offer strong potential for synergy. It is recommended that in order to increase mainstreaming of ozone layer depletion activities in World Bank programming, outreach efforts should be targeted to Bank teams and clients in relevant sectors through the development and dissemination of guidance notes and examples of good practices, including related to "green procurement". In this context, efforts could be focused in regions where energy efficiency financing efforts are being pursued and where MP phase-out obligations (from an ODP perspective) remain high. In particular, the LAC region stands out as one with strong potential for synergies with significant remaining HCFC phase out needs and strong Bank activities in related sectors. On the other hand, the EAP region appears one where there would be potential for increased energy efficiency-related Bank activities to match the significant size of the related sectors as evidenced by the size of the remaining HCFC phase-out needs. IFC, the private sector arm of the World Bank, is also supporting a range of climate-smart investments and activities that support the MP agenda and there are many potential opportunities for more direct linkages in this area.

145. Alignment of MLF funding with Bank lending may prove challenging however, even when directly related to energy efficiency financing, given the different business models at play. The MLF applies a systematic approach in its provision of support, in order to ensure that all developing country Parties have access to the financing necessary to allow them to meet their compliance obligations. A World Bank lending project, in contrast, develops organically, from the ground up, with a focus on its emergence as a priority issue of national concern within a fixed lending envelope. This raises issues of timing with respect to matching opportunities to leverage relevant energy efficiency operations with the MLF funding and development timeline, which is guided by global compliance targets. Furthermore, additional constraints may arise from the fact that, often, different national line ministries or departments would be involved, requiring good management of dialogue amongst government stakeholders. In view of the significant opportunities for climate co-benefits financing, it is recommended that the Parties to the Montreal Protocol promote strong inter-sectoral discussions within Government, and that the Executive Committee take into consideration Agencies' comparative advantage and relevant energy efficiency financing country programs in the context of pipeline and funding decision-making.

146. Innovative financing schemes, nevertheless, are being developed and piloted that could be adapted to support energy efficiency benefits linked to HCFC transition. An attractive example is in India where, in partnership with the Bureau for Energy Efficiency, the Bank is

working with fan manufacturers to support energy efficiency improvements through a reverse auction scheme. The same project design approach could be replicated in other countries and circumstances more directly relevant to the Montreal Protocol, with appliance manufacturers including fridges and room AC, wherein the MLF could finance some of the conversion and Bank financing would support the manufacturers in developing more efficient equipment. It is recommended that the Bank's Montreal Protocol team keep abreast of the implementation of this project with a view to sharing relevant lessons learned with the Parties to the Montreal Protocol and the Executive Committee as appropriate.

147. The global carbon markets do not, at present, offer viable financing options. In the near term, CDM related schemes will not be available to support energy efficiency or other financing needs at the nexus of the ozone/climate agenda, due to, amongst other things, the severe downturn in the CDM. Moreover, to date, the CDM has had limited success in contributing to overcome investment barriers and channeling financing for GHG mitigation interventions for less mature technologies or targeting large scale, long-term investments, and addressing sectors (countries) with weak investment climates[41]. This is due in part to the CDM's cumbersome procedures that resulted in a long and unpredictable project cycle (it takes an average of four years for a project to reach the issuance of certified carbon credits). In addition, regulatory risks limit the CDM's capacity to facilitate access to advance payments critical for projects, in particular in least developing countries (LDCs). Reducing such risks is indispensable in order to direct climate finance and result-based developmental finance into CDM projects, as well as attract private sector investment. The issues of efficiency and outreach under the CDM are at the center of the on-going CDM reform and figure in recommendations formulated by the High-level Panel on the CDM Policy Dialogue that took place in 2012. The World Bank is actively contributing to the dialogue on ways to make the CDM more efficient, flexible and better adapted to the needs of different countries to contribute to net global emission reductions and sustainable development, and is also engaged in discussions and support to the development of new generation carbon market instruments - both nationally and internationally.

148. One of the premises for this report is that in any event, Carbon revenues are usually only paid once a project is fully commissioned, while project developers invariably need finance to reach financial closure. To overcome these problems, approaches to develop financial products to frontload future carbon credits continue to be explored. Potentially, instruments such as green bonds, designed to deliver financing to developing countries through the sale of bonds that return both interest and carbon credits, have been under discussion to leverage and scale up investment, provided that the price of carbon is sufficiently high. Insurance and guarantee products can underwrite risks and enable the development of existing and new low-carbon technologies that may, on their own, not be commercially attractive. It is recommended

[41] It is important to understand that carbon finance was not designed to address investment barriers in underlying projects as most carbon purchasing contracts (e.g., emission reductions purchase agreements – ERPAs) consider payments for credits upon delivery.

that these approaches be kept under review so that they can be applied to Montreal Protocol-related activities when the second generation of carbon markets is up and going.

149. The severe downturn in the CDM market and the widespread ban on carbon credits from HFC-23 projects present another challenge since HCFC production for feedstock results in HFC-23 being released to the atmosphere for the foreseeable future if it is not captured and destroyed. It may require that governments address the issue through regulation, with technical assistance provided as appropriate. It is recommended that, if incorporated in a domestic trading scheme, the allocation of such credits would have to be carefully prescribed and limited to avoid domestic markets being flooded with cheap credits, as happened with the CDM.

150. The outlook with respect to development of domestic carbon markets in a number of developing countries however, remains promising. A number of pilots underway or planned by countries participating in the Partnership for Market Readiness are being launched with the support of the Bank. A case in point is the development of several regional cap-and-trade schemes in China. The Partnership for Market Readiness is working to build readiness for market-based instruments and may support piloting schemes in selected countries in the future. It is possible that these will evolve into new markets which may eventually be able to support financing of activities to which HCFC phase-out projects could link. Within a 3-5 year timeframe, it is envisaged that these markets may be able to support financing. At that stage, financial engineering tools and approaches that were conceptualized and developed to facilitate the upfront financing of investments under the CDM should be applicable. It is recommended that the Executive Committee and the Parties to the Montreal Protocol be kept abreast of these developments, and that countries engaged with the PMR explore Montreal Protocol-related activities as part of their readiness efforts.

151. Following the request of the Executive Committee, the report considers reflows back to the MLF and concludes that these are, in theory, possible provided robust domestic carbon markets exist with high enough carbon prices to justify the additional effort. It is recommended that should such approach be followed, very careful consideration should be taken to not unduly increase transaction costs and create new barriers to investments which would inevitably reduce attractiveness to private sector investments.

152. The on-going phase-out of HCFCs will create stocks of used HCFCs (so-called “banks”). It is recommended that Parties to the Montreal Protocol and members of the Executive Committee work with the Implementing Agencies and the international community to ensure that these banks do not accumulate and add to the existing CFC banks. Proactive approaches could include support to manufacturers and others to develop buy-back schemes that address the final disposal of the ODS.

153. In conclusion, the renewed commitment by World Bank senior management that puts climate change at the core of the Bank’s fight for poverty eradication and shared prosperity

offers a framework for enhanced engagement with the World Bank upon which to build Montreal Protocol/energy efficiency/climate mitigation linkages, including through partnerships to build clean cities.

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ANNEX I – Sector Background

1. This Annex provides background material for the analyses presented in Section 2 on Sector Background. The ODP and GWP of the main chemical substances relevant to this study are provided in Table 1. Table 2 gives the assumptions behind the model and the details of the calculations presented in Table 2 of the main text of the report.

Table 1. *Range of lifetimes, ODPs, and GWPs (20-yr and 100-yr) of some relevant ODS and HFCs*

Substance	Lifetime (years)	ODP	GWP (20-yr)	GWP (100-yr)
Chlorofluorocarbons (CFCs)				
CFC-11	45	1	6,730	4,750
CFC-12	100	1	11,000	10,900
Hydrochlorofluorocarbons (HCFCs)				
HCFC-22	12	0.055	5,160	1,810
HCFC-141b	9.3	0.11	2,250	725
HCFC-142b	17.9	0.065	5,490	2,310
Hydrofluorocarbons (saturated HFCs)				
HFC-23	270	-	12,000	14,800
HFC-32	4.9	-	2,330	675
HFC-125	29	-	6,350	3,500
HFC-134a	14	-	3,830	1,430
HFC-161	0.3	-	43	12
HFC-245fa	7.6	-	3,380	1,030
Hydrofluorocarbons (unsaturated HFCs)				
HFC-1234yf	10.5 days	-		4
trans-HFC-1234ze	16.4 days	-		7

Source: Handbook for the Montreal Protocol, UNEP (2012); IPCC AR4 (2007); WMO/ UNEP (2010)

Table 2. *Detailed back-of-the-envelope estimate of the energy efficiency and climate mitigation related impacts of a program addressing 1 million[42] energy efficient room air conditioners; summarized in main text Table 3.*

Personal savings from one room AC

- Assume average size room air conditioner: 1,500 W / 18,000 BTU
- Air conditioner cost: $700
- Assume new unit is 20% more energy efficient (300W)
- Use varies per region: assume 12 hours for 270 days for (sub)-tropical climate
- Energy savings: 300 W x 12 hours X 270 days = 972 kWh per annum
- Energy savings @$0.12 per kWh = 972 x 0,12 = $117 per annum. Over 10 years = $1,170
- Potential "Carbon value" per annum @ $5 per ton of carbon and grid emission factor of 0,7 tCO_2eq per MWh = 0.972 X 0.7 x $5 = $3,40 per air conditioner per annum

Impact on power generation

- Program saves 972,000 MWh of electricity per year
- Avoided cost of new power plant: 111 MW of installed power. Capital cost in order of $95- $216 million depending on source of power
- Saving per air conditioner is in order of $9.5- $21.6 (excluding operating costs)

Program carbon finance income

- Annual income from sale of emission reductions for 1 million air conditioners = $3.4 million
- Carbon finance income over 10 years is $34 million
- Carbon finance program costs:
    - One-off costs: Carbon finance program preparation: $200,000 - $400,000
    - Program validation: $15,000 - $50,000
    - Program registration: $50,000
    - Annual monitoring: $20,000 - $60,000
    - Annual verification: $15,000 - $30,000
    - Annual issuance fees: $50,000

  Program cost over 10 years: $265,000 - $500,000 + 10 X ($85,000 - $140,000) = $1.15 million - 1.9 million
- Net income from carbon finance: $32.1 - $32.75 million

Possible (theoretical) impact from refrigerant

- Average size window air conditioner might contain 0.7 kg of refrigerant
- HCFC-22 GWP of 1,810; substituted with a gas with 0 GWP
- would result in reduction of 126,700 tCO_2eq if assuming 10% leakage rate, or
- @ $5 per ton, a revenue of $633,500 per annum; representing only $0.6 per unit
- ➔ In contrast the savings from displacement of HCFCs even if it were eligible for earning carbon credits (it is not), is much smaller.

Source: this report

[42] 553 million units of HCFC-22 air conditioners were estimated to be operating worldwide in 2008; in the order of 50 million new units might therefore reach the market yearly (TEAP, RTOC, 2010).

ANNEX II – Climate Finance Instruments

2. This Annex expands on Section 3.1, Overview of Climate Finance Instruments. A number of policy and fiscal instruments are available that could be used to target various sets of stakeholders at different stages of the product development cycle, which may be summarized as follows:

- Financing the enabling, regulatory and fiscal/tax environment. Financing of energy efficiency (EE) and ODS standards and labels are usually undertaken by governments in MICs and in the case of LDCs, through concessional sources of finance and technical support from MDBs and bilateral and donor agencies. Financing needs are relatively low but the correct design of the enabling environment is critical for program success. A range of existing instruments to more innovative instruments can be used. Criteria for selecting the correct instruments include: effectiveness in changing behavior, cost effectiveness of administration, economic efficiency, financial sustainability and predictability of results. For instance, taxes are often a highly effective and predictable instrument for changing behavior. In contrast, carbon finance as a means of financing new products and services in order to change behavior carries a high administrative burden, provides low financial rewards and is highly unpredictable in terms of delivering financial rewards.
- The most obvious and relatively easier fiscal instruments that may be used to incentivize a change in retailer and consumer behavior include:
    - Reducing or eliminating import duties and or sales taxes on energy efficiency and low ODS appliances;
    - Providing tax rebates to suppliers who reconfigure manufacturing lines to support EE and low ODS appliances. Given that new business investments are usually tax deductible, this is not a new instrument as such unless further tax deductible benefits are created;
    - Providing rebates to consumers who submit receipts demonstrating that they have replaced old energy inefficient and high ODS appliances with new EE and low ODS appliances. Though such programs exist in many developed countries they need to be expanded to cover low ODS equipment in developing countries together with the development of ODS bank facilities;
    - Investment level support to manufacturers of equipment and ESCOs may take the form of grants, or soft loans to manufacturers to ramp up production and sales of more EE appliances until such time as they become the new market norm/baseline technology. Regulation may simultaneously be tightened to support higher standards in order to support the phase-in;
    - ESCOs play an important role in many countries in providing new EE appliances to consumers who in turn, recover the costs of the investment in the appliances through savings on energy bills. Utilities, equipment suppliers, municipalities or private agents may provide such a service to consumers. ESCOs often require upfront soft finance from government or a utility in order to make the upfront purchase of appliances on behalf of the consumer. That is, the ESCO effectively

leases the appliance or extends credit to the consumer until it is paid off from energy savings on the electricity bill. Various donor and MDB programs have also supported such initiatives;

- National revolving energy efficiency funds may be established to support the above activities. Such funds may be established through government budget, MDB loans or through green bonds;
- Green bonds may be structured in the same way as regular government or bank bonds but provide the principal amount to the financing of energy efficiency activities. Prior to the decline in carbon markets, green bonds were being developed which would allow the bond holder to opt for receipt of a fixed coupon (interest) or to be paid in certified emission reductions (CERs) or income derived from the sale of CERs. While green bonds are likely to continue to be used, it will be difficult to pay the coupon in emission reductions or from the income derived from the sale of emission reductions until carbon prices stabilize.

3. Specific instruments are varied and include the following list, by no means comprehensive:

4. Capital formation through investors. The most important source of finance remains banks and private/corporate investors responding to the perceived investment opportunities offered by the market in the expanding range of energy efficient appliances driven by technology improvements, consumer demand, the increasing costs of energy and increasing energy efficiency standards imposed by governments.

5. MDB and donor related programs to support developing countries. A large number of loan facilities are managed by MDBs and donors to support developing countries to eradicate poverty and to achieve their development targets. Though energy access is more commonly stated as a development goal in donor/development partner country program documents than EE, the latter is gaining increasing importance as a financing/development priority. This is due to the fact that countries recognize that EE programs can deliver results more quickly and at lower cost than building new power plants. The main financing instruments include market related interest rate loans associated with technical assistance, low interest rate loans, and grants. Various guarantee instruments are also provided.

6. The Global Climate Change Alliance (GCCA) is an initiative of the European Union (EU). Its overall objective is to build a new alliance on climate change between the EU and developing countries that a) are most affected and, b) have the least capacity to deal with climate change. The GCCA does not intend to set up a new fund or governance structure, but will work through the European Commission's established channels for political dialogue and cooperation at both the national and international levels.

7. The Global Energy Efficiency and Renewable Energy Fund (GEEREF) is a Public-Private Partnership designed to maximize the private finance leveraged through public funding made

available by the European Commission and managed by the European Investment Bank. GEEREF is structured as a fund of funds and invests in private equity sub-funds that specialize in financing small and medium-sized project developers and enterprises (SMEs) to implement EE and renewable energy projects in developing countries and economies in transition.

8. The Climate Investment Funds (CIF) are a $7.6 billion partnership to scale up both financing and knowledge for climate solutions in 49 countries. The CIFs are demonstrating scaled-up support to transformative adaptation and mitigation planning, leveraging investment finance and deployment of technologies. Current demand for CIF assistance outweighs available resources indicating a need for additional financing to cover the gap before the Green Climate Fund (GCF) is fully operational. CIF contributors agreed that "the CIF should play its part in ensuring the continuity of climate finance provided to recipient countries while the GCF's structures are put in place." Of the four CIF windows, two are focusing on sustainable energy, the Clean Technology Fund (CTF) and the Program for Scaling-up Renewable Energy in low-income countries (SREP).

9. With $5.2 billion in pledges, the Clean Technology Fund (CTF) provides middle-income countries with resources to trigger investments for scaling up demonstration, deployment and transfer of low-carbon technologies. Investment Plans for 15 pilot countries and one region have been endorsed, as well as $2.3 billion in funding for 41 projects under 14 investment plans. The amount is expected to leverage $18.8 billion in co-financing from governments, MDBs, and other sources, with nearly one third funded by the private sector. Virtually all of the CTF's Investment Plans have a component to finance EE improvement (mostly through financial intermediaries, coupling credit lines/risk facilities and capacity building). While not all may target sectors linked to ODS, these investment plans offer opportunities. The World Bank is the Trustee of the CTF, as well as an implementing agency together with the regional development banks (Asian Development Bank, African Development bank, Inter-American Development Bank and European Bank for Reconstruction and Development).

10. The Global Environment Facility (GEF). The GEF is the financial mechanism for a number of Multilateral Environmental Agreements, including the United Nations Framework Convention on Climate Change, and also supports the Montreal Protocol in countries with economies in transition. As of 2011, the GEF EE window had allocated $80 million to ESCOs and $61 million to appliances projects[43]. It finances the incremental costs of project activities, i.e. those activities which are only being undertaken to broadly meet the objectives of the Convention/ to create global benefits. The GEF, in principle, should be well suited to support the funding of climate co-benefits associated with the Montreal Protocol, but in practice this has not always been the case, in part due to the constraints that arise from the GEF's resource allocation system.

11. The Indonesia Climate Change Trust Fund (ICCTF) is a national funding entity which aims to develop innovative ways to link international finance sources with national investment

[43] http://www.thegef.org/gef/whatisgef

strategies. Created by the Government of Indonesia, it acts as a catalyst to attract investment and to implement a range of alternative financing mechanisms for climate change mitigation and adaptation programs. The ICCTF receives non-refundable contributions from bilateral and multilateral donors. The main funding mechanism of the ICCTF is the "Innovation Fund" which provides grants to line ministries to support climate change related projects.

12. The UK International Climate Fund (ICF) is the primary channel of UK climate change finance. It became operational in 2011 emanating from the Spending Review 2010 and replacing the Environmental Transformation Fund. The ICF is designed to help developing countries adapt to climate change, embark on low carbon growth and tackle deforestation.

13. The German International Climate Initiative (ICI) finances climate projects in developing and newly industrialized countries, as well as in countries with economies in transition. The ICI focuses on promoting a climate-friendly economy, measures for climate change adaptation and for the preservation or sustainable use of carbon reservoirs/reducing emissions from deforestation and forest degradation (REDD).

14. The Japan Fast-Start Financing. In December 2009, Japan announced the Hatoyama Initiative (now commonly referred to as the Fast-Start Financing), which pledged $15 billion in public and private financial assistance to help developing countries address climate change. Consisting of $11 billion in public finance and $4 billion in private finance, this Fast-Start Financing replaced the government's previous financing mechanism known as the "Cool Earth Partnership" (2008 - 2010).

15. The Green Climate Fund (GCF). The decision to establish the Green Climate Fund was taken by the Conference of the Parties to UNFCCC in December 2010. The GCF is intended to provide funds to developing countries to finance climate change adaptation and mitigation activities, including for energy efficiency[44]. The Green Climate Fund was designated as an operating entity of the financial mechanism of the UNFCCC. As per the UNFCCC, the Fund is to operate in a transparent and accountable manner guided by efficiency and effectiveness. The Fund is to play a key role in channeling new, additional, adequate and predictable financial resources to developing countries and is to catalyze climate finance, both public and private, and at the international and national levels. The Fund will pursue a country-driven approach and promote and strengthen engagement at the country level through effective involvement of relevant institutions and stakeholders. The Fund which is to be scalable and flexible is to seek a balance between adaptation and mitigation, while promoting environmental, social, economic and development co-benefits and taking a gender-sensitive approach. The target of GCF is to raise Climate Finance to US$100 billion for low carbon investment by 2020.

[44] http://gcfund.net/about-the-fund/mandate-and-governance.html. At this point it is unclear what level of funding will materialize given the current global economic climate. No commitment of funds to the GCF has been fixed. The Copenhagen Accord contains a pledge from developed countries of 100 billion by 2020, which can come from "a wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance."

16. De-risking instruments. De-risking instruments may be useful where loan guarantees or Letters of Credit are required by banks to lend to firms seeking to expand production of new appliances; that is, for firms that are less credit worthy and do not have strong balance sheets or assets and are therefore, less able to access bank credit, or only at significantly higher interest rates. Facilities which partially cover the default by the borrower help to reduce the risks which lenders face in lending to firms.

17. Carbon Finance. The carbon offset market exists through regulation or voluntary action. Signatory countries to the Kyoto Protocol have agreed to reduce their GHG emissions. They pass this obligation onto firms in the form of legally binding GHG emission caps or targets that are measured in tons of carbon dioxide equivalent (tCO2-eq). Firms in turn, are required to reduce their emissions accordingly to meet their targets or caps. The voluntary carbon market, in contrast, caters to the needs of entities that voluntarily decide to reduce their carbon footprint as part of a corporate social responsibility framework. In addition, some voluntary carbon market schemes cater to consumers who are attracted to buy carbon neutral products or services. The anticipation of legislation on GHG emissions also motivates some pre-compliance activity. Carbon offset markets did catalyze investment in ODS-mitigation projects with pre-compliance and/or voluntary markets with projects focusing on destruction of ODS banks under the Climate Action Reserve (CAR).

ANNEX III – Carbon Finance Concepts

1. This Annex expands on the overview provided in Section 3.3 of the Report. The United Nations Framework Convention on Climate Change (UNFCCC) governs climate change negotiations. The UNFCCC's Kyoto Protocol (KP) in turn contains the targets and timeline to which so-called Annex I Parties agreed[45] to reduce their GHG emissions as well as the flexible mechanisms they may use in meeting their targets. Parties who ratified the Protocol can either meet their emission cap through domestic action, or they may purchase emission quotas ("Assigned Amount Units") from other Annex I Parties or project-based carbon offsets ("Certified Emission Reductions") from developing countries through the Protocol's Clean Development Mechanism (CDM). Outside the Kyoto Protocol and the demand generated by Parties needing to meet legally-binding emissions targets, a (smaller) voluntary carbon market has also emerged consisting of voluntary demand for emissions offsets not required for regulatory compliance.

2. Carbon finance projects are defined as activities that can demonstrate that they have reduced GHG emissions measured in tons of CO_2 equivalent (tCO_2-eq) compared to a baseline (often a business-as-usual (BAU) activity or scenario. For example, a project which proposes to install more costly energy efficient air conditioners compared to the existing baseline equipment, and which demonstrates reduced consumption of energy and hence lowered CO_2 emissions from the power grid, may qualify as a carbon finance project.

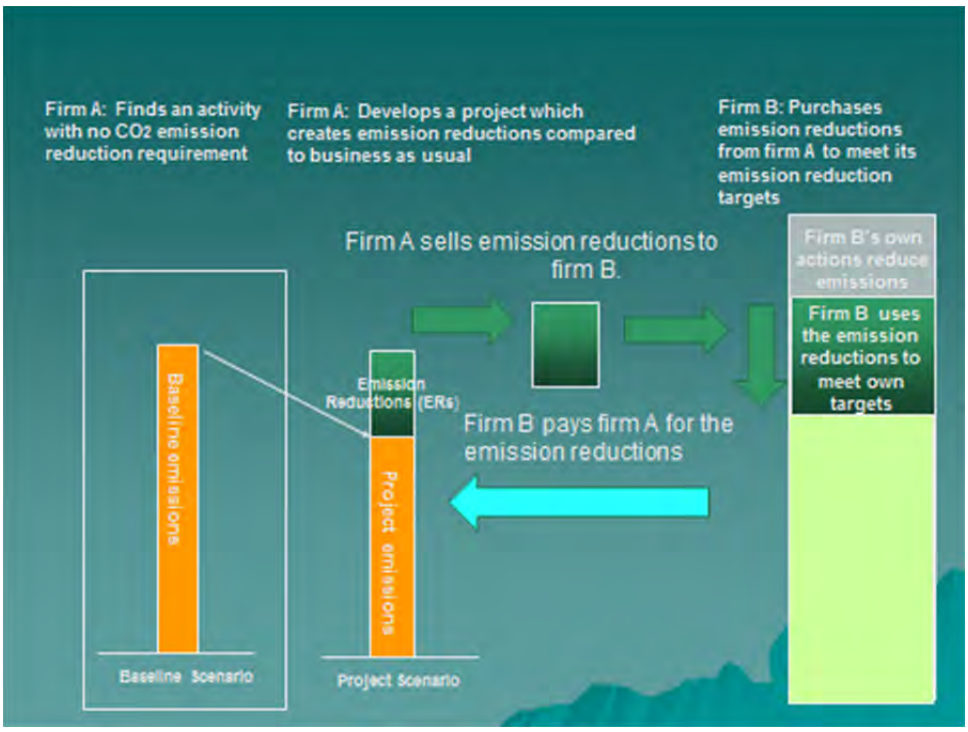
3. A project and the resulting emission reductions will usually be registered with a carbon trading clearinghouse (the UNFCCC for the CDM or one of several voluntary registries). This will assist the project developer to sell the expected or actual emission reductions to another party wishing to offset its CO_2 emissions. While carbon finance projects target, in the first instance, GHG emission reductions or CO_2 reductions which can be purchased by another party, the sale of the emission reductions can also be intended to be a key mechanism through which the project developer may raise project finance. That is, carbon finance projects are also intended as a mechanism for financing the introduction of energy efficient and cleaner technologies to developing countries.

4. Project-based carbon finance instruments are structured as performance-based payment schemes with internationally defined overarching principles and methodologies for assessing project eligibility and quantifying, monitoring, reporting and verifying GHG impacts of project activities. Project-based carbon finance has been instrumental in reducing emissions of short-lived climate pollutants (SLCPs), such as methane and HFCs that are covered by the mandate of the Kyoto Protocol.

[45] Countries with legally binding emissions objectives under the KP those that were member of the OECD in 1997 (when the Protocol was negotiated and adopted) and the countries with economies in transition. While most Annex I Parties observed the Protocol's first Commitment Period (2008-12), the USA never ratified the Protocol and Canada withdrew after having ratified it. The Protocol's agreed second Commitment Period is supported by even fewer countries (essentially only the European Union). A new climate treaty with broader participation is currently being negotiated and planned to come into force in 2020.

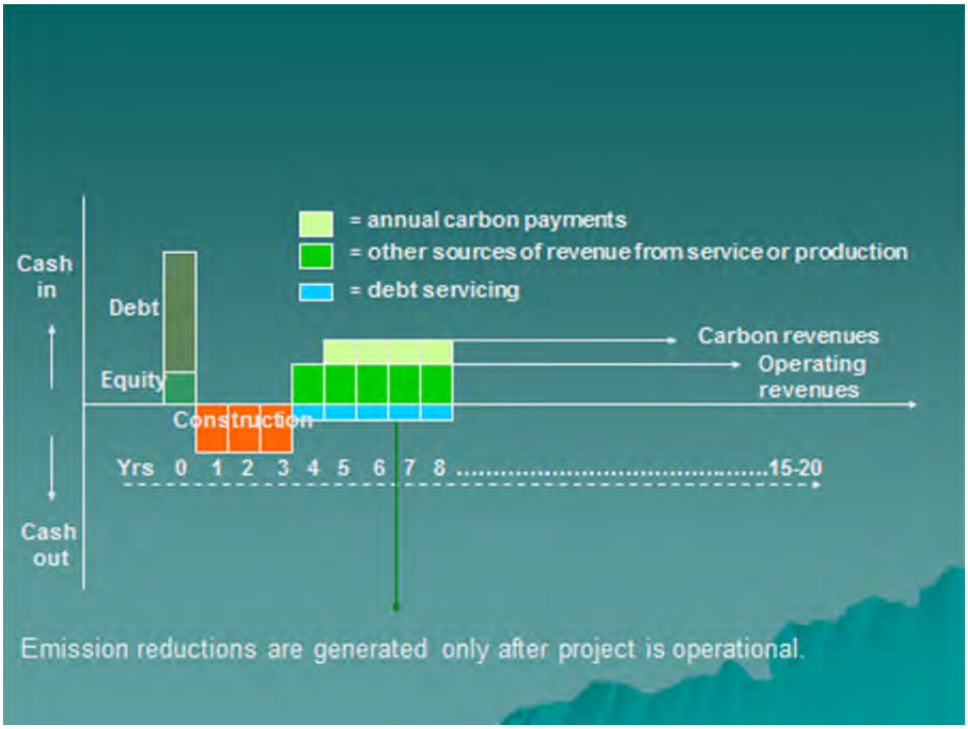
5. Carbon finance is a market mechanism regarded by most as being a more efficient mechanism than either imposing taxes on emissions of CO2 or fixing strict targets that each firm would have to meet. In principle it allows firms to more efficiently plan new investments and how best to allocate capital in order to meet targets. Carbon finance projects are also referred to as emission reduction projects and they have given rise to the carbon market in which emission reductions are traded. Hence we also refer to emission reductions as "carbon credits" and to the carbon trade which is the trade in carbon credits and which has given rise to the carbon finance business.

Figure 1. Concept of emission reductions and carbon finance



Source: this report

Figure 2. Carbon finance income is generally earned once a project is operational and emission reductions have been issued by a registry



Source: this report

Key Carbon Finance Activities

6. The key carbon finance activities which need to be understood include: (i) demonstrating that project emission reductions will be generated and the estimated volume; (ii) the carbon finance project cycle and institutional and implementation arrangements; and (iii) negotiating an agreement to sell emission reductions – emission reductions purchase agreement.

<u>Demonstrate that emission reductions will be generated and the estimated volume</u>

- Decide which mechanism the project will be registered under: Several different mechanisms or registries exist for registering emission reduction projects each with their own unique rules. The general concepts as described below are broadly similar.

- Identify and use an approved methodology[46]: Methodologies provide the general guidance for determining whether a project is eligible to claim carbon credits and the method which it needs to comply with to calculate the emission reductions and

46 http://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_NUYR4LTAJWFFEKSTJRJDZ8YDRKJB3T/AMS_II.C.Efficiency_Demand_side_ver09.pdf?t=dXJ8bWxpajE1fDCC7AaNc8w7GdGoGPbwCKLP

demonstrate that the project is additional (see below). For instance under the Clean Development Mechanism (CDM), a number of methodologies can be used to claim emission reductions from energy efficiency projects. As HCFCs are not included in the Kyoto Protocol "basket" of gases, no methodologies exist for claiming emission reductions from projects which destroy or do not use HCFCs. While it is conceivable that methodologies could be developed under the voluntary carbon market now that there are stricter control measures for HCFCs, the key issue is that this would probably not be worth the effort financially: An average size window air conditioner not using HCFCs would only displace 0.09 t equivalent of CO_2 which at $5 per t of CO_2-eq would be worth $0.45 per annum. This compares to income of approx. $3.40 which would be earned from energy efficiency measures.

- Project must be additional/not business as usual: In order to demonstrate that the project will generate emission reductions the project developer has to demonstrate that the project would not take place under business as usual. The project developer usually needs to demonstrate that: (i) they considered that the project would be eligible to earn carbon revenues at the time of investment decision such as a company board meeting; (ii) that the project will face significant barriers in being implemented such as financial barriers (cannot raise funds); technological barriers (technology is first of its kind/ new/risky/ lacks suppliers and maintenance providers); implementation barriers (roll out requirements are new and untested), etc. or (iii) the project faces investment barriers, i.e. the project is more costly than business as usual and does not generate the required company rates of return, or consumers would not buy the more expensive appliance.

- Establish the baseline and project emissions: In the case of an energy efficient air conditioner project for example, the project developer needs to establish the energy consumption of the type of air conditioner which the project will replace. He also needs to establish the energy consumption of the proposed project equipment. The projected difference in energy consumption will constitute the projected energy savings per piece of equipment and for all of the air conditioners for the program as a whole. The energy savings are then converted into GHG emission reductions by applying the power grid GHG emission factor.

- Clear monitoring parameters: All methodologies specify the parameters which need to be determined during project design and the parameters which will be monitored annually. These general parameters are typically as follows:

    - the power consumption of the baseline or pre-project equipment (measured in kW);
    - the power of the project equipment to achieve the same level of performance (kW);
    - estimated operating hours of the equipment (hours);

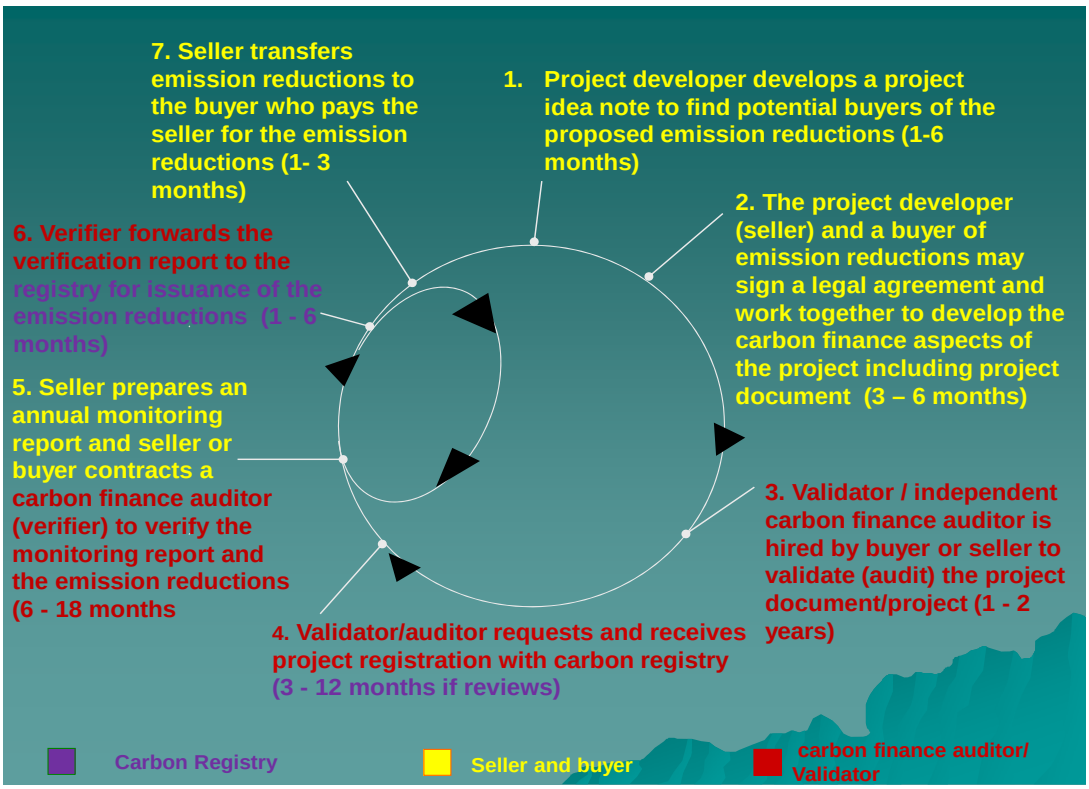
- Number of pieces of equipment;
- Scrapping of old equipment: it may be needed to demonstrate that old equipment is scrapped and does not continue to be used – otherwise emissions have not gone down – but baselines that allow for growth are possible as well;
- Projected emission reductions: The baseline energy consumption – the project energy consumption x the grid emissions factor for the power grid provides the overall projected CO_2 savings/ emission reductions;
- Clearly defined monitoring requirements and arrangements: The institutional responsibilities for monitoring arrangements including data capture and storage must be described and the frequency of monitoring and type of monitoring must be specified. The actual number of pieces of equipment which will form part of the project together with the date of installation, the power of the equipment, the place of installation etc. must be recorded in the project database. Where a very large numbers of pieces of equipment are installed, annual sample surveys are usually allowed to demonstrate that the equipment remains installed and in working condition. Depending on the methodology, it may be necessary to demonstrate through actual continuous monitoring of a sample of equipment for how many hours it operates per annum. In other instances it may be possible to adopt conservative default values.

Carbon finance project cycle and institutional/ implementation arrangements

7. The carbon finance project cycle involves several routine key steps which are indicated in Figure 3 below. There are four key players:

- The project developer who develops the underlying project also referred to as the seller of the emission reductions.
- The buyer of the emission reductions who will often support the seller technically or financially through advances to get the project registered. They will usually also be assisted by their own consultants given the highly specialised content of the project documents which must be prepared.
- Third party independent auditors who validate the project document (validators) and verifiers who verify the annual monitoring report prepared by the seller each year to demonstrate the volume of emission reductions which have been generated.
- Carbon Registries are the technical extension of the regulator – the key stakeholder in establishing a market. There are various registries serving different types of carbon assets and different markets. The best known is the CDM serving the Kyoto Protocol. Until recently it was the main registry serving MICs and LDCs. The transaction costs associated with administrative requirements vary significantly between registries. The procedures for the CDM are considered by many to place excessive burden on project stakeholders, creating barriers for investors. The voluntary Verified Carbon Standard while ensuring a similar high level of integrity is considered less burdensome on project developers, but is unable to issue emission reductions for CDM purposes which rest solely with the CDM Executive Board.

Figure 3. General steps forming part of the carbon finance project cycle



Source: this report

Negotiating emission reduction purchase agreements (ERPAs)

8. Negotiating an emission reductions purchase agreement between seller and buyer involves several key issues with the identification of risk mitigation measures being a most critical one. The most obvious aspects to be negotiated include: overall emission reduction volume/size of the contract, volume of emission reductions to be delivered each year, the type of emission reduction (whether for instance based on a monitoring report or an actual issued emission reduction).

9. With Europe having decided to restrict emission reductions into its trading scheme from projects registered post December 31, 2012 to LDCs, MICs are effectively shut out of the European market, and hence the origin of the emission reductions is key.

10. On pricing, approaches have shifted from fixed price contracts to variable pricing contracts as well as a mixture of both. Currently, with the decline in carbon markets, the few sovereign (government buyers) recognize the need to offer prices which are partially delinked from the market and which offer a price required to make it attractive to project developers to

undertake a carbon finance project. However, the volume of funds available for such activities are insignificant compared to the needs.

11. Risk mitigation measures aim to create certainty for both buyers and seller especially to insulate against under-delivery of emission reductions and damaging price fluctuations. The most common risk mitigation measures include using milestone dates by when projects should be registered, commissioned and generating emission reductions and what emission reduction volumes would constitute under-delivery and allow the buyer to renegotiate the emission reduction purchase agreement or to cancel it.

Assessment of carbon market risks based on the 12 years of carbon markets

12. Overall, while carbon finance instruments have established very detailed procedures for accounting of, and banking on, GHG emission reductions, they are not without risk for the reasons that follow:

(i) carbon finance instruments pose risk for both project developers and buyers of carbon credits. For the former, carbon finance procedures are burdensome, projects are time consuming to develop, and they present risk with regard to the possibility of non-registration, or if registered to the possibility that expected volumes of emission reductions may not be issued. From the perspective of the buyer, if the expected income from a carbon finance project is critical to the success of a project, such risks may be perceived to be too high to proceed with carbon financing;

(ii) carbon finance rules, especially under the CDM and in the European market, change frequently and while some minor simplifications are introduced, often the revisions lead to greater stringency;

(iii) recent severe downturn in prices of emission reductions which does not encourage the use of carbon finance at this time. Nonetheless, a number of actors, including the European Union and the World Bank[47] are exploring measures and means to revitalize the market.

13. In conclusion, carbon finance programs can take anywhere from 3 – 6 years to deliver actual financing, and they currently, given the market situation, do so at very low returns. As a result, this presents a disincentive for any project that would be dependent on carbon finance income. Results based schemes funded by sovereign donors could offer a stop gap solution however.

[47] For example work of the World Bank's Carbon Finance Unit under the Partnership for Market Readiness.

ANNEX IV – Experiences with Carbon Finance Related to the Montreal Protocol

1. This Annex expands on section 3.3 of the Report by providing additional information regarding experiences with using carbon finance to finance the mitigation of releases of relevant substances in two key areas: the destruction of HFC-23 by-products (not an ODS) and the destruction of ODS "banks".

Targeting HFC-23 incineration with the Kyoto project-based mechanisms

2. One sector that has seen the development of a number of projects for support through the Kyoto project[48]-based mechanisms is the incineration of HFC-23. The bulk of HFC-23 generation comes as a by-product in the production of HCFC-22, either for refrigerant or as input ("feedstock") for the further production of synthetic polymers. HFCs are part of the Kyoto basket of gases but, having no ODP, are not regulated by the Montreal Protocol, while HCFCs that have both ODP and GWP are regulated by the Montreal Protocol only. . Given the high GWP of HFC-23, plant operators were, until recently, able to earn significant revenue through the carbon offset market, far exceeding the cost of purchasing, installing and operating HFC-23 incinerators and the transaction costs linked to the carbon market. However, concerns over the abundance of HFC-23 credits and with the risk/perception for perverse incentives, and questions regarding their additionality and contribution of these activities to host country sustainable development, all led to a decision in 2012 by the EU to no longer allow the use of carbon credits from such projects for compliance within the EU Trading Scheme (ETS), thereby effectively halting most carbon finance flows to HFC-23 destruction projects.

3. There are currently 23 such CDM projects[49] in existence, all but one registered, and 19 are active and have issued CERs. Virtually all are in East Asia and the Pacific, with 11 projects in China, nine in India (including one not registered) and one in South Korea. Though they represent only a tiny fraction of CDM projects registered (0.3%) or with issuance (0.9%) globally, 'HFC' projects nevertheless account for the top category in terms of issuance, with 40% of certified emission reductions (CERs) issued to date, or approximately 483 $MMtCO_2$-eq.[50]

4. 'HFC' projects also represent the top category in terms of CDM transactions by project type, or about 20% of CERs transacted in the primary pre-2013 CDM market, reflecting the preference of buyers and intermediaries for asset types with large potential and predictable issuance. Together, these forward transactions account for $4.9 billion in potential flows to "HFC" projects (or 17% of global estimated value of CDM transactions in the primary pre-2013

[48] When covered by carbon market regulation, HFC sources have been so far addressed through the project market and not included under the cap. New Zealand is the only exception, where HFCs (and PFCs and SF_6) are regulated by the New Zealand ETS since January 2013, and California (where compliance started in 2013).
[49] There are, in addition, four 4 CDM projects in India that substitute HFC-134a as a blowing agent for polyurethane foam. All but one are registered, but with no issuance so far.
[50] Source: *UNEP Risoe CDM/JI Pipeline Analysis and Database*, March 1st 2013.

CDM market, with already $4 billion in realized[51] financial flows (or 34% of estimated payments for issued CERs globally).[52]

5. This by far outweighs the estimated $59 million in underlying investment behind these projects.[53] To capture part of this rent and mobilize public revenues for domestic climate action, China (the largest host of such HFC-23 projects) has set up a revenue sharing arrangement for the sale of carbon credits from these projects. Regulation requires that project owners share 65% of revenue generated from HFC-23 CDM projects with the China CDM Fund[54]. There are also different percentages for other types of projects. The CDM Executive board repeatedly reviewed these projects and made adjustments to the applicable rules. In 2012, the EU decided to no longer accept carbon credits from such projects under the EU Trading Scheme (ETS).

6. As a result of this ban, carbon market flows to HFC-23 destruction projects have almost halted. In the absence of government regulations or creation of domestic carbon markets, the venting of HFC-23 might resume. Moreover, and in any event, a large fraction of the developing countries HCFC-22 production is not covered by CDM projects, in part because the HFC-23 incineration methodology prevented any new HFC-23 incineration projects from being added because there was a requirement that the maximum production of HCFC-22 needed to be established with three consecutive years between 2000-2004. Total annual production of HCFC-22 in developing countries continues to increase however mainly due to the increasing demand for feedstock production (e.g., use for production of Teflon). Production for feedstock is not covered under the Montreal Protocol and thus not covered under the scheduled phase-out for HCFCs[55].

7. While carbon finance proved extremely effective at catalyzing investments for mitigation of HFCs, eligibility restrictions on HFC assets in the compliance market raises doubts that this mechanism could be expanded to finance related future ODS mitigation efforts. Overall, the HFC-23 issue presents a paradox. HFC CDM projects were desirable because they required low capital investment, and generated a very large and predictable volume of carbon credits. However, if a domestic or international pricing scheme were to be developed such that no moral hazard was associated with the generation of the credits, it is conceivable that the low capital cost, size and predictability of these projects could again prove attractive to investors

[51] Actual financial flows to developing countries through the CDM are likely of a smaller magnitude as a vast majority of transactions are forward purchase agreements with payment on delivery. Depending on project financing, registration, and performance as well as delays in the regulatory process, the amount and schedule of payments may prove different.

[52] As transactions and their contractual terms are confidential, it is extremely difficult to estimate actual payments. One assumes here that a project registered in year Y has been contracted in the previous year (Y-1) and that all payments occur on delivery. Actual financial flows through the CDM primary market are thus estimated as the sum, for all projects with issuance, of volume of CERs issued times contract price. Source: for CER issuance, *UNEP Risoe CDM/JI Pipeline Analysis and Database*, March 1st 2013; for market price, World Bank (2012). *State and Trends of the Carbon Market*.

[53] Source: *UNEP Risoe CDM/JI Pipeline Analysis and Database*, March 1st 2013 (applies only to registered projects).

[54] See www.cdmfund.org

[55] Source: Stephen A. Montzka, Lambert Kuijpers, Mark O. Battle, Murat Aydin, Kristal Verhulst, Eric S. Saltzman, and David W. Fahey (2010). "Recent increases in global HFC-23 emissions", *Geophysical Research Letters*.

and project developers in the future. But, unless carefully designed, such schemes could again flood the market with cheap carbon credits, thereby undermining the overall intent of such schemes which is to provide a sufficiently high carbon price to incentivize investment in low carbon technologies.

Destroying ODS Banks with the voluntary carbon markets

8. At a much smaller scale, the voluntary carbon market is creating incentives for the recovery and destruction of ODS even though much of the potential remains to be tapped and the voluntary markets today are suffering from the same uncertainties and depressed prices as the CDM. While the MP regulates the production and consumption of ODS, a significant amount of ODS still remains contained in equipment, products, and stockpiles, and risks being released into the atmosphere in the absence of appropriate regulatory or financial incentives.

9. To date, there are three programs or standards that have approved methodologies to regulate such ODS destruction projects (see Table 7). Activity has, thus far, been limited, except in California where transactions have increased in number and volume since 2010, at least to 2012, given that Climate Action Reserve (CAR) early action ODS credits could be used for compliance under the U.S. Global Warming Solutions Act of 2006. Though volumes (6 million tCO2-eq) over the period 2010-11 remain moderate, prices currently fetch US $8/ton. While this demonstrates that interest from buyers exists, the level of interest expressed remains low in comparison to the volume of ODS potentially eligible for destruction, as provided by some estimates[56]. The recent severe downturn in the CDM is also affecting the voluntary markets, though these appear comparatively less affected.

Table 1. *ODS destruction projects registered with the voluntary market*

Standard/Program	Geographical eligibility	Number of registered projects	Volume issued ($MMtCO_2$-eq)	Activity
Chicago Climate Exchange[57] (closed 2010)	Destruction must occur within U.S. territory with import possible	13	NA	No transaction publicly disclosed on the ICE
Climate Action Reserve (CAR)[58]	ODS must be destroyed within U.S. territory but can be sourced in Art. 5 countries[59]	31 (incl. 3 from India and Mexico)	9.9 (39% from Art. 5 countries)	2.4 $MMtCO_2$-eq transacted at $\$8.2/tCO_2$-eq in 2011 (CAR-eligible only)[60]
Verified Carbon Standard (VCS)	Destruction can occur in any MP country (allowing for import).	0 [61]	0	NA

[56] See "*Study on Financing the Destruction of Unwanted Ozone-Depleting Substances through the Voluntary Carbon Market*", ICF International, Feb 2010.
[57] Source: the Intercontinental Exchange (the ICE) https://www.theice.com/ccx.jhtml
[58] Source: http://www.climateactionreserve.org/
[59] Only offset from the destruction of ODS sourced and destroyed in the US are eligible under the California ETS.
[60] Molly Peters-Stanley and Katherine Hamilton (2012). *Developing Dimension: State of the Voluntary Carbon Markets 2012*. Ecosystem Marketplace & Bloomberg New Energy Finance.
[61] There are 3 registered F-gas projects: 2 HFCs from the CDM and 1 for refrigerant leak detection (US-based).

Source: this report; from various sources

ANNEX V - Review of Experiences with Multi-Source Financing: the "Chillers Replacement" Cohort of Projects

1. A cluster of projects that targeted the conversion of building chillers, with the explicit intent to address servicing uses of CFCs, potential climate co-benefits and identification of additional financing from other sources offers useful insight and lessons learned regarding securing and implementing multi-source financing .

2. The analysis reviews the achievements and on-going challenges associated with five projects: India, Indonesia, the Philippines, Thailand and Turkey. This analysis does not constitute a formal evaluation, nor is it comprehensive. Rather, it provides a qualitative overview of some of the difficulties encountered at the various stages of implementation, and reflects upon the lessons that may be extracted and serve as possible guidance for future such work.

***Table 1**. Status of World Bank implemented chiller projects with multi-source financing*

Project name[62]	Start date (effectiveness)	Funding	Status
Turkey	1995	MLF $4.1m	**Completed** and closed Dec 2007
Thailand - Building Chiller Replacement Project	Oct 2001	MLF $2.5m ($1.3m cancelled) GEF $2.5m ($1.3m cancelled)	**Completed** and closed 30 Sep 2005
India - Chiller Energy Efficiency Project	Nov 2009	MLF $1m GEF $6.3m + CF component estimated $15.5m	**Under implementation** CF component being dropped
Philippines - Chiller Energy Efficiency Project	Jan 2011	MLF $1m GEF $2.5m + CF component estimated at $7.3m (KfW) Private (chiller owner) $37m	**Under implementation** CF component being dropped
Indonesia- Chiller Energy Efficiency Project	NA – appraisal completed Dec 2012	MLF $1m GEF $3.7m Private (chiller owner) $21m	**Cancelled** CEO endorsement was not achieved due to GEF Council members concerns with private sector's choice of refrigerant alternatives.

[62] The World Bank is also implementing chiller replacement projects with MLF support in Argentina, Jordan, and Mexico, but these did not involve co-financing/blending from different multilateral sources of financing and therefore are not treated in this section. Turkey is included because of its reliance on an innovative revolving fund.

Source: this report; based on project documentation

3. Overall experience with this cohort of projects has been mixed. While they represent a clear effort to acknowledge synergies inherent amongst the different global environmental conventions and their financing mechanisms, they also speak to the complexities that can arise as additional financing partners become involved, as well as when a "blended" approach applies in name only. Such challenges have ranged from an inability to synchronize the timing of financing approvals, the collapse of the carbon market, the impact of the 2008 financial crisis, competing institutional and implementation arrangements (e.g. dual reporting), namely under the MLF and GEF, and issues regarding the suitability and commercial availability of alternatives.

4. The market for primary CDM has dropped to its lowest level since 2004, linked to declining demand for offsets resulting from economic turbulence, a growing long-term oversupply of carbon offsets in the EU ETS and plummeting carbon prices. This has impacted the vision behind the strategy governing the more recent group of projects, requiring that they be restructured to adapt to the new context, and deliver the best possible outcomes in terms of chillers replacement in that context.

Turkey Chiller

5. The project was developed not as a stand-alone "chiller" project, but as part of the refrigeration sector phase out, the Turkey ODS II project, which was approved in 1995 and closed in December 2007 having disbursed $18.7 million in total (with $12 million under the Refrigeration Sector Plan overall, and $4.1 million for the chiller component[63]). Through this project, Turkey was the first to establish a Revolving Fund to ensure sustainable actions on phase out of ODS. Private sector enterprises were the principal beneficiaries of the project.

6. The Turkish Technology Development Foundation (TTGV), the financial intermediary and implementing agency, provided technical support and funds to large companies and SMEs on a loan and grant basis. Specifically for the chiller component, support was a combination of grant (25%) and soft loan (75%) provided by TTGV. Payback for the loan was over three years, with zero interest. The combination of grant and soft loan under a revolving fund scheme proved to be an effective tool motivating hotel owners to replace their old chillers with more energy efficient systems. In effect in this instance, the MLF grant allowed for the capitalization of the Revolving Fund that would serve to finance the energy efficiency / climate mitigation benefits. The high gains in energy efficiency that accrued on replacement coupled by the active marketing conducted by TTGV enabled nearly 40 chillers to be replaced across the country, compared with only four as originally contemplated.

[63] MLF Project Completion Report

7. Internally, staff continuity[64] contributed to the success of the project. Rather unusually, from project approval in 1995 until completion in 2007, the World Bank Task Manager and the TTGV Project Manager remained on the project. This resulted in substantial continuity of project knowledge, helped consensus building with officials of pertinent government agencies, and an enhanced ability to streamline project procedures and allowed TTGV to overcome a number of implementation related issues, including the noted lack of flexibility in funding.

Thai chiller

8. The overarching objectives of the proposed project were to assist Thailand to (i) improve energy efficiency and reduce greenhouse gas emissions in the building chiller sector, and (ii) reduce consumption of ozone depleting substances (ODS) as required under the Montreal Protocol on Substances that Deplete the Ozone Layer (MP). Specifically, the project was designed to work through EGAT (state-owned electric utility) to demonstrate the potential energy and environmental benefits that could be achieved through early replacement of low-energy efficient chillers using chlorofluorocarbons (CFCs) with newer, more energy-efficient non-CFC chillers. The project design was originally meant to demonstrate the benefits of the approach by replacing 24 old CFC chillers. This demonstration activity was meant to lay the foundation for a follow-on project that would replace about 444 chillers, estimated to be approximately 30% of the entire Thai chiller market in 1999 (estimated at about 1500 units). It was anticipated that this initial push to the sector would result in a "market transformation" that would lead to the accelerated replacement of all CFC-based chillers in the country.

9. The project was prepared in 1996 and 1997 and was approved by the MLF Executive Committee and the GEF Council during the fourth quarter of 1998. The project was originally to be implemented by EGAT, but in the fall-out after the 1997 financial crisis, the Government decided to privatize EGAT, making it no longer interested in demand-side management activities, including chiller replacement. The project was finally approved and became effective in October 2001, but in the re-design, the executing agency was changed to the Industrial Finance Corporation of Thailand (IFCT) who operated as a financial intermediary utilizing the project's funding (drawing $2.5 million from GEF and $2.5 million from MLF) as the basis for softening chiller replacement loans.

10. Because of the market corrections following the crisis, the commercially available interest rate dropped so low that the preferential rate provided through GEF and MLF grants was not competitive. Moreover, at the same period, the Ministry of Energy offered successfully several financial subsidy schemes to promote energy efficiency that were more attractive for the private sector as the interest rates were lower, with longer repayment periods and because there was no requirement to dismantle the old CFC chiller and install a data logger for the new chiller. The project therefore closed one year earlier than anticipated due to the limited uptake of loans by chiller owners. By that time, 17 out of the targeted 24 chillers had been replaced, but there was significant funding remaining with $1.3 million being returned to the GEF and

[64] World Bank, Implementation Completion and Results Report (ICR)

$1.27 million to the MLF. Nevertheless, the Implementation Completion Report for the project notes that the project was considered to have achieved Satisfactory results as the 17 chillers replaced had resulted in the project exceeding its stated targets (CFCs phased out; kWh energy saved; and CO_2 abated) and, as a demonstrations, had stimulated the market transformation resulting in a much larger replacement of chillers via local financing.

11. A number of lessons have been drawn from the Thailand experience. The project was deemed successful in achieving its stated goals even though it did not directly replace as many chillers through the demonstration program as expected. However, some participants noted the complex and at times seemingly unnecessary complications arising from the conditions placed upon participants through the financing agreement. The monitoring and evaluation procedures and cost of participation in general did place an extra cost burden on project participants (estimated at 15% of chiller cost as documented by one supplier). Additional complications were created by the somewhat duplicative and unsynchronized approval procedures required for GEF and MLF programming.

12. The Thai chiller project demonstrated that synergistic initiatives blending funds from different sources could be used to achieve complementary global environmental benefits. In this instance, benefits from CFC phase-out and reduced GHG emissions were stimulated by focusing on a unitary approach to chiller replacement. This idea provided the basis for the next generation of chiller-replacement projects in India, Philippines, and Indonesia.

India Chiller

13. Conceived as part of a programmatic effort to catalyze further synergies between ODS Phase-out and GHG emission reduction through energy efficiency, the India Chiller Energy Efficiency project was allocated $1 million by the MLF Executive Committee in 2007. The GEF Council approved an allocation of $6.3 million for the project in May 2008. But in order to upscale the project and mobilize the maximum amount of funding possible for chiller phase-out in India, it was decided to also tap resources available under the CDM. The original potential for CDM funding was estimated at $15.5 million, a sum which would be made available to proponents not at the beginning of the project, but only after the replacement of their chillers had been completed, they had generated and verified CO_2 savings, and certified emission reductions had been issued. The GEF and MLF clearances to begin project implementation were granted to allow the project to become effective in November 2009.

14. Because of the need to combine resources from three funding sources, each with different mechanisms with slightly different priorities and requirements, the project assumed a complex structure with strict requirements for eligibility. A “slot” window was developed to eliminate chillers from the eligibility of support if they were either too old as it is not possible to claim carbon credits for equipment which needs to be replaced in any event, or for those which are new and would have little to offer in way of reduced ODS or improved energy efficiency. Chiller owners had two choices. They could choose to obtain a one-time, up-front subsidy,

signing over any potential carbon-linked payments to the project's revolving fund. Or they could choose to receive all of their subsidy payments in the form of carbon-payments over the initial years of the chillers lifespan so long as that period was covered by the first commitment period of the Kyoto protocol.

15. The project faced various challenges in the early stages of implementation linked to its inherent complexity, the preference for shorter-term paybacks on the part of chiller owners, and the lag in getting the project registered. The initial financial intermediary which was meant to support the project withdrew from the project, and the new financial intermediary which took over decided to sign an ERPA with another buyer. Once the new buyer became fully acquainted with the project risks to registration and issuance of CERs as well as the slow implementation progress, they chose to terminate the ERPA.

16. Because of the initial over-ambitious project design, various project delays, and uncertainty with the carbon market, at the time of World Bank Board Approval (June 2009), the amount of funding expected from carbon financing streams was reduced to $5.85 million from the initial estimate of $15.5 million. The project was expected to support the replacement of 370 of the estimated 12,500 chillers in the Indian market. These demonstrations were intended to show how profitable the investments would be both to the financial intermediary serving as executing agency and to the chiller owners. This business model demonstrating mutually beneficial activities was expected to be sustainable and to lead to the eventual transformation of the market. The economic rate of return for the project was estimated at between 68 and 71%, depending upon the assumptions employed regarding the value of carbon purchased by 2013. These economic benefits included both the value of the energy savings and the overall reduction in demand resulting in capacity savings to the electric utility. From a typical chiller owner's perspective, the investment would demonstrate a financial rate of return of between 30% and 36% and a payback of 3.3 years. Clearly, the analysis undertaken during project appraisal showed that this project would be a "win" for the chiller owner; a "win" for the electricity supply companies; and a "win" for the global environment in terms of both a reduction in ODS and in GHG emissions.

17. However, implementation has not proceeded apace. As of early 2013, this project is in the midst of a restructuring. Several lessons can be drawn from these challenges. The first is linked to the overly complex project design (three instruments and complex financing and institutional arrangements); the second to the change in financial intermediaries, and the third to the time consuming process for registering a project with the CDM Executive Board. In the meantime the opportunity to tap carbon resources has effectively disappeared. In addition, the GoI became reluctant to see public resources under this project channeled to support private sector chiller owners. Further, during the short period of project implementation, no chiller owners consulted expressed an interest in utilizing the second approach to obtaining the subsidy through reliance upon carbon payments even though it was designed to be more lucrative than the up-front subsidy. Most chiller owners considered it to be too complex and fraught with risk of non-payment (which now appears to have been true). Finally, the

complexity of the institutional set up is no doubt leading also to ownership issues, and might explain, in part, the reluctance of the Government of India noted above.

Philippines Chiller

18. The structure of the chillers project for the Philippines is very similar to that of India, and consequently the story of the implementation of the project and of the problems faced is very similar. The project is currently in the process of being restructured to remove the carbon finance aspects of the project. The Emissions Reduction Purchase Agreement between the buyer (KfW) and the Department of Environment and Natural Resources (DENR) has been terminated and, as a result, the performance targets of the project will be scaled down to what is achievable with MLF and GEF funding only, targeting 50 chillers only in lieu of the 195 as originally intended.

19. The project provides financial incentives on a grant basis to support 15% of chiller replacement costs, in exchange for chiller owners surrendering potential carbon credits to the overall program. Alternatively, the project would have coordinated the redistribution of carbon finance revenues from energy savings to the individual chiller owners, minus a 20% fee to cover program administration, marketing, and various CDM-related costs. Based on discussions with stakeholders during preparation, it was established that no more than 20% of the chiller owners would prefer that option – even if it potentially meant less financial returns (with hindsight, however, and as noted above in the India case, the chiller owners were justified to take a cautious approach and preferring an immediate cash benefit).

20. Based on lessons learned with the previous projects, and in order to be more attractive for chiller owners, project funds are dedicated to covering the costs of data loggers connected to a centralized management information system. Whilst this addresses the issue of cost, it still leaves the door open to reluctance from participants to provide centralized data regarding their operations. The project also explicitly allows the replacement of all “inefficient” chillers, including HCFC chillers, rather than only CFC-based chillers. Whilst this evolution in the eligibility criteria was largely driven by the chiller replacement methodology which emphasizes the age of the equipment to be replaced, it also brings a welcome element of flexibility. (Eligible chillers must not be so old that they should have been replaced already due to having reached their full expected lifetime).

21. As with other similar projects, the fate of the recovered refrigerant is not directly addressed, in line with the funding policies of the Multilateral Fund. Chiller owners can either keep the recovered refrigerant for their later servicing needs, or they can hand it over to the Ozone Desk at the DENR’s Environmental Management Bureau. However, the country lacks access to appropriate destruction technology. To address the lack of funding through the MLF for the destruction of unwanted ODS, the World Bank is engaged in a separate technical assistance effort with MLF funding to work with the Governments of the Philippines and Indonesia to facilitate the destruction of unwanted ODS. This effort will hopefully lead to providing a solution for the ODS recovered through the project, even though it is not designed to directly address the project.

Indonesia chiller

22. The project as designed will offer a financial incentive for the replacement of old inefficient chillers with CFC/HCFC-free energy efficient chillers. A grant incentive payment will be about 15% of the cost of a new energy efficient chiller. GEF grant in the amount of $3.66 million is available to fund the incentive. The grant amount is estimated to be sufficient for the replacement of approximately 160 chillers of average cooling capacity of 350 TR (ton of refrigeration).

23. In order to simplify and provide clarity to stakeholders regarding the financial incentive to be paid by the Project, the payment is to be calculated on the basis of a normative price – assumed to be approximately $400/TR – multiplied by the rated cooling capacity of the new chiller (but not to exceed the rated cooling capacity of the old chiller), and multiplied by 15%. At the start of project implementation, the Project Management Unit will conduct a chiller price survey to confirm the normative price or propose adjustments.

24. The incentive payment to chiller owners will be disbursed as a lump sum after confirmation that the chiller replacement activity has been completed in compliance with all relevant provisions in the agreements. It will be the chiller owner's responsibility to pre-finance the chiller replacement and provide adequate co-financing from own resources or financing arrangement to cover the costs of new chiller(s), and any ancillary costs of chiller replacement activities (except certain measurement and monitoring services provided by the project). The ancillary costs are estimated at 10% of the cost of a new chiller.

25. Similar to the Philippines project, the project documentation acknowledges the issue of destruction of unwanted ODS, but cannot directly address the issue since this cannot be covered by MLF funding. As noted above, this is addressed through related efforts, and the project documentation notes that "the World Bank will assist the Government of Indonesia to explore funding opportunities for the disposal of unwanted ODS".

26. As in the other related projects in this portfolio, and due to donor requirements although this was already highlighted as detrimental in the Implementation Completion Report for the first, the Thailand project, the Project must track and report separately for each source (MLF and GEF) of funds. This also is adding rigidity and complexity to both project design and implementation, for no apparent benefit.

27. Finally, in spite of considerable efforts and resources spent in the preparation of this project by the Bank team and Indonesia counterparts, and of the significant energy savings and CO_2 emissions reduction that would accrue, the project was not approved at final Endorsement stage by the GEF CEO responding to issues raised by a number of GEF Council members regarding the global warming potential of refrigerant in replacement chillers the private sector are most likely to select, and a desire to fund only replacement chillers using "natural" low GWP

refrigerants in the circumstances. The Bank and Indonesia concluded the project would be non-viable under these circumstances given the specifics of the application.

Choice of refrigerant (R134)

28. HFC-134a is considered a good alternative refrigerant, but it has a high GWP of 1300. At concept approval stage, one GEF Council member had therefore requested exploring alternatives to HFC-134a use in new chillers and recommended the use of ammonia, which has a GWP of zero, in order to tap the full climate mitigation potential of the project. In the case of roof-top chillers, the Council member considered hydrocarbons a viable alternative for HFC-134a, and maintained that these cooling agents and technologies are already available at reasonable costs for new chillers in the international market and are in use in some developing countries. However, the UNEP Technical and Economic Assessment Panel of the Montreal Protocol endorses the use of HFC-134a in new chillers.

29. Ammonia and hydrocarbons have significant safety issues as their use can conflict with building safety requirements and would for example trigger additional World Bank safeguard policies. In particular, ammonia is a strong poison and hydrocarbons are explosive and flammable. Their application in chillers in commercial and residential buildings such as in office towers, hospitals, malls and other places frequented by large numbers of people, the focus of the Indonesia chillers project, therefore poses significant safety considerations within the prevailing building safety requirements which limits its attractiveness with the private sector.

30. An analysis of the GWP of HFCs and their alternatives – if conducted on a life cycle basis – and of the climate benefits of the proposed chiller replacement program shows that the claimed advantage of zero and low GWP refrigerants is not clear in practical applications. The life-cycle analysis accounts for the high leakage rate (up to 30%) of high GWP refrigerants in existing chillers and considers that modern chillers have a leakage rate of only about 1% and reduce GHG emissions due to their much higher energy efficiency. Given the practical difficulties with predicted low uptake and implementation delays of introducing ammonia and hydrocarbon based chillers, the net climate benefits of a replacement strategy that permits the use of HFC-134a in new chillers is positive.

Elements of lessons learned

31. In general, carbon finance in and of itself has not driven the financing of chiller projects largely due to doubts associated with the status of the Clean Development Mechanism in light of the political uncertainty regarding the post-Kyoto timeframe, as well as the current depleted state of the carbon market. Where the integration of carbon finance has been tested, it has tended to overburden projects with heavy monitoring procedures and, in general, higher transaction costs. Moreover, within the context of chiller replacement, the principal barrier lies in the opportunity cost of access to up-front financing for the investment, a challenge that can also be compounded by low energy tariffs. The India experience, in particular, shows that as a

result of this barrier, participants will choose up-front compensation over greater compensation in future.

32. Analyses drawn from an extensive study on chiller replacement in India formed the basis of the World Bank's design to secure MLF financing for the global chiller demonstration program. Based on the recognition that carbon finance would not address the opportunity cost barriers, the strategy adopted was for MLF and GEF funding to cover the upfront costs for the first round of chiller replacement and, once carbon finance returns started to flow, these could in turn be utilized for upfront financing to bring additional chiller owners onboard. Unfortunately, this premise could never be effectively tested given the global economic downturn and subsequent collapse of the carbon market.

33. Nevertheless, a number of important lessons have been generated. For one, project boundaries must be clearly thought out, balanced against goals and purposes at the time of project design, then carefully monitored throughout implementation. The emphasis on chillers in the Thailand project, for example, was considered ultimately to have been too narrowly defined in view of the fact that greater EE outcomes might have been generated if a broader "cooling system"-oriented approach had been followed. Nonetheless, the project's results did compel the Thai government to establish an Energy Conservation Fund that went on to support the replacement of an additional 500 chillers, allowing for both the MLF and GEF financing to be reimbursed.

34. Another lesson involves the choice of refrigerant. The more recent projects are hindered by uncertainty regarding what constitutes the most appropriate alternative refrigerant to use. Fairly significant differences in perception exist at present with respect to commercial availability, cost effectiveness, and suitability, including safety considerations, of alternatives for use in different circumstances: for example between a resort hotel complex with outside space to locate their chillers safely, and a large urban area where chillers are located inside buildings, which poses greater safety challenges. Experience demonstrates that independent external reviews are not sufficient to bridge the view held by different stakeholders involved. This issue is further exacerbated by the fact that the views and policies espoused by the different funding mechanisms are not always fully coordinated, nor are their expressions of opinion or oversight restricted to their areas of comparative advantage. This has manifested itself in pressure being applied to promote adoption of specific alternatives which, while of interest given their low or no-ODP/GWP properties, pose concerns with respect to commercial availability, costs and safe use. A consideration might be to make available additional funding to compensate – where possible – for the additional barriers associated with the use of less proven alternatives.

35. Experience with these projects has also demonstrated that multi-source financing tends to lead to heavy implementation structures and procedures. There is a need to simplify procedures and processes not only to streamline obtaining financing from multiple sources, but also with respect to reporting requirements imposed during implementation. At present, for

example, it is a requirement to maintain strictly separate progress reporting and accounting of relatively small amounts of MLF and GEF financing for 'blended' projects, despite the similarities between the instruments and their quasi identical shareholder base. The design of similar future projects should strive to simplify procedures and minimize additional administrative requirements, and may consider exploring the potential for joint project design, approval and oversight functions in order to enhance efficiency and reduce transaction costs.

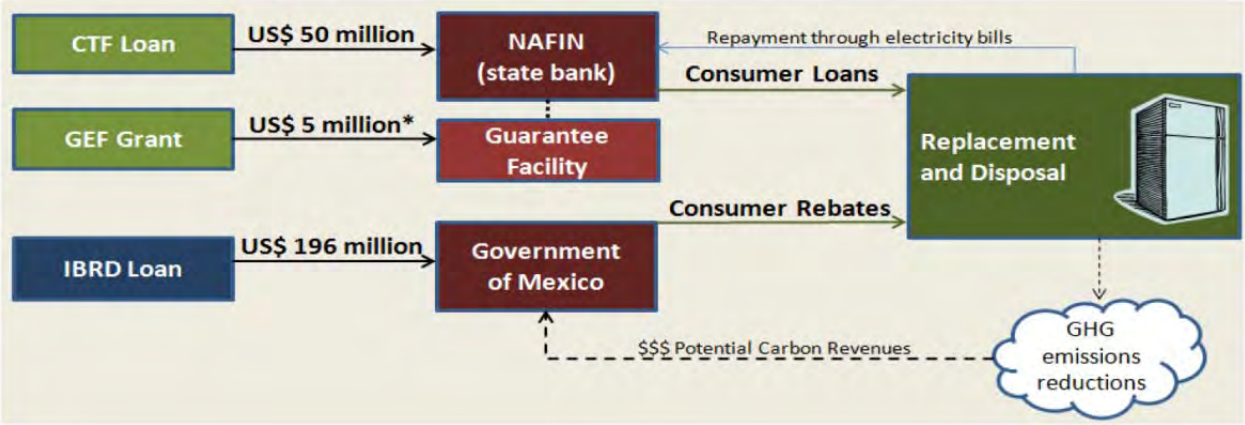
36. The experience gained in Turkey on the other hand demonstrates how positive results may be derived through application of a simple and targeted project design, which can rapidly deliver the desired market transformation. Here, non-grant instruments were used to overcome the opportunity cost, low energy tariffs and lack of fiscal incentive barriers that were faced. The Turkish counterparts who managed the project on the ground offered an interesting financing package and also actively promoted chiller replacement, which ultimately led to the project achieving a high success rate.

37. Finally, another salient feature of this cohort of projects has been the relatively small level of grant financing, which limits impact and visibility in the middle income large countries in which the projects are being implemented. Had a larger sum of funds been made available, it is likely that greater impact would have been manifested, due in part to the convening power that larger sums of upfront funding generate. Large-scale World Bank lending projects, for example, build synergies in support of full market transformation.

ANNEX VI – Opportunities for Synergies – Models and Examples

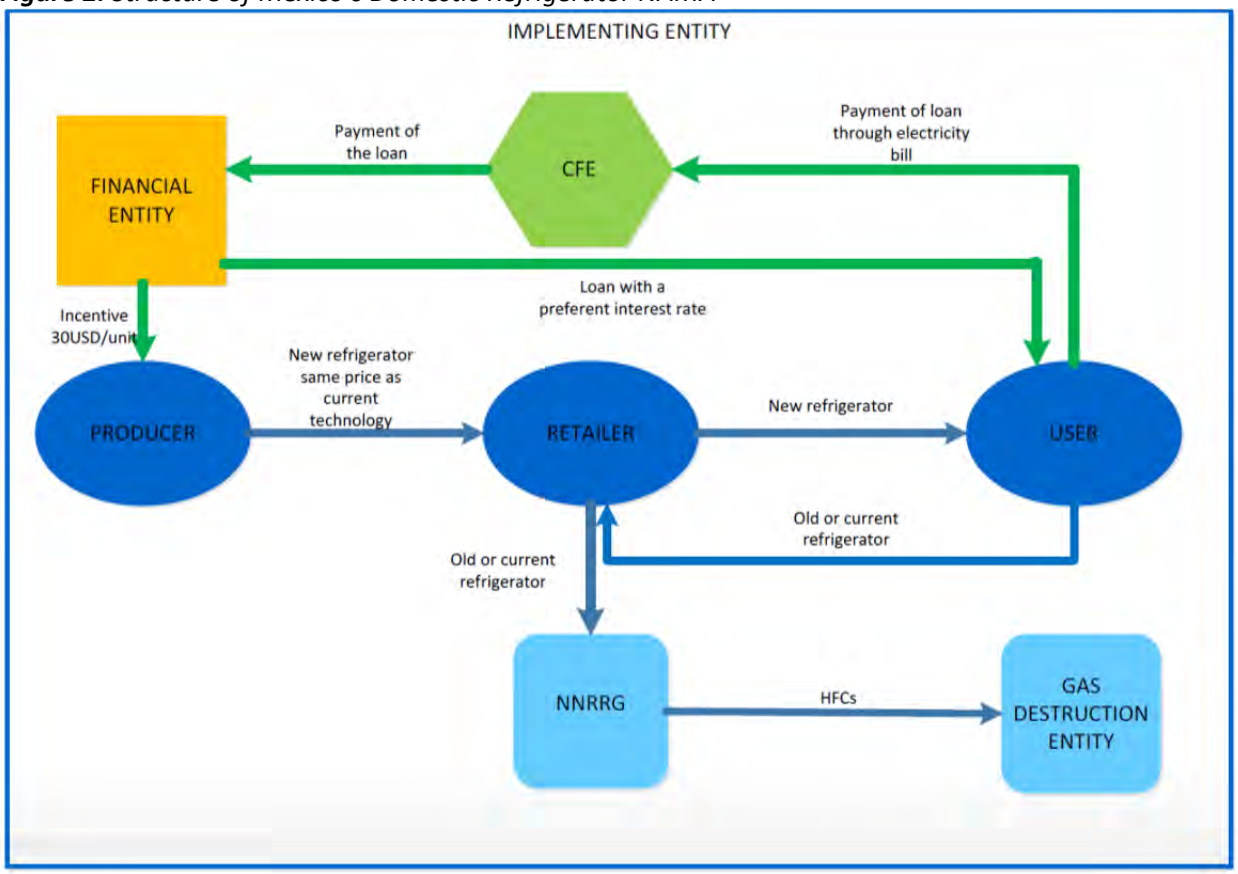
This Annex provides additional illustration for the model examples described in Section 4.2 of the Report. Figure 1 provides an overview of the financing structure of the Mexico Efficient Lighting and Appliances project, while Figure 2 gives a graphic description of the Mexico NAMA.

Figure 1. *Mexico Efficient Lighting and Appliances project financing*



Source: Mexico Efficient Lighting and Appliances Project Fact Sheet, World Bank (2011)

Figure 2. *Structure of Mexico's Domestic Refrigerator NAMA*



Source: Mexico Refrigerators NAMA, DNV KEMA (2013)

ANNEX VII - Elements from Dec. 63/24 of the Executive Committee

1. Further to the approval by the Executive Committee (ExCom) of the Study for Resource Mobilization for HCFC Phase-out and Climate Mitigation Co-benefits, the World Bank was requested to prepare a Progress Report for the consideration of to the 66th meeting of the ExCom that highlighted how a series of specific considerations were informing the Study's preparatory phase. The following provides an overview of the manner in which these considerations were taken into account in finalizing the Study.

Additionality of the projects proposed

2. Taking into account the scope of this Study, "additionality" is defined and addressed in Paras 84-85, in keeping with the information contained in the Progress Report presented to ExCom 66. From the perspective of the Multilateral Fund (MLF), "additionality" is understood as assurance that the set of activities to be promoted will generate environmental benefits beyond the baseline of MLF-supported interventions, which would not happen without the additional effort.

3. The resource mobilization approach developed in the Study seeks to link the ODS phase out supported by the Multilateral Fund with broader financing for energy efficiency and climate mitigation. Emphasizing and making this link explicit in order to maximize synergies and avoid lost opportunities represents, in essence, an 'additional' effort with respect to both MLF financing and climate mitigation and energy efficiency financing.

4. Moreover, the Study notes that additionality can also refer to ensuring that any grant component introduced with private sector beneficiaries helps tackle barrier removal but does not distort existing markets. This is particularly important today when, contrary to the early days of CFC phase-out, the market is much more fragmented, with large volumes of chemicals of interest produced in developing (Article 5) countries in either wholly domestic, foreign owned, or joint venture-type enterprises. The World Bank, including the IFC, possesses rich experience in project economic analysis to ensure that any grant element or concessional loan is set to an appropriate level for barrier removal but does not interfere with the market.

Transparency and good governance

5. Transparency and good governance are core values for the World Bank and hence, are addressed broadly throughout the Study. Specific projects and activities that are developed would have to demonstrate transparency and establish specific measures to promote good governance. As noted in the Progress Report to the 66th Meeting of the ExCom, the World Bank was recognized recently as the "best performer" in terms of aid transparency out of 58 donors by the civil society group "Publish What You Fund".

6. The World Bank's new Access to Information Policy (2010) represented a fundamental shift in the institution's approach to transparency and is considered to set the standard for international organizations. The Policy sets forth a ground-breaking change in how the World Bank makes information available to the public by moving to an approach of broad disclosure of any information in its possession, save a clear list of limited exceptions.

Assurance that these projects would avoid perverse incentives for countries

7. Given the broad scope of the Study, the issue of "perverse incentives" is addressed in an overall manner. Specific projects and activities that may be developed would pay specific attention to this issue. The Study outlines how the concern of the ExCom, as well as the international community, regarding "perverse incentives" may be addressed by presenting a specific case, outlined on page 57 of the Study, and summarized in the Conclusion (Para 127).

8. The case in point outlines possible approaches to address the destruction of HFC-23 emitted as a by-product in the production of HCFC-22. Such production, in particular production for feedstock which will continue in the foreseeable future, presents a challenge, for HFC-23 can be minimized through process optimization but at present cannot be eliminated and therefore, will continue to be released to the atmosphere if not captured and destroyed.

9. Two approaches may be envisaged. On the one hand, it may suffice that governments address the issue through regulation, with technical assistance from the international community provided, as appropriate. On the other hand, the issue could be addressed within the framework of future domestic trading schemes. A market mechanism with a cap need not lead to the same difficulties being experienced by the CDM, though significant attention would have to be taken to ensure that the allocation of credits is adroitly prescribed and limited to avoid flooding domestic markets with cheap credits.

Exploring possibilities of profit-sharing, including return of funds to the Multilateral Fund

10. Profit-sharing and return of funds to the Multilateral Fund are addressed in the Study in section 5 (Paras 86-89) that describes and discusses how a scheme with "profit-sharing" and reflows could operate. These points are also summarized in the Conclusion section (Para 131).

11. Section 5 explores a model, by way of example, wherein the MLF would provide support to manufacturers of HCFC-using Ref/AC equipment to convert to alternatives, as well as to introduce EE and low GHG equipment which would generate energy and/or GHG savings. In return for the MLF providing funds to manufacturers, the MLF could share in the income earned from the sale of the energy or GHG savings. The Study notes that the concept is feasible in principle, and provides some generic design features that such a program could include. The concept is predicated on a robust carbon market, and the Study further discusses other conditions that could apply.

12. Regarding possible reflows, the Study notes that the concept that the MLF could benefit from the reflows of a market mechanism/climate finance scheme tied to conversion to low ODS, low GHG and higher energy efficient equipment manufacturing production lines is theoretically possible. Experience under the GEF is that reflows can be managed transparently when this is well planned from the start. Due to the current depression of the international carbon market, no such profitable opportunities exist in the short-term, but the Bank continues to work with clients to monitor developments and possible opportunities.

Ensuring sustainability of the projects proposed

13. The scope of this Study is somewhat different from the others approved by the Committee for the other Implementing Agencies in that the scope of the World Bank Study does not envisage specific projects being identified as part of it. Therefore, this element is not further elaborated upon as analysis of conditions and measures to ensure sustainability would only apply to specific concrete project circumstances.

Avoidance of duplication of similar projects

14. The Study, overall, seeks ways to mainstream ODS phase-out within the broader EE and climate mitigation agenda. While some limited examples exist from which lessons could be drawn, the issue has not been considered through the lens presented in this Study before. As a result, the resource mobilization models outlined in the Study do not, in principle, offer options that are duplicative of “similar” projects.

Information on transaction costs

15. There is no doubt that information pertaining to transaction costs would have been a key element to be applied to earlier ideas proposed by the Bank around the concept of resource mobilization, as well as to project-level monetization. This consideration does not however, apply directly to the Study as developed since, as was presented in the Progress Report to the 66th ExCom meeting, the emphasis on carbon markets was reduced from the original concept due to the global downturn in the markets. The issue of transaction costs is nevertheless, highlighted throughout the Study, including in Para 8 and on page 43. Specifically, a model is presented for a carbon finance intervention to support energy efficiency improvements for air conditioners that describes and takes into account the cost of developing and running such a scheme.

SUPERCRITICAL CO_2 TECHNOLOGY

FOR POYURETHANE SPRAY FOAM

UNDP REPORT

SEPTEMBER 2013

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ASSESSMENT OF THE USE IN COLOMBIA OF THE SUPERCRITICAL CO_2 TECHNOLOGY

UNDP REPORT

Executive Summary

This project was developed as response to the Decision 55/43 of the Multilateral Fund Executive Committee and is part of a limited group of projects with the objective to assess new technology options that use non-ODP low GWP blowing agents; this project was specifically approved by Decision 60/29 in April 2010.

In the context of Decision XIX/6 there is a concern on the availability in Article 5 parties of validated cost effective and environmental sound technologies to phase-out HCFC-141b. This is particularly critical for the application of polyurethane (PU) spray rigid foam where most of the end users are small enterprises with a poor control of the operation and safety discipline. Several work orders are done in-doors with limited ventilation.

The proven technical options to replace HCFC-141b as blowing agent for PU spray foam are mainly limited to high GWP HFCs, HFC-245fa or HFC-365mfc/HFC-227ea blend, which have GWP values of 1030 and 964 respectively. Recent publications show promissory results with the new unsaturated HFC/HCFC blowing agents, commonly known as HFOs, that exhibit GWP values lower than 10, but the commercial availability is uncertain for the time of the conversion. The barrier for hydrocarbon technology in this application is safety during foaming because of their flammability.

The present project was designed to evaluate in an article 5 party such as Colombia the performance of super-critical CO_2, a proven technology applied in Japan for PU spray foam since 2004. A local commercialised HCFC-141b based formation was used as standard. Espumlatex, the largest Colombian 100% owned PU system house, served as local technical host to coordinate the demonstration, foam application and testing activities. The experimental protocol included two statistical full factorial designs, one 2x2x3 for polyurethane foam (PUR) and other 2x2 for polyisocyanurate (PIR). The qualitative factors (independent variables) were the technology (super-critical CO_2 versus HCFC-141b), the foaming location (Barranquilla at sea level versus Bogota at 2600 m over sea level) and foam density. To check processability field in-door applications were done in industrial warehouses in Barranquilla and Bogota and to determine the physical properties test foam sprayed samples were prepared and analysed following ASTM and JIS methods in Achilles and Espumlatex laboratories. In addition few samples (PIR and PUR) were made for E-84 fire performance testing at QAI laboratories in the United States.

The following conclusions can be pointed out:

- Supercritical CO_2 technology is a non-flammable, 0 ODP and low GWP technology. Compared to HCFC-141b based technology it does not create any incremental industrial hygiene and safety hazard.
- Supercritical CO_2 is a proven commercialised technology for spray foam that has been used in Japan since 2004.
- In Colombia, a developing country with tropical weather and various levels of altitude over sea level, Supercritical CO_2 showed a similar processability to the standard HCFC-141b based system currently used. Polyol and isocyanate components of both technologies were stable during the six months of project duration.
- In terms of physical properties of PUR foam, compared to HCFC-141b based formulations Supercritical CO_2 showed:
  - ✓ Higher thermal conductivity but better aging. The difference in lambda value between the two technologies decreased with time.
  - ✓ Similar aging behaviour in compressive strength. Values kept stable with time (initial versus six months)
  - ✓ Similar dimensional stability performance at -20 ºC. All values for both technologies were below 0.6%.
  - ✓ Improved dimensional stability at 60 ºC and 96% RH.
  - ✓ Similar adhesion strength to galvanised steel.
- In terms of physical properties of PIR foam, compared to HCFC-141b based formulations Supercritical CO_2 showed the same performance pattern than PUR:
  - ✓ Higher thermal conductivity but better aging. The difference in lambda value between the two technologies decreased with time.
  - ✓ Similar aging behaviour in compressive strength. Values kept stable with time (initial versus six months)
  - ✓ Similar dimensional stability performance at -20 ºC. All values for both technologies were below 0.6%.
  - ✓ Similar dimensional stability at 60 ºC and 96% RH in absolute values. However, the behaviour was totally different: meanwhile Supercritical CO_2 experienced a negative change in volume the HCFC-141b formulation had a positive one.
  - ✓ Lower adhesion strength to galvanised steel.
- According to fire performance test ASTM E84-12c, run on just one sample per formulation, the PIR and PUR foams based on Supercritical CO_2 would be classified as A and B respectively (NFPA).
- The cost of the required retrofit of a typical spray machine to apply the Supercritical CO_2 is in the range from 9,800 to 13,700 US dollars for PUR foam and from 11,800 to 15,700 US dollars for PIR foam.

- Supercritical CO_2 technology is based on proprietary polyol and isocyanate formulations developed by Achilles. The FOB price in Japan of the Supercritical CO_2 system by kg is 7 dollars.
- Supercritical CO_2 technology is a patented technology owned by Achilles Corporation. The interested parties should come to an agreement with Achilles on technology fees.

It is worth noting that Decision 60/29 stated that "…The demonstration would be carried out in cooperation with a local systems house and included foaming equipment designed for use with the technology, an evaluation of relevant foam properties, a performance/cost analysis, and dissemination of the technology to systems houses in Colombia and other Latin American countries…", as can be seen in this report, the demonstration project covered and fulfilled the different aspects specified in the decision.

While the demonstration project in on large Latin American country was successful, the application of the Supercritical CO_2 technology should be carefully evaluated in context of the local situation prevailing in each country. The report by no means concluded that the technology was sufficiently consolidated to be applied in all countries, and did not address issues of availability and cost in the field. Finally, interested parties must take into consideration the proprietary issues related to the technology.

1. INTRODUCTION

In the context of Decision XIX/6 there is a concern on the availability in Article 5 parties of validated cost effective and environmental sound technologies to phase-out HCFC-141b in the different foam applications.

This project was developed as response to the Decision 55/43 of the Multilateral Fund Executive Committee and is part of a limited group of projects with the objective to assess new technology options that use non-ODP low GWP blowing agents. UNDP has prepared six demonstrations projects covering a wide spectrum of foam applications on methyl formate, methylal, pre-blended hydrocarbons and HFO-1234ze for XPS. They are already completed or are being implemented. The present project was designed to evaluate in developing countries the performance of super-critical CO_2, a relatively new technology currently used in Japan for polyurethane (PU) spray rigid foam.

PU spray rigid foams are closed-celled, air tight, resistant to mildew and fungal attack, provide no food value to rodents and have good vapour barrier properties (Randall & Lee, 2002). They find utility as an *in situ* applied insulation in applications where irregular shapes or the need for a monolithic layer of foam exists. These applications include building envelope, pipe insulation, tank insulation, rail cars, residential roofing and floors (Gum, 1992). Spray foam is now finding increasing use in retrofitting/refurbishing roofs, walls, floors and windows of existing buildings as well as in new constructions such us commercial offices, industrial factories and warehouses, agricultural pig and chicken farms (Randall & Lee, 2002). In the 2008 Progress Report the Foams Technical Options Committee (FTOC) states: "*PU Spray Foam is being increasingly recognized as an efficient means of retrofitting a number of building types*".

For developing countries, the proven technical options to replace HCFC-141b as blowing agent for PU spray foam are mainly limited to high GWP HFCs, HFC-245fa or HFC-365mfc/HFC-227ea blend, which have GWP values of 1030 and 964 respectively (100yr ITH, IPCC 4th Assessment Report 2008). Recent publications show promissory results with the new unsaturated HFC/HCFC blowing agents, commonly known as HFOs, that exhibit GWP values lower than 10, but the commercial availability is uncertain for the time of the conversion (Bodgan, 2011; Costa, 2011). The barrier for hydrocarbon technology in this application is safety during foaming because of their flammability. This issue is particularly critical for this sector where most of the enterprises are small in size with a poor control of the operation and safety discipline. Several work orders are done in-doors with limited ventilation.

One alternative that has been sporadically applied is the use as sole blowing agent of CO_2 generated from the water-isocyanate reaction (all water blown foam). It is a non-flammable and low GWP technology that does not require significant modifications in the machinery. However, despite of some success, three major drawbacks are generally associated with this approach: poor dimensional stability, caused by the high CO_2 permeability through the polyurethane matrix; poor adhesion to

the different substrates due to the significant polyurea content of the polymer and relatively high thermal conductivity.

In 2004, in an effort to overcome some of the weaknesses of water blown foam, Achilles Corporation, a Japanese company, patented a spray technology based on the direct injection of CO_2 to a PU all water blown system (Japanese Patent JP2004107376). It was reported that with a minor modification to a conventional spray machine (Gusmer FF type with a 1:1 mixing ratio by volume) and by adding 1.5% of liquid CO_2, isotropic cells were obtained which lead to dimensional stable foams at the density comparable to HCFC-141b blown foams (Ohnuma & Mori, 2003, figure 2). Figure 1 shows how the modified equipment looks like. Liquid CO_2 cooled to 0 °C with a heat exchanger is supplied to the Gusmer auxiliary pump which is remodelled so that brine might circulate internally and injected to the polyol component.

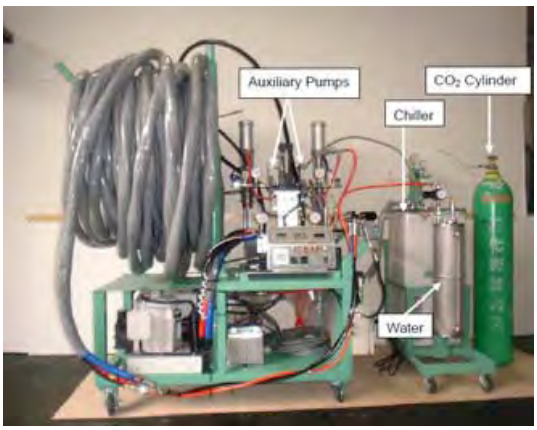


Figure 1. Modified spray machine for Supercritical CO_2

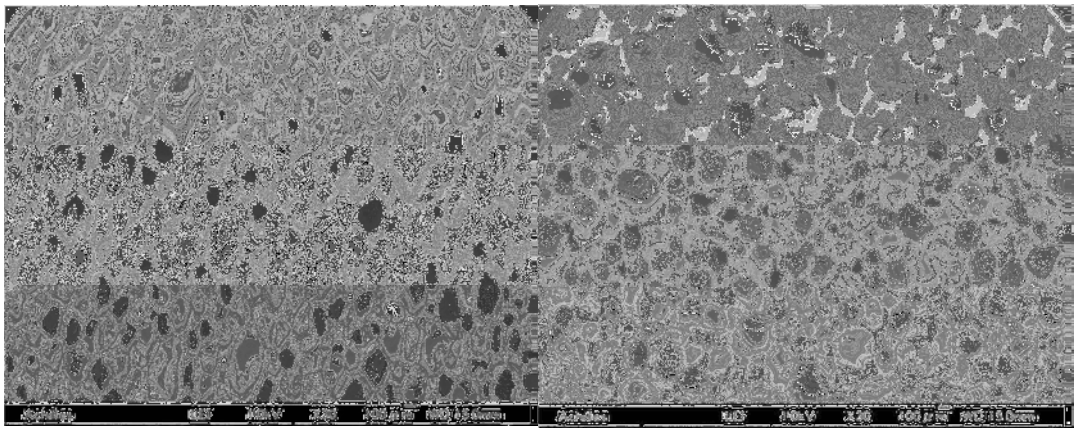


Figure 2. Spray foam with 0% liquid CO_2 versus spray foam with 1.5% liquid CO_2

The FTOC registered this development and in its 2008 progress report wrote: "*Super-critical CO_2 spray foam technologies have become established in Japan but market penetration is no more than 10%. The technology is yet to make any significant market penetration beyond Japan*".

2. PROJECT OBJECTIVES AND IMPLEMENTATION

According to the document submitted and approved in the 60th meeting of the Executive Committee of the Multilateral Fund held in Montreal in April 2010, the project objectives are:

1. Make a technical and economic assessment of the use in an Article 5 party (Colombia) of the super-critical CO_2 technology for the application of PU spray rigid foam. **Local commercial formulation based on HCFC-141b served as standard.**
2. Disseminate the technology to interested system houses in Colombia and other Latin American countries.

Espumlatex, the largest Colombian 100% owned PU system house, served as local technical host to coordinate the demonstration, foam application and testing activities.

The start-up of the project took place the week of July 25, 2012. The implementation was done in a team effort among Achilles Corp., Espumlatex, the National Ozone Unit (UTO) and UNDP. The following activities were carried out:

Activity	Date
Project Kick-off. Definition of evaluation plan and experimental protocol.	June 25 - 29, 2012
Shipment of injection equipment modified to use the Supercritical CO_2 technology. Shipment of Achilles PU materials, nationalization and in-land transportation.	July 13 - September 30
Application of Supercritical CO_2 and HCFC-141b based systems. Preparation of foam samples to test physical properties	October 1 - 7
Evaluation of foam physical properties (Espumlatex, Achilles, QAI laboratories)	October 15, 2013 - March 31, 2013
Preparation of Final Report	May, 2013
Presentation of the final results and conclusions in an international seminar	June, 2013

3. EXPERIMENTAL

3.1 Experimental Design

When a specific process or experiment is repeated under what are, as nearly as possible, the same conditions, the observed results are never identical (Box & Hunter & Hunter, 1978). This statement is particularly true in the field of PU foam. This fluctuation that occurs from one repetition to another is called *experimental error* and refers to variations that are unavoidable such as human errors of measurement, analysis and sampling. The no consideration of experimental error can lead to false conclusions about the *real* effect of a specific independent variable. In the line of these

thoughts and having in mind that usually is most efficient to estimate the effects of several variables simultaneously, it was decided to apply for this project the technique of statistical design of experiments, commonly known as DOE.

Two full factorial designs were conducted, one 2x2x3 for polyurethane foam (PUR) and other 2x2 for polyisocyanurate (PIR). The qualitative factors (independent variables) and levels are described in tables 1 and 2. *Genuine* replicates were made in all points of the design to have the best estimate of the error variance across the experimental region.

Table 1. Experimental Design for PUR	
Factors (independent variables)	**Levels**
Technology	Supercritical CO_2
	HCFC-141b, High Water
	HCFC-141b, Low Water
Location	Barranquilla: sea level, high ambient temperature (30 ºC), high relative humidity (80%)
	Bogotá: 2,600 m over sea level, low ambient temperature (20 ºC), moderate relative humidity (60%)
Foam Density	High
	Low

Table 2. Experimental Design for PIR	
Factors (independent variables)	**Levels**
Technology	Supercritical CO_2
	HCFC-141b
Location	Barranquilla: sea level, high ambient temperature (30 ºC), high relative humidity (80%)
	Bogotá: 2,600 m over sea level, low ambient temperature (20 ºC), moderate relative humidity (60%)

3.2. Formulations

For **Supercritical CO_2 technology** three Achilles proprietary water blown formulations were used:

- PUR formulation, 30 kg/m_3 density, designed for walls in Japan. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "Supercritical CO_2, PUR, Low Density (LD)".
- PUR formulation, 40 kg/m_3 density, designed for roofing. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "Supercritical CO_2, PUR, High Density (HD)".
- PIR formulation, 30 kg/m_3 density, designed for walls in Japan. It was applied in Bogota and Barranquilla. Because of the high altitude over sea level for the application in Bogotá a reduced amount of water was added in the machine, directly to the polyol component. For the experimental design it was denominated as "Supercritical CO_2, PIR".

For **141b based technology** five Espumlatex proprietary formulations, four for PUR and one for PIR, were used:

- PUR formulation, high water content, low density. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "HCFC-141b, PUR, High Water (HW), Low Density (LD)".
- PUR formulation, high water content, high density. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "HCFC-141b, PUR, High Water (HW), High Density (HD)".
- PUR formulation, low water content, low density. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "HCFC-141b, PUR, Low Water (LW), Low Density (LD)". **This is the commercial formulation sold by Espumlatex in the local market.**
- PUR formulation, low water content, high density. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "HCFC-141b, PUR, High Water (HW), High Density (HD)". **This is the commercial formulation sold by Espumlatex in the local market.**
- PIR formulation. It was applied in Bogota and Barranquilla. For the experimental design it was denominated as "HCFC-141b, PIR".

The table 3 summarizes the blowing agent characteristics of the HCFC-141b based formulations for PUR:

Table 3. Blowing agent characteristics of HCFC-141b formulations for PUR

	LW-LD	LW-HD	HW-LD	HW-HD
CO_2 moles /kg of polymer	0.23	0.21	0.66	0.58
HCFC-141b moles /kg of polymer	0.94	0.84	0.38	0.38
Total gas moles/kg of polymer	1.17	1.05	1.04	0.96
Initial mole fraction, CO_2	0.19	0.20	0.64	0.61
Initial mole fraction HCFC-141b	0.81	0.8	0.36	0.39

3.3. Spray application conditions

Field in-door applications of both systems, Supercritical CO_2 and HCFC-141b, were done in industrial warehouses in Barranquilla and Bogota. *Both materials were easy to process and no particular issues were observed.*

For physical test samples the foam was sprayed to a thickness of 5 mm in one primer and three passes applied in crossed directions (dead time between passes: 1 minute) on 1.50 m x 0.80 m pieces of plywood. Additional samples were sprayed on 2.50 m long pieces for E-84 testing. The Table 4 shows the spray conditions.

Table 4. Spray conditions				
	Supercritical CO_2		HCFC-141b	
	Barranquilla	Bogota	Barranquilla	Bogota
Spray machine	NF-12J Proportioning unit		Graco E-10	
Spray gun	GAP Pro (round pattern)		Fusion AP	
Percentage by weight of CO_2, %	1.0 for PUR, 1.75 for PIR		Non applicable	
Ambient Temperature, ºC	31	19 - 20	31	19 - 20
Relative Humidity, %	62 - 89	62 - 69	62 - 67	52 - 62
Substrate Temperature, ºC	31	19 - 20	32	20 - 22
Iso Temperature, ºC	45	45	50	50
Polyol Temperature, ºC	45	45	49	49
Primary Heater	Off	45	Off	Off
Hose length, m	45	45	15	15
Hose Temperature, ºC	40 (PUR) 45 (PIR)	40 (PUR) 45 (PIR)	40	40
Static Pressure, psi	1,000		1,600	
Dynamic Pressure, psi	750		1,400	
Tack Free Time, /Rise Time, (s/s)	6/10 (PUR) 2/5 (PIR)	10/15 (PUR) 3/7 (PIR)	2/7 sec (PUR) 2/5 sec (PIR)	4/12 sec (PUR) 2/7 sec (PIR)

3.4. Test Methods

Table 5 lists the different test methods to determine the foam physical properties

Table 5. Test Methods		
Property	**Test**	**Testing Laboratory**
Reactivity	Visual	In-situ during application
Foam core density	ASTM D-1622	Espumlatex
Thermal Conductivity	ASTM C-518	Espumlatex
Compression strength	ASTM D-1621	Espumlatex
Adhesion strength	ASTM D-1623	Espumlatex
Water vapour permeability	JIS A-9526	Achilles
Water absorption	JIS A-9511	Achilles
Closed cell content	ASTM D-2856	Achilles
Dimensional stability	ASTM D-2126	Espumlatex
Aging		
Thermal Conductivity	ASTM C-518	Espumlatex
Compressive strength	ASTM D-1621	Espumlatex
Fire Performance	ASTM E-84, 12c	QAI Laboratories

4. RESULTS

During the six months of the duration of the project the polyol side formulations of both technologies, Supercritical CO_2 and HCFC-141b based, were stable and no component separation was observed. The table 6 and 7 show the physical properties of the PUR and PIR foams. They correspond to the experimental designs described in tables 1 and 2.

Table 6. Physical Properties of PUR foam

Property	Supercritical CO_2				HCFC-141b, Low Water				HCFC-141b, High Water			
	Barranquilla		Bogota		Barranquilla		Bogota		Barranquilla		Bogota	
	HD	LD	HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
Core Density, kg/m^3	46.5	35.3	38.0	28.5	43.6	37.8	36.0	31.0	45.0	48.3	41.2	34.(
	44.1	41.1	33.9	33.6	44.2	40.5	39.3	31.1	45.1	47.3	43.9	36.3
Thermal Conductivity, 24ºC, 24 hours, mw/mK	34.23	33.95	34.09	34.02	23.97	24.84	24.47	23.79	25.99	28.84	28.47	28.3
	34.11	33.94	34.07	33.99	24.23	24.24	24.11	24.34	27.32	29.01	29.78	28.5
Thermal Conductivity, 24ºC, 2 weeks at 20 ºC and 50% RH, mw/mK	34.19	34.04	34.30	34.05	24.68	25.82	25.40	24.88	29.81	29.84	29.89	29.5
	34.06	33.88	34.19	34.01	24.83	25.18	25.11	24.92	29.05	30.04	30.36	29.5
Thermal Conductivity, 24ºC, 4 weeks at 20 ºC and 50% RH, mw/mK	34.22	34.28	34.19	34.19	25.35	26.05	25.80	25.37	30.19	30.16	30.15	29.3
	34.07	34.04	34.03	34.03	25.42	25.61	25.76	25.56	29.68	30.35	30.70	30.3
Compressive Strength, parallel to rise, kPa	179.98	191.00	158.20	134.78	313.37	254.48	248.76	206.24	350.60	302.43	265.25	174.2
	206.32	211.05	160.27	153.08	330.79	268.94	275.35	189.37	343.67	306.85	249.03	202.2
Compressive Strength, parallel to rise, 6 months, kPa	213.41	189.79	151.61	123.83	326.28	251.45	248.95	204.36	325.64	289.19	289.50	195.(
	233.68	245.68	154.51	136.54	339.74	299.32	269.66	171.86	339.34	305.15	264.46	235.
Dimensional Stability, -20 ºC, 24 hours, Vol. %	0.026	-0.414	-0.126	-0.304	0.021	-0.003	-0.141	-0.269	0.032	-0.056	-0.010	-0.07
	-0.150	0.094	-0.115	-0.121	0.082	0.045	-0.242	0.055	-0.139	-0.067	-0.023	-0.67
One week, %	-0.145	-0.568	-0.023	-0.389	-0.045	-0.003	-0.221	-0.378	0.092	-0.189	0.065	0.10
	-0.531	-0.198	0.014	-0.329	-0.224	-0.069	-0.040	-0.243	-0.004	-0.173	0.075	-0.14
Two weeks, %	-0.139	-0.262	-0.132	-0.563	0.045	-0.138	-0.332	-0.024	0.105	0.074	-0.113	-0.12
	-0.433	0.069	-0.039	-0.056	0.165	0.032	-0.242	-0.433	0.022	0.036	0.010	-0.26
Dimensional Stability, 60 ºC, 95% RH, 24 hours, Vol. %	3.114	1.056	10.449	3.231	1.903	2.933	2.939	2.882	0.284	1.679	0.979	1.81
	1.731	2.030	8.103	3.132	1.542	2.514	2.501	2.817	0.445	1.795	2.112	1.79
One week, %	0.572	0.584	6.066	1.009	2.456	3.534	3.153	3.201	0.510	1.660	0.791	1.86
	-0.809	0.783	4.803	0.745	1.987	3.302	2.922	3.178	0.482	2.100	1.594	1.49
Two weeks, %	0.069	0.430	5.271	0.412	2.521	3.789	3.347	3.382	0.743	1.821	0.814	1.72
	-1.314	0.545	4.261	0.515	2.156	3.585	3.094	3.302	0.878	2.037	1.720	1.32
Dimensional Stability, 70 ºC, Ambient RH, 24 hours, Vol. %	-2.670	0.315	3.724	0.189	-0.114	0.780	-0.664	0.453	-0.962	-0.822	-1.551	-1.1(
	-0.768	-0.080	1.116	0.595	-0.103	-0.233	0.407	0.139	-0.883	-0.399	-0.544	-1.14
One week, %	-3.084	-0.240	2.972	-0.438	-0.043	0.886	-0.672	0.961	-0.709	-0.510	-1.400	-0.84
	-1.387	-0.831	0.639	-0.058	0.044	-0.090	0.485	0.036	-0.684	-0.638	-0.274	-0.93
Two weeks, %	-3.893	-0.473	2.883	-0.451	0.098	1.073	-0.432	1.293	-0.627	-0.808	-1.002	-0.38
	-1.726	-0.399	0.630	-0.244	0.212	-0.043	0.641	0.662	-0.591	-0.023	0.058	-0.47
Closed Cell Content, %	64.30	64.00	83.50	71.10	75.80	81.50	92.30	91.60	78.40	81.80	89.10	90.1
	72.30	73.90	80.10	82.00	69.90	78.10	91.80	90.50	74.10	86.60	90.40	90.3
Water absorption, g/100 cm^2	0.80	1.12	1.17	1.53	0.77	1.01	0.58	0.42	0.76	0.84	0.56	0.8
	0.75	0.93	1.02	1.31	0.84	0.88	0.56	0.50	0.73	0.92	0.57	0.6
Water Vapour Permeability, ng/Pa.s.m	3.44	6.06	4.57	5.89	3.88	4.61	3.72	4.14	4.43	4.46	4.41	4.9
	3.92	3.82	5.62	4.00	3.59	4.01	3.65	3.57	4.33	4.62	4.14	4.7
Adhesion Strength to metal (galvanized steel), N/cm^2	14.33	20.56	7.83	14.99	11.14	4.31	11.36	8.46	12.34	20.59	6.63	15.4
	13.96	15.33	7.94	15.24	4.70	1.66	31.35	8.02	15.91	6.66	27.99	15.5

HD: High Density. LD: Low Density

Table 7. Physical Properties of PIR foam				
Property	Supercritical CO_2		HCFC-141b	
	Barranquilla	Bogota	Barranquilla	Bogota
Core Density, kg/m3	40.8	37.0	43.0	32.3
	35.7	37.8	44.4	32.4
Thermal Conductivity, 24ºC, 24 hours, mw/mK	34.42	34.02	28.39	20.70
	34.27	34.11	27.92	20.82
Thermal Conductivity, 24ºC, two weeks at 20 ºC and 50% RH, mw/mK	34.66	34.33	30.05	22.48
	33.76	34.27	28.23	22.22
Compressive Strength, parallel to rise, kPa	141.18	126.32	225.37	132.89
	119.38	144.49	235.59	134.43
Compressive Strength, parallel to rise, 6 months, kPa	119.15	139.77	221.62	140.29
	129.40	130.58	209.99	142.68
Dimensional Stability, -20 ºC, 24 hours, Vol. %	0.258	0.598	0.117	-0.041
	0.148	0.013	0.156	-0.229
One week, %	0.018	-0.228	-0.023	-0.120
	-0.194	-0.044	0.072	-0.178
Two weeks, %	0.299	-0.449	-0.018	0.030
	0.572	-0.023	0.067	-0.006
Dimensional Stability, 60 ºC, 95% RH, 24 hours, Vol. %	-1.695	-2.121	4.355	3.347
	-1.920	-2.768	5.904	2.565
One week, %	-3.197	-3.798	3.721	4.865
	-3.851	-4.904	4.986	4.211
Two weeks, %	-3.731	-4.180	3.107	5.944
	-4.371	-5.502	4.406	5.537
Dimensional Stability, 70 ºC, Ambient RH, 24 hours, Vol. %	-0.877	-0.292	-0.484	-0.371
	-1.515	0.033	-0.387	-0.316
One week, %	-2.929	-1.618	0.212	-0.086
	-4.108	-1.042	-0.767	-0.226
Two weeks, %	-3.768	-2.168	-0.053	-0.030
	-3.793	-1.554	-1.073	-0.067
Closed Cell Content, %	19.60	39.60	88.50	86.50
	42.20	53.10	89.30	84.50
Water absorption, g/100 cm2	1.67	1.70	1.94	3.13
	1.59	1.54	1.89	3.26
Water Vapour Permeability, ng/Pa.s.m	8.63	5.88	8.58	6.34
	8.38	6.27	8.62	6.59
Adhesion Strength to metal (galvanized steel), N/cm2	7.58	6.57	16.97	11.23
	8.71	9.34	16.30	6.89

The table 8 shows the results of the fire performance test, ASTM E-84, run on four foam samples: Supercritical CO_2, PUR and PIR, and HCFC-141b, PUR -low water content- and PIR.

Table 8. Fire Performance Test, ASTM E84-12c				
Technology		Flame Spread	Smoke Developed	NFPA Class
Supercritical CO_2	PUR	70	331	B
	PIR	20	286	A
HCFC-141b	PUR, low water	390	100*	C
	PIR	25	200	A

* Due to heat production and lack of air flow through the chamber, the test was terminated at 1 minute, 42 seconds. Had the test continued for the normal 10 minute period, the flame spread value would have remained unchanged. The smoke number is the smoke value at time of termination.

5. ANALYSIS OF RESULTS

To assess the statistical significance of the effect of the different factors on the foam properties an analysis of variance (ANOVA) was developed for each property. In this section the ANOVA of few selected foam properties, critical for the thermal insulation performance, such as initial thermal conductivity (lambda value) and aging of lambda value, will be shown for PUR and PIR. The analysis of core density, dimensional stability, compressive strength, aging of compressive strength and adhesion to galvanised steel are described in the annex 1.

5.1. PUR foam

Analysis of initial thermal conductivity for PUR

The tables 9 and 10 show a summary of the results of the initial thermal conductivity (Lambda value) and the corresponding ANOVA.

Table 9. Lambda Value, 24 °C, 24 hours, mW/mK							
	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	34.17*	33.95	24.10	24.54	26.66	28.93	28.72
Bogotá	34.08	34.01	24.29	24.07	29.13	28.47	29.01
AVERAGE	34.05		24.25		28.29		

	AVERAGE
HD	28.74
LD	28.99

* All the values are the average of two genuine replicates (table 6).

Table 10. ANOVA of Lambda value, 24 ºC, 24 hours						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P**	
Technology	2	388.174	194.087	1052.437	0.000	Significant
Density	1	0.388	0.388	2.1039	0.173	
Location	1	0.479	0.479	2.5974	0.133	
Tec*Dens	2	0.977	0.489	2.6489	0.112	
Dens*Loc	1	1.978	1.978	10.7257	0.007	Significant
Tec*Loc	2	1.582	0.791	4.2892	0.039	Significant
Pure Error	12	2.213	0.184			

* Probability of Type I error (rejecting the null hypothesis when it is in fact true). If $P < 0.05$ it is considered that the effect of the factor is significant.

From table 9 it is concluded there is a statistical significant difference in the initial lambda value among the three systems: Supercritical CO_2 developed a thermal conductivity 20.3% higher than high water-HCFC-141b and 40.4% higher than low water-HCFC-141b. As expected the low water-HCFC-141b provided a better (lower) value than high water-HCFC-141b because of the greater initial mole fraction of HCFC-141b in the gas cell. No significant differences in Lambda between the two locations and the high and low density formulations were observed.

Lambda value, aged 4 weeks at 20 ºC and 50% RH, 24 ºC

The tables 11 and 12 describe the results of Lambda value, aged four weeks at 20 ºC and 50% RH, and the corresponding ANOVA.

Table 11. Lambda Value, 24 ºC, 4 weeks, mW/mK							
	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	34.14	34.16	25.38	25.83	29.93	30.25	29.95
Bogotá	34.11	34.11	25.78	25.47	30.43	29.85	29.96
AVERAGE	34.13		25.61		30.11		

	AVERAGE
HD	29.96
LD	29.94

Table 12. ANOVA of Lambda value, 24 ºC, 4 weeks						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	2	290.529	145.265	1725.91	0.000	Significant
Density	1	0.002	0.002	0.02	0.885	
Location	1	0.000	0.000	0.00	0.962	
Tec*Dens	2	0.041	0.021	0.24	0.787	
Dens*Loc	1	0.469	0.469	5.57	0.036	Significant
Tec*Loc	2	0.007	0.004	0.04	0.958	
Pure Error	12	1.010	0.084			

Results are similar to those of the initial lambda value (24 hours) but the difference among the three PU systems became shorter: Supercritical CO_2 provided a thermal conductivity 33.2% higher than high water-HCFC-141b and 13.3% higher than low water-HCFC-141b.

Aging of Lambda, 4 weeks versus 24 hours

The variation percentage of the lambda value, four weeks versus 24 hours, was calculated and analysed in a similar way than the other properties.
The tables 13 and 14 show a summary of the results and the corresponding ANOVA.

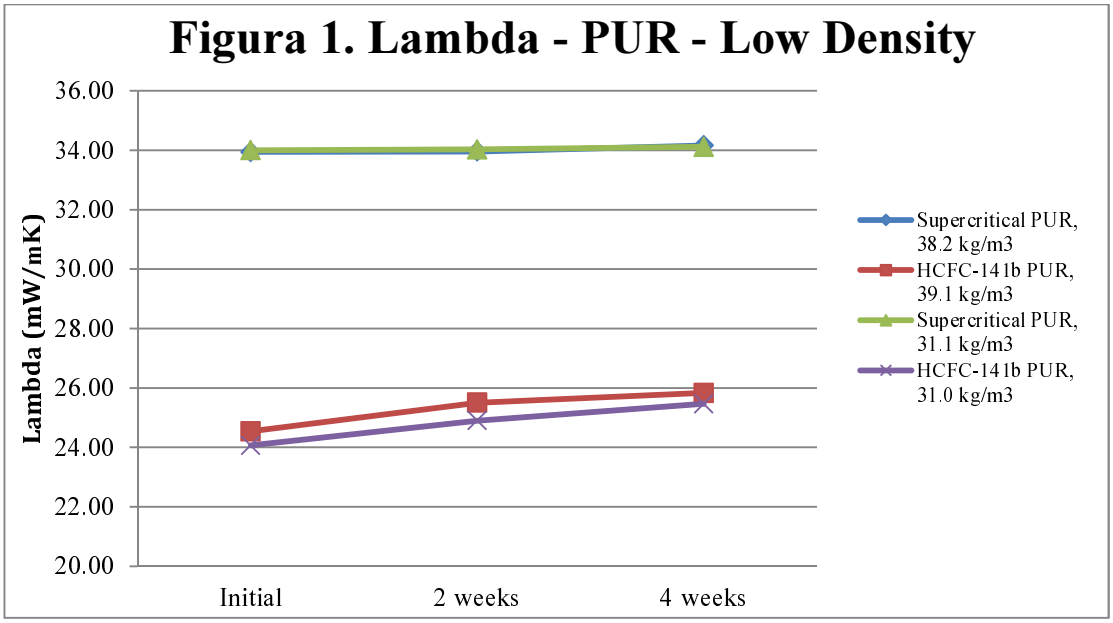
Table 13. Variation Percentage in Lambda Value, 4 weeks versus 24 hours, %							
	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	-0.08	0.64	5.33	5.26	12.39	4.59	4.69
Bogotá	0.09	0.32	6.13	5.83	4.50	4.84	3.62
AVERAGE	0.24		5.64		6.58		

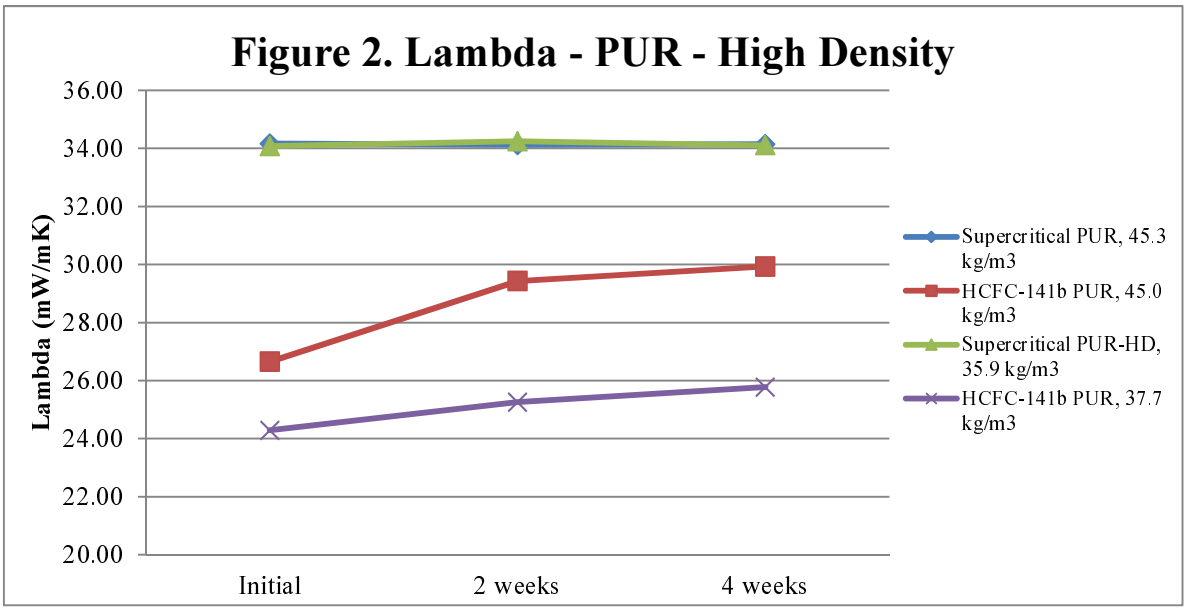
	AVERAGE
HD	4.73
LD	3.58

Table 14. ANOVA of variation percentage in lambda value						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	2	187.161	93.581	28.17	0.000	Significant
Density	1	7.880	7.880	2.37	0.149	
Location	1	6.865	6.865	2.07	0.176	
Tec*Dens	2	20.403	10.202	3.07	0.084	
Dens*Loc	1	9.154	9.154	2.76	0.123	
Tec*Loc	2	23.233	11.617	3.50	0.064	
Pure Error	12	39.870	3.323			

The Supercritical CO_2 technology exhibited a statistically significant better performance than the 141b based systems: its variation percentage was in average 0.24% compared to 5.64% of low water-HCFC-141b and 6.58% of high water-HCFC-141b.

These results are graphically shown in figures 1 and 2.





5.2. PIR foam

Initial thermal conductivity for PIR

The tables 15 and 16 show the results of initial thermal conductivity (lambda) and the corresponding ANOVA.

	Table 15. Lambda Value, 24 °C, 24 hours, mW/mK		
	Supercritical CO_2	HCFC-141b	AVERAGE
Barranquilla	34.35*	28.16	31.25
Bogotá	34.07	20.76	27.41
AVERAGE	34.21	24.46	

* All the values are the average of two genuine replicates (table 7).

Table 16. ANOVA of lambda value, 24 °C, 24 hours						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	1	190.060	190.060	5590.0	0.000	Significant
Location	1	29.440	29.440	865.8	0.000	Significant
Tec*Loc	1	25.323	25.323	744.8	0.000	Significant
Pure Error	4	0.136	0.034			

From table 16 there is a statistical significant difference in the initial lambda value between the two systems: on average Supercritical CO_2 developed a thermal conductivity 39.9% higher than HCFC-141b although the difference greatly varied with the location (significant interaction between technology and location).

Thermal Conductivity (lambda), aged 4 weeks at 20 ºC and 50% RH, 24 ºC

The tables 17 and 18 describe the results of the thermal conductivity (lambda), aged four weeks at 20 ºC and 50% RH, and the corresponding ANOVA.

	Table 17. Lambda Value, 24 ºC, 4 weeks, mW/mK		
	Supercritical CO_2	HCFC-141b	AVERAGE
Barranquilla	34.06	29.51	31.78
Bogotá	33.59	23.41	28.50
AVERAGE	33.82	26.46	

Table 18. ANOVA of lambda value, 24 ºC, 4 weeks						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	1	108.511	108.511	580.27	0.000	Significant
Location	1	21.550	21.550	115.24	0.000	Significant
Tec*Loc	1	15.839	15.839	84.70	0.001	Significant
Pure Error	4	0.748	0.187			

Results were similar to those of the initial lambda value (24 hours) but the difference between the two PU systems became shorter: Supercritical CO_2 provided a thermal conductivity 27.8% higher than HCFC-141b. It is important to note the significant interaction between the technology and location, especially in the case of HCFC-141b that provided when sprayed in Barranquilla a lambda 26% higher than the formulation applied in Bogotá. Supercritical CO_2 gave similar values for both locations.

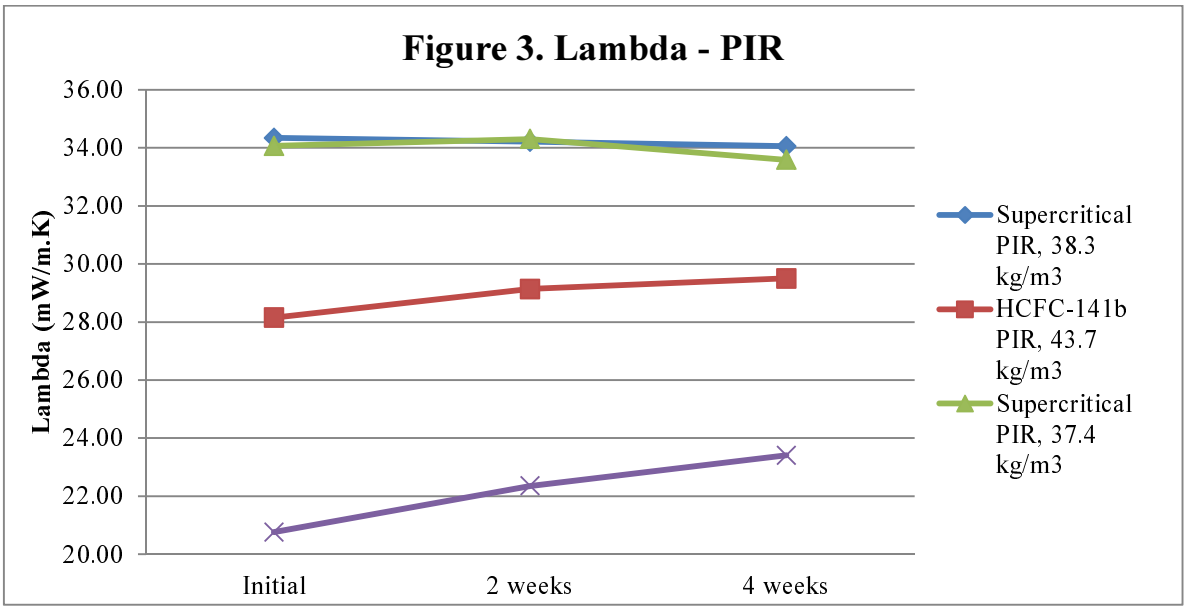
Aging of Lambda value, 4 weeks versus 24 hours

The variation percentage of the lambda value, 4 weeks versus 24 hours, was calculated and analysed in a similar way than the other properties. The tables 19 and 20 show a summary of the results and the corresponding ANOVA.

	Table 19. Variation Percentage in Lambda Value, 4 weeks versus 24 hours		
	Supercritical CO_2	HCFC-141b	AVERAGE
Barranquilla	-0.85%	4.56%	1.85%
Bogotá	-1.42%	11.31%	4.94%
AVERAGE	-1.14%	7.93%	

Table 20. ANOVA of variation percentage in lambda value						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	1	0.0164463	0.0164463	176.32	0.000	Significant
Location	1	0.0019077	0.0019077	20.45	0.011	Significant
Tec*Loc	1	0.0026864	0.0026864	28.80	0.006	Significant
Pure Error	4	0.0003731	0.0000933			

The Supercritical CO_2 technology exhibited a statistically significant better performance than the 141b based system: the lambda values measured in 4 weeks were in average 1.14% lower that the initials (24 hours) meanwhile the thermal conductivity of HCFC-14b based formulation increased by 7.93%. This result is graphically observed in figure 3.



6. SAFETY & INDUSTRIAL HYGIENE

The Supercritical CO_2 technology is based on PU all water blown systems. Compared to conventional HCFC-141b based formulations they do not exhibit any incremental issue on safety and industrial hygiene. Nevertheless, when not properly handled the PU chemicals can severely affect the human health. Handling procedures and precautions stipulated by suppliers should be followed. The Material Safety Data Sheets (MSDS) of the Achilles products for Supercritical CO_2 are provided in the Appendix.

7. INCREMENTAL COSTS OF THE SUPERCRITICAL CO_2 TECHNOLOGY

7.1. Incremental Capital Costs

Several conventional spray machines can be retrofitted to work with Supercritical CO_2 technology. The critical features that they should have are:
Proportioning Pump: working pressure of 2,000 psi, piston stroke equal or higher than 3 inches.
Heated hose: longer than 45 meters (40 ºC for PUR, 45 ºC for PIR).

The table 21 lists some models of typical spray machines that are suitable for retrofit and the associated cost.

Table 21. Example of suitable spray machines suitable to retrofit and associated retrofitting cost

Model	PUR (US dollars)	PIR (US dollars)
Gusmer models: FF 1600(converted hydraulically-driven), HF-1600	9,800	11,800
Gusmer models: H-2000, H20/35	13,700	15,700
Graco models: A-20, A25	9,800	11,800
Graco models: H-25	13,700	15,700

The Supercritical CO_2 technology is a patented technology owned by Achilles Corporation. The interested parties should come to an agreement with Achilles on technology fees.

7.2. Incremental Operating Costs

The Supercritical CO_2 technology is based on proprietary polyol and isocyanate formulations developed by Achilles. The FOB price in Japan for the PUR and PIR systems is 7.00 US dollars per kg. The CIF price of a HCFC-141b based spray system for PUR in Colombia is in the range from 3.80 to 4.20 US dollars.

8. CONCLUSIONS

- Supercritical CO_2 technology is a non-flammable, 0 ODP and low GWP technology. Compared to HCFC-141b based technology it does not create any incremental industrial hygiene and safety hazard.
- Supercritical CO_2 is a proven commercialised technology for spray foam that has been used in Japan since 2004.
- In Colombia, a developing country with tropical weather and various levels of altitude over sea level, Supercritical CO_2 showed a similar processability to the standard HCFC-141b spray system currently used. Polyol and isocyanate components of both technologies were stable during the six months of project duration.
- In terms of physical properties of PUR foam, compared to HCFC-141b based formulations Supercritical CO_2 showed:
  - ✓ Higher thermal conductivity but better aging. The difference in lambda value between the two technologies decreased with time.
  - ✓ Similar aging behaviour in compressive strength. Values kept stable with time (initial versus six months)
  - ✓ Similar dimensional stability performance at -20 ºC. All values for both technologies were below 0.6%.
  - ✓ Improved dimensional stability at 60 ºC and 96% RH.
  - ✓ Similar adhesion strength to galvanised steel.
- In terms of physical properties of PIR foam, compared to HCFC-141b based formulations Supercritical CO_2 showed the same performance pattern than PUR:
  - ✓ Higher thermal conductivity but better aging. The difference in lambda value between the two technologies decreased with time.
  - ✓ Similar aging behaviour in compressive strength. Values kept stable with time (initial versus six months)
  - ✓ Similar dimensional stability performance at -20 ºC. All values for both technologies were below 0.6%.
  - ✓ Similar dimensional stability at 60 ºC and 96% RH in absolute values. However, the behaviour was totally different: meanwhile Supercritical CO_2 experienced a negative change in volume the HCFC-141b formulation had a positive one.
  - ✓ Lower adhesion strength to galvanised steel.
- According to fire performance test ASTM E84-12c, run on just one sample per formulation, the PIR and PUR foams based on Supercritical CO_2 would be classified as A and B respectively (NFPA).
- The cost of the required retrofit of a typical spray machine to apply the Supercritical CO_2 is in the range from 9,800 to 13,700 US dollars for PUR foam and from 11,800 to 15,700 US dollars for PIR foam.

- Supercritical CO_2 technology is based on proprietary polyol and isocyanate formulations developed by Achilles. The FOB price in Japan of the Supercritical CO_2 system by kg is 7 dollars.
- Supercritical CO_2 technology is a patented technology owned by Achilles Corporation. The interested parties should come to an agreement with Achilles on technology fees.

9. REFERENCES

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ANNEX 1. ANALYSIS OF VARIANCE OF THE FOAM PROPERTIES

In the section 5 of the report the ANOVA corresponding to the foam thermal conductivity and its aging was presented. In this annex the ANOVA of the rest of the foam properties are shown for PUR and PIR.

1. PUR

Foam Core Density

The tables A-1 and A-2 show a summary of the results of the foam core density (values taken from table 6) and the corresponding ANOVA. As expected there are statistically significant differences in density between the high and low density formulations (HD > LD), explained by the different recipes, and between the two locations (Barranquilla > Bogota), explained by the different altitudes over sea level. It is also observed that Supercritical CO_2 and low water-HCFC-141b exhibit similar core densities, but lower than high water-HCFC-141b.

Table A-1. Foam core density, kg/m^3

	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	45.3*	38.2	43.9	39.2	45.1	47.8	43.23
Bogotá	36.0	31.1	37.7	31.1	42.6	35.6	35.63
AVERAGE	37.63		37.94		42.74		

	AVERAGE
HD	41.73
LD	37.13

* All the values are the average of two genuine replicates

Table A-2. ANOVA of foam core density, PUR

Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P**	
Technology	2	131.401	65.701	13.99	0.001	Significant
Density	1	126.96	126.960	27.04	0.000	Significant
Location	1	346.56	346.560	73.81	0.000	Significant
Tec*Dens	2	18.483	9.242	1.97	0.182	
Dens*Loc	1	14.727	14.727	3.14	0.102	
Tec*Loc	2	1.308	0.654	0.14	0.871	
Pure Error	12	56.34	4.695			

The tables A-3 and A-4 show a similar summary and ANOVA than the tables A-1 and A-2 but only comparing Supercritical CO_2 and low water-HCFC-141b in an effort to check if there is a significant difference in density between these two formulations.

	Table A-3. Foam core density, kg/m^3				
	Supercritical CO_2		HCFC-141b, low water		AVERAGE
	HD	LD	HD	LD	
Barranquilla	45.3	38.2	43.9	39.2	41.64
Bogotá	36.0	31.1	37.7	31.1	33.93
AVERAGE	37.63		37.94		

	AVERAGE
HD	40.70
LD	34.86

Table A-4. ANOVA of foam core density, PUR						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	P	
Technology	1	0.391	0.4	0.06	0.810	
Density	1	136.306	136.3	21.64	0.002	Significant
Location	1	237.931	237.9	37.78	0.000	Significant
Tec*Dens	1	0.106	0.1	0.02	0.900	
Dens*Loc	1	0.131	0.1	0.02	0.946	
Tec*Loc	1	1.156	1.2	0.18	0.680	
Pure Error	8	50.385	6.3			

From table A-4 it is concluded that there is no evidence that there is a density difference between the two PU systems: Supercritical CO_2 and low water - HCFC-141b. Having in mind that some foam properties depend on the density, particularly compressive strength and dimensional stability, *this result is important for a fair comparison.*

Aging of Compressive Strength, 6 months versus 24 hours

Similar to the case of lambda (table 13), from the table 6 the variation percentage of compressive strength, 6 months versus 24 hours, was calculated and analysed (Tables A-5 and A-6). From the ANOVA there is no evidence of any difference in aging among the three PU systems.

Table A-5. Variation Percentage in Compressive Strength, 6 months versus 24 hours							
	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	13.69	6.73	3.30	4.47	-4.47	-2.57	3.52
Bogotá	-4.03	-10.48	-1.02	-5.56	7.10	12.46	-0.25
AVERAGE	1.48		0.30		3.13		

	AVERAGE
HD	2.43
LD	0.84

Table A-6. ANOVA of variation percentage in compressive strength						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	2	0.324	0.162	0.72	0.506	
Density	1	0.151	0.151	0.67	0.428	
Location	1	0.857	0.857	3.82	0.074	
Tec*Dens	2	1.068	0.534	2.38	0.135	
Dens*Loc	1	0.005	0.005	0.02	0.883	
Tec*Loc	2	9.810	4.905	21.86	0.000	Significant
Pure Error	12	2.692	0.224			

Dimensional Stability

As observed in the table 6, the values of dimensional stability at low temperature (-20 ºC) were all below 0.6%. For this reason it was decided to analyse the dimensional stability at 60 ºC and 95% RH (tables A-7 and A-8).

Table A-7. Dimensional Stability at 60 ºC and 95% RH, two weeks, Vol. %							
	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	-0.622	0.488	2.338	3.687	0.811	1.929	1.438
Bogotá	4.766	0.463	3.220	3.342	1.267	1.527	2.431
AVERAGE	1.274		3.147		1.383		

	AVERAGE
HD	1.963
LD	1.906

Table A-8. ANOVA of Dimensional Stability at 60 ºC and 95% RH, two weeks						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	2	17.6668	8.833	50.38	0.000	Significant
Density	1	0.0204	0.020	0.12	0.739	
Location	1	5.8979	5.898	33.64	0.000	Significant
Tec*Dens	2	7.1311	3.566	20.34	0.000	Significant
Dens*Loc	1	9.3507	9.351	53.33	0.000	Significant
Tec*Loc	2	8.5984	4.299	24.52	0.000	Significant
Pure Error	12	2.1039	0.175			

There is a statistically significant difference in dimensional stability among the three PU systems: Supercritical CO_2 provided the best performance (average 1.274 % in volume change) followed by high water-HCFC-141b (3.147 %) and low water-HCFC-141b (1.383 %). The fact that the location when the foam was raised gave a significant difference could be explained by the variation in atmospheric pressure that is in equilibrium with the cell pressure during the foaming process (Bogota: 560 mm Hg; Barranquilla: 760 mm Hg).

Adhesion to metal (galvanized steel)

The tables A-9 and A-10 show a summary of the results and the ANOVA for the adhesion strength to galvanized steel. From the statistical analysis it is concluded that none of the factors has a significant effect on adhesion. There is no evidence that there exits a difference among the performance of the three PU systems in relation to adhesion.

Table A-9. Adhesion strength to metal, N/cm^2							
	Supercritical CO_2		HCFC-141b, low water		HCFC-141b, high water		AVERAGE
	HD	LD	HD	LD	HD	LD	
Barranquilla	14.144	17.946	7.922	2.983	14.124	13.627	11.791
Bogotá	7.887	15.117	21.355	8.241	17.310	15.530	14.240
AVERAGE	13.773		10.125		15.148		

	AVERAGE
HD	13.790
LD	12.241

Table A-10. ANOVA of Adhesion Strength to metal						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	*P*	
Technology	2	107.79	53.90	1.14	0.353	
Density	1	14.41	14.41	0.30	0.592	
Location	1	35.98	35.98	0.76	0.401	
Tec*Dens	2	212.00	106.00	2.23	0.150	
Dens*Loc	1	6.06	6.06	0.13	0.727	
Tec*Loc	2	192.93	96.47	2.03	0.174	
Pure Error	12	569.58	47.47			

2. PIR

Foam Core Density

The tables A-11 and A-12 show a summary of the results of the foam core density (values taken from table 7) and the corresponding ANOVA.

	Table A-11. Foam core density, kg/m^3		
	Supercritical CO_2	HCFC-141b	AVERAGE
Barranquilla	38.25	43.69	40.97
Bogotá	37.40	32.33	34.87
AVERAGE	37.83	38.01	

Table A-12. ANOVA of foam core density						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	P	
Technology	1	0.067	0.06700	0.018	0.899	
Location	1	74.517	74.51700	20.302	0.011	Significant
Tec*Loc	1	55.166	55.16600	15.030	0.018	Significant
Error	4	14.682	3.67050			

From the table A-12 there is no statistical evidence of a difference in density between the foam samples of the two PU systems, Supercritical CO_2 and HCFC-141b. The average values are quite close, 37.83 versus 38.01 kg/m^3.

Dimensional Stability

Similar to what happened with PUR foam, the values of dimensional stability (Vol. %) at low temperature (-20 ºC) were all below 0.6%. For this reason it was decided to analyse the most critical case: dimensional stability at 60 ºC and 95% RH (tables A-13 and A-14).

	Table A-13. Dimensional Stability at 60 ºC and 95% RH, two weeks, Vol. %		
	Supercritical CO_2	HCFC-141b	AVERAGE
Barranquilla	-4.051%	3.756%	-0.147%
Bogotá	-4.841%	5.740%	0.450%
AVERAGE	-4.446%	4.748%	

Table A-14. ANOVA of Dimensional Stability at 60 ºC and 95% RH, two weeks						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	P	
Technology	1	0.0169067	0.0169067	337.12	0.000	Significant
Location	1	0.0000713	0.0000713	1.42	0.299	
Tec*Loc	1	0.0003848	0.0003848	7.67	0.050	Significant
Pure Error	4	0.0002006	0.0000502			

From the table A-14 there is a statistically significant difference in dimensional stability between the two PU systems. The behaviour was totally different: meanwhile Supercritical CO_2 experienced a negative change in volume the HCFC-141b formulation had a positive one. Similar to PUR the foams raised in Bogota experienced a greater volume change in absolute values that those developed in Barranquilla.

Adhesion to metal (galvanized steel)

The tables A-15 and A-16 show a summary of the results and the ANOVA for the adhesion strength to galvanized steel.

	Table A-15. Adhesion strength to metal, N/cm^2		
	Supercritical CO_2	HCFC-141b	AVERAGE
Barranquilla	8.146	16.637	12.392
Bogotá	7.958	9.061	8.509
AVERAGE	8.052	12.849	

Table A-16. ANOVA of Adhesion Strength to metal						
Factor	Degrees of Freedom	Sum of Squares	Mean Square	F	P	
Technology	1	46.032	46.032	13.07	0.022	Significant
Location	1	30.143	30.143	8.56	0.043	Significant
Tec*Loc	1	27.293	27.293	7.75	0.050	Significant
Pure Error	4	14.084	3.521			

The table A-16 shows that there is a significant difference in adhesion to galvanised steel between the two PU systems: in average the HCFC-141b based formulation gave an adhesion strength 59.6% higher than Supercritical CO_2.

ANNEX 2. Material Safety Data Sheets of Supercritical CO_2 components

See PDF attachment.

ACHILLES CORPORATION

MATERIAL SAFETY DATA SHEET (MSDS)

MSDS No. May 31, 2012

1.	**Chemical Name and Company Information**	Product Name	:	Achilles Airlon-R, Component I (R-100)
		Company Name	:	Achilles Corporation
		Address	:	22 Daikyo-cho, Shinjuku-ku, Tokyo, Japan
		Dept. in charge	:	Insulation Materials Sales
		Telephone Number	:	+81-3-5379-4574
		Facsimile Number	:	+81-3-5379-4909
		Emergency Telephone	:	+81-284-73-9326

2. Hazard Identification

GHS Classification:

Physical Hazard:

- Explosives	Not applicable
- Flammable gases	Not applicable
- Flammable aerosols	Not applicable
- Oxidized gases	Not applicable
- Gases under pressure	Not applicable
- Flammable liquids	Not classified
- Flammable solids	Not applicable
- Self-reactive substance and mixture	Not applicable
- Pyrophoric liquids	Not classified
- Pyrophoric solids	Not applicable
- Self-heating substances and mixture	Classification not possible
- Substance and mixtures which, in contact with water, emit flammable gases	Not applicable
- Oxidizing liquids	Not applicable
- Oxidizing solids	Not applicable
- Organic peroxides	Not applicable
- Corrosion to metals	Not classified

Health Hazards:

- Acute toxicity (oral)	Not classified
- Acute toxicity (dermal)	Not classified
- Acute toxicity (gases)	Not applicable
- Acute toxicity (vapors)	Classification not possible
- Acute toxicity (dust, mist)	Category 4
- Skin corrosion/irritation	Category 2
- Serious eye damage/eye irritation	Category 2A
- Respiratory sensitization	Category 1
- Skin sensitization	Category 1
- Germ cell mutagenicity	Not classified
- Carcinogenicity	Not classified
- Reproductive toxicity	Not classified
- Specific target organ toxicity (single exposure)	Category 3 (airway irritation)
- Specific target organ toxicity (repeated exposure)	Classification not possible
- Aspiration hazard	Classification not possible

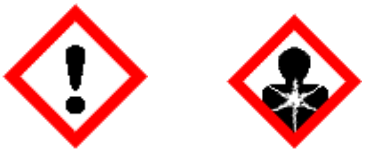
2. Hazard Identification (continued)

Environmental Hazards:

- Aquatic hazards (acute) — Classification not possible
- Aquatic hazards (chronic) — Classification not possible

Label elements:

Symbol:



Signal word: DANGER

Hazard Statement:

- Harmful if inhaled
- Causes skin irritation
- Causes serious eye irritation
- May cause allergy or asthmatic symptoms or breathing difficulties if inhaled
- May cause an allergic skin reaction
- May cause respiratory irritation

Cautionary statements:

[Safety measures]

- Carefully read the MSDS before handling the material.
- Do not drink/eat foods or smoke while using this material.
- Do not take in, inhale, or let eyes and skin touch the material. Wear appropriate protective equipment such as protective glasses, gloves and masks while handling the material.
- Carefully wash hands after handling.
- Do not take out contaminated working clothes from the work site.
- Avoid exposure of the material to environment.
- Do not let isocyanate contact water to avoid reaction.
- Do not use the material near a fire source.

[First aid]

- Inhalation: Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Ingestion: Immediately wash inside the mouth with water. Do not forcibly vomit.
- Eye contact: Thoroughly wash the eyes with clean water. When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- Skin contact: Thoroughly wash with soap and a large volume of water.
- Skin contact through clothing: Immediately take off the contaminated clothing.
- Thoroughly wash contaminated working clothes before using them again.
- In case of exposure or possible exposure to the material, seek medical assistance.
- When feeling physically sick, consult a doctorthat .
- In case of fire, initially extinguish it with either dry powder, CO2 or foam extinguisher. When the fire spreads, extinguish it with a large amount of spray water.
- In case of leakage, first collect the spill into a container as much as possible. Neutralize the material that remains uncollected with ammonia water, alcohol, etc. or let soil/sand absorb it, then dispose of it.

[Storage]

- Store the material in airtight containers and keep the containers in a well-ventilated and locked storage at around 20 deg. C.
- When stored outdoors, cover the containers with waterproof sheets to prevent infiltration of rainwater.
- Keep fire away from the storage area.

[Disposal]

- Have a waste disposer authorized by municipal governor undertake disposal of recovered material and its container.

3	**Composition / Information on Ingredients**	Pure or Mixture	Substance
		Chemical Name	Polymethylenepolyphenylisocyanate, Polymeric MDI
		Components and contained amount	99% or more (contains 1 % or more of 4, 4' diphenylmethanediisocyanate)
		AECS*) No.	(7)-872 (Polymethylenepolyphenylisocyanate) (4)-118 (4, 4' diphenylmethanediisocyanate)
		ISHA**) No.	Existing
		CAS No.	9016-87-9 (Polymethylenepolyphenylisocyanate) 101-68-8 (4, 4' diphenylmethanediisocyanate)
		Hazardous Ingredients and impurity	4, 4' diphenylmethanediisocyanate 30 to 50%

Notes: AECS*): Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
ISHA**): Industrial Safety and Health Act

4 First Aid Measures

Inhalation:
- Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Immediately consult a doctor.
- When breathing is stopped, loosen clothes and establish an airway, then give artificial respiration.
- When coughing or producing sputum persists, immediately consult a doctor.

Skin contact:
- Thoroughly wash with soap and a large volume of water.
- Take off all the contaminated clothes.
- When the skin irritates, rash develops or feeling sick, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.

Eye contact:
- Even if the amount in contact with eyes is small, thoroughly wash the eyes with clean water for at least 15 minutes, and consult a doctor.
- When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When the eyes irritate, consult a doctor.

Ingestion:
- Immediately wash inside the mouth with water, and take in water or milk of 250ml to dilute the ingested matter. Do not forcibly vomit the diluted matter.
- When becoming unconscious, do not take in anything through the mouth.
- Immediately consult a doctor for treatment including washing stomach.

5. Fire-Fighting Measures

Suitable extinguishing media: Powdered dry chemical, CO_2, foam, spray water
Unsuitable extinguishing media: Water jet

Specific fire extinguishing method:
- Use CO_2 or powdered dry chemical for initial fire fighting.
- When the fire spreads, extinguish it with a large amount of spray water.
- Wet the drums with spray water to prevent the drums from catching fire and blowing up.
- After the fire is put out, neutralize the spilt MDI.

Special protective equipment and precautions for fire-fighters:
- When fighting a fire, wear a self-contained breathing apparatus and other protection equipment, as hazardous MDI vapor can generate.
- Wear appropriate protective equipment such as protective glasses, gloves and masks.
- Fight a fire from windward side as much as practicable to avoid intake of toxic gas.

6. Accidental Release Measures

Personal precautions , protective equipment and emergency procedures:	Other than people wearing appropriate protection equipment, evacuate all people from the leakage. Secure ventilation of the place where leakage occurred.
Environmental precautions:	Do not release the spillage directly to rivers or sewage system. Neutralize spillage by dispersion with neutralizing agent, or absorb the spillage with soil/sand to recover the spillage as much as possible.
Methods and materials for containment and cleaning up:	Neutralize and decontaminate the floor from where spillage was removed. Do not seal up the container in which the spillage is recovered. Dispose of the container in accordance with cautions in Sec. 13.Disposal Procedures. Typical neutralizing agent: Water/Sodium Carbonate/Liquid detergent = 90 to 95/5 to 10/0.2 to 2 (wt.%)

7. Handling and Storage

Precautions for safe handling:

Technical measures	- Take countermeasures in Sect. 8. “Exposure Prevention and Protection! and wear protective equipment. - Install local exhaust equipment where the material is handled indoors. - When MDI is heated or powder is handled, wear protection equipment appropriate to avoid direct contact with skin.
Local/Total exhaust	- Install local/total exhaust equipment in accordance with Sect. 8. Exposure Prevention and Protection.
General cautions:	- Carefully read the MSDS before handling the material. - Do not touch, inhale or intake the material. - Carefully wash hands after handling. - Handle the material only outdoors or indoors provided with appropriate ventilation. - Do not take out contaminated working clothes from the work site. - Do not drink/eat foods or smoke while using the material.
Safe handling precautions:	- Be careful so that MDI will not cantact water to avoid reaction. - Always have sufficient number of protecting equipment and sufficient quantities of neutralization agent ready for emergency. - Handle the container with care to avoid over-turning or dropping.
Substances that should not be in contact with the material:	Refer to Sect. 10. Stability and Reactivity.

7.	**Handling and Storage**	**(continued)**
	Conditions for safe storage , including any incompatibilities:	
	Technical handling:	- Indoor storage shall be of fireproofing construction and well ventilated. - Flooring material shall be non-absorbing type. - Appropriate light letting-in and lighting equipment shall be installed.
	Appropriate storage site:	- Store the material in airtight containers and keep the containers in a well-ventilated and cooled place. - Store the containers in a lockable storage. - Displace vapor in the gaseous phase with nitrogen gas or dry air (due point to be -30 deg. C or lower) before storage. - Post caution signs such as “Flammable – Keep Fire Away” and “Unauthorized Personnel. Off limits.”
	Hazardous material when mixed	Refer to Sect. 10. Stability and Reactivity.
	Packaging material	Use containers specified by the Fire Service Act and UN Transportation regulations.

8. Exposure Controls/Personal Protection

Appropriate engineering controls	- Facilities where the material is handled shall be of tightly sealed construction. Local exhaust equipment or other suitable means for ventilation shall be installed near the place where vapor or mist of the material is generated. - When handling the material, wear appropriate protection equipment. Install eye washing and body washing equipment near the place where the material is handled. - Flooring material shall be non-absorbing type.
Control Limit:	Not specified
Occupation expose limit values:	
- Japan Society for Occupational Health.	TWA (time-weighted average) 0.05mg/m3 (4.4'MDI) (2007) [8)]
- American Conference of Governmental Industrial Hygienists	TWA (time-weighted average) 0.005 ppm (0.051mg/m3) (4.4'MDI) (2007) [9)]
Individual protection measures,such as personal protective equipment:	
- For respiratory organ	Air-breathing apparatus JIS T 8155, Air-supplied respirator JIS T 8153
- For Hands	Rubber or plastic protective gloves (impermeable)
- For eyes	Protective glasses with side protective cover plates
- For skin and body	Long sleeve working clothes and safety shoes
Hygiene measures	- Wash hands thoroughly after handling. - Contaminated work clothing should not be allowed out of the workplace.

9. Physical/Chemical Properties

Appearance	Dark brown liquid
Odor	Almost no odor
pH	No data available
Boiling point	Lower than 300 deg. C [10)]
Flash point	208 deg. C [10)]
Explosion limits	No data available
Vapor pressure	7 x 10^{-4}Pa (@25deg.C)
Vapor density (air = 1)	8.5 (4,4' MDI)
relative density	Approx. 1.23 (@25deg.C)
Solubility	Not soluble in water. Soluble in a number of organic solvents such as esters, ketone, and aromatic solvents.
Octanol/water partition coefficient	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity	50 to 300 mPa・s (@25deg.C) [10)]

10. Stability and Reactivity

Chemical stability:	-	Chemically stable against light, heat and impact under normal handling conditions.
Reactivity:	-	As MDI is highly active, it tends to react with active hydrogen compounds such as water, alcohol and amines to generate heat.
	-	Coexistence with basic substances and certain metallic compounds can cause polymerization and heat generation.
	-	Reaction with water generates CO^2.
Possibility of hazardous reactions	-	Severely reacts with active hydrogen compounds such as water, alcohol and amines to generate heat, causing possible danger of explosion due to pressure increase.
Incompatible materials	-	Active hydrogen compounds such as water, alcohol and amines, and oxidizing agents
Hazardous decomposition products	-	Nitrogen compounds, CO

11 Toxicological Information

Acute toxicity (oral):	Based on "rat LD50 = 49,000 mg/kg (RTECS)," judged to be "Not classified".
Acute toxicity:(dermal)	Based on "rabbit LD50 > 10,000 mg/kg (SIDS)" and "rabbit LD50 ≧ 94,000 mg/kg (RTECS)," judged to be "Not classified". Skin contact to 4, 4'diphenylmethanediisocyanate can cause reddish swelling of skin. Eye contact to 4, 4'diphenylmethanediisocyanate causes acute pain, and can cause disturbance of vision unless it is removed immediately.
Acute toxicity (gases)	Since the material is a liquid, we judged the material to be "Not applicable".
Acute toxicity (vapors)	Since no information was available, we judged the material to be "Classification not possible".
Acute toxicity (dust, mist)	Based on "LC = 50mg/kg (calculated)," we judged the material to be "Category 4".
Skin corrosion, irritation	Base on description in IARC 19 (1979) that the material irritates rabbit skin, we judged the material to be "Category 2".
Serious eye damage/eye irritation	Base on description in IARC 19 (1979) that the material irritates rabbit skin, we judged the material to be "Category 2A".
Respiratory sensitization	Based on the following facts, we judged the material to be "Category 1". - Classified as "Air passage; Group 1 (Recommendation by the Society for Industrial Studies, Japan 2005)" by Japan Society for Occupational Health. - Classified as Sa (MAK/BAT, 2004) by DFG. Listed as a "respiratory sensitization substance" by Japanese Society of Occupational and Environmental Allergy (its academic journal, 2004).

11. Toxicological Information (continued)

Skin sensitization	Since CICAD (2007) states that the Mouse Ear Swelling Test (MEST) results show clear evidence of skin sensitization, we judged the material to be "Category 1"
Germ cell mutagenicity	Analysis results of chromosome/micronucleus in human peripheral blood, which is an in vivo mutagenicity test using cells of the body, and micronucleus tests results using red blood cells of a mouse has shown negative (DFGOT vol.8, 1997). Therefore we judged the material to be "Not Classified".
Carcinogenicity	Since the material is classified as Group 3 (LARC 71, 1997) by IARC and as CBD (IRIS 1998) by EPA, we judged the material to be "Not classified".
Reproductive toxicity	Results of in-pregnancy exposure test using rats as per IARC 71(1999), IRIS (1998) and CICAD 27 (2000) showed no definitive reproductive toxicity at the dosage where general toxicity is found in the parent animal. Therefore we judged the material to be "Not classified".
Specific target organ toxicity (single exposure)	" Based on the descriptions in DFGOT (vol.8, 1997) and IARC71 (1997) that the material has airway irritation, we judged the material to be "Category 3 (airway irritation)".
Specific target organ toxicity (repeated exposure)	The toxicity observed was not considered an organizational toxicity due to repeated dosage, but was considered local actions occurring when contact-exposed to the tissue. For GHS against the local actions, the material is covered as Category 3 in particular target organs/systemic toxicity (single exposure) and as Category 1 in respiratory sensitization. Therefore, as the material needs not be classified for repeated exposure, "Classification not possible" was selected.
Aspiration hazard	Since no information was available, we judged the material to be "Classification not possible"

12. Ecological Information

Ecotoxicity/Fish toxicity	TLm 48H Japanese rice fish ("Himedaka") 3000ppm or higher
Aquatic hazard (acute)	"Classification not possible" as no information is available
Aquatic hazard (chronic)	"Classification not possible" as no information is available

13. Disposal Considerations

Residual Waste Disposal

- Have a waste disposer authorized by municipal governor undertake disposal of residual wastes.
- Incinerate the waste at an appropriate facility.
- When the waste disposer undertakes the task, be sure to have the disposer thoroughly understand hazardousness and toxicity of the residual wastes.
- Wastes contaminated with MDI shall be detoxified in open system using neutralizing agent, then disposed of by an appropriate measure.

13. Disposal Considerations **(continued)**

Contaminated Container/Package	- Containers shall be cleaned for recycling, or disposed of in appropriate manners in accordance with applicable laws and local municipality's regulations. - When disposing of an empty used container, remove the contents completely.

14. Transport Information

International regulation:	For Air transportation, follow requirements of ICAO/IATA, and for sea transportation, follow requirements of IMDG.
UN Classification	Not applicable
UN Number	Not applicable
Domestic regulations:	
Land transportation	Follow transportation rules provided in Fire Service Act, Industrial Safety and Health Act, Road Trucking Vehicle Act, etc.
Sea transportation	Follow transportation rules provided in Ship Safety Act.
Air transportation	Follow transportation rules provided in Civil Aeronautics Act.
Special safety measures:	Prior to transportation, make sure that there is no leakage from the container and that signs and marking are properly placed. Load up the cargoes properly so that they will not be overturned, dropped, collapsed or damaged during transportation.
Fire Service Act:	As the material belongs to Hazardous material Group 4 the 4th Petroleum of Fire Service Act, follow the requirements of the law when selecting containers and loading the cargoes.
Emergency Measures Guide No.	171

15. Regulatory Information

	:
Industrial Safety and Health Act	
Notifying substance (Article 57.2, enforcement order 18-2 Table 9)	4, 4' diphenylmethanediisocyanate
Guidance/Transmittal Substance (Existing mutagenic chemical substance, etc.)	4, 4' diphenylmethanediisocyanate
Labor Standards Act, Disease Chemical Substance (Article 75.2, enforcement regulation 35, Table 1-2-4)	4, 4' diphenylmethanediisocyanate
Pollutant Release and Transfer Register Law (PRTR)	
Class 1 Designated Chemical Substance	4, 4' diphenylmethanediisocyanate (No. 448)
Fire Service Act	
Hazardous material	Group 4 the 4th Petroleum, hazardous class III
Air Pollution Control Act	
Hazardous Air Pollutant (Article 2.13, Notice by Ministry of Environment)	4, 4' diphenylmethanediisocyanate

16. Other Information

Reference List:

1) Urethane Materials Industry Association: Outline of Polyurethane Industries (2005)

2) Urethane Materials Industry Association: Polyurethane Material – Guidance to safe handling (2008)

3) Urethane Materials Industry Association: Control Guidance for transportation of polyol (2008)

4) The Chemical Society of Japan: Disaster-prevention Guideline for diphenylmethanediisocyanate (MDI) (1996)

5) M. H. Litch Field “Review of MDI Toxicity Studies” III ref.: 10844,7 (1991)

6) Health, Labor and Welfare Ministry, Kihatsu No. 315-2 (Heisei 5)

7) Japan Society for Occupational Health “Journal for Occupational Health” (2007)

8) IARC Monographs (2006)

9) “TVLs and BEIs” (2007) (ACGIH)

10) MDI and TDI: Safety, Health and Environment edited by D.S. Gilbert, etc.(2003)

Notes:

The text of this MSDS is prepared based on data, knowledge and information available at the time of preparation or revision. Therefore, the text is subject to change and supplementation whenever new knowledge and experiment results become available. Neither of the figures included in this MSDS such as and physicochemical properties are for guarantee.

Cautions recommended in this MSDS are subject to general handling. If specific and special handling procedures are required, determine appropriate safety standards/requirements for such specific and special handling of the material under the user’s own responsibility.

ACHILLES CORPORATION

MATERIAL SAFETY DATA SHEET (MSDS)

MSDS No. May 16, 2012

1.	**Chemical Name and Company Information**	Product Name	:	Achilles Airlon-FR-NF, Component I (FR-300)
		Company Name	:	Achilles Corporation
		Address	:	22 Daikyo-cho, Shinjuku-ku, Tokyo, Japan
		Dept. in charge	:	Insulation Materials Sales
		Telephone Number	:	+81-3-5379-4574
		Facsimile Number	:	+81-3-5379-4909
		Emergency Telephone	:	+81-284-73-9326

2. Hazard Identification

GHS Classification:

Physical Hazard:

- Explosives	Not applicable
- Flammable gases	Not applicable
- Flammable aerosols	Not applicable
- Oxidized gases	Not applicable
- Gases under pressure	Not applicable
- Flammable liquids	Not classified
- Flammable solids	Not applicable
- Self-reactive substance and mixture	Not applicable
- Pyrophoric liquids	Not classified
- Pyrophoric solids	Not applicable
- Self-heating substances and mixtures	Classification not possible
- Substance and mixtures which, in contact with water, emit flammable gases	Not applicable
- Oxidizing liquids	Not applicable
- Oxidizing solids	Not applicable
- Organic peroxides	Not applicable
- Corrosion to metals	Not classified

Health Hazards:

- Acute toxicity (oral)	Not classified
- Acute toxicity (dermal)	Not applicable
- Acute toxicity (gases)	Not applicable
- Acute toxicity (vapors)	Not classified
- Acute toxicity (dust, mist)	Category 4
- Skin corrosion/irritation	Category 2
- Serious eye damage/eye irritation	Category 2A
- Respiratory sensitization	Category 1
- Skin sensitization	Category 1
- Germ cell mutagenicity	Not applicable
- Carcinogenicity	Not applicable
- Reproductive toxicity	Not applicable
- Specific target organ toxicity (single exposure)	Category 3 (airway irritation)
- Specific target organ toxicity (repeated exposure)	Classification not possible
- Aspiration hazard	Not classified

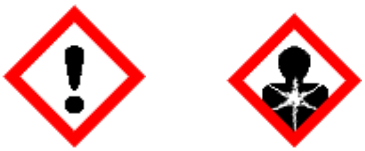
2. Hazard Identification (continued)

Environmental Hazard:

- Aquatic hazard (acute) Not classified
- Aquatic hazard (chronic) Not classified

Label elements:

Symbol:



Signal word: DANGER

Hazard statement:

- Harmful if inhaled
- Causes skin irritation
- Causes serious eye irritation
- May cause allergy or asthmatic symptoms or breathing difficulties if inhaled
- May cause an allergic skin reaction
- May cause respiratory irritation

Cautionary statements:

[Safety measures]

- Carefully read the MSDS before handling the material.
- Do not drink/eat foods or smoke while using this material.
- Do not take in, inhale, or let eyes and skin touch the material. Wear appropriate protective equipment such as protective glasses, gloves and masks while handling the material.
- Carefully wash hands after handling.
- Do not take out contaminated working clothes from the work site.
- Avoid exposure of the material to environment.
- Do not let isocyanate contact water to avoid reaction.
- Do not use the material near a fire source.

[First aid]

- Inhalation: Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Ingestion: Immediately wash inside the mouth with water. Do not forcibly vomit.
- Eye contact: Thoroughly wash the eyes with clean water. When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- Skin contact: Thoroughly wash with soap and a large volume of water.
- Skin contact through clothing: Immediately take off the contaminated clothing.
- Thoroughly wash contaminated working clothes before using them again.
- In case of exposure or possible exposure to the material, seek medical assistance.
- When feeling physically sick, consult a doctorthat .
- In case of fire, initially extinguish it with either dry powder, CO2 or foam extinguisher. When the fire spreads, extinguish it with a large amount of spray water.
- In case of leakage, first collect the spill into a container as much as possible. Neutralize the material that remains uncollected with ammonia water, alcohol, etc. or let soil/sand absorb it, then dispose of it.

[Storage]

- Store the material in airtight containers and keep the containers in a well-ventilated and locked storage at around 20 deg. C.
- When stored outdoors, cover the containers with waterproof sheets to prevent infiltration of rainwater.
- Keep fire away from the storage area.

[Disposal]

- Have a waste disposer authorized by municipal governor undertake disposal of recovered material and its container.

3.	**Composition / Information on ingredients**	Pure or Mixture	Substance
		Chemical Name	Modified polyisocyanate
		Components and contained amount	98% or more (contains 1 % or more of 4, 4' diphenylmethanediisocyanate)
		AECS*) No.	(7)-820 (modified polyisocyanate) (4)-524 (alkylene carbonate)
		ISHA**) No.	Existing
		CAS No.	101-68-8 (4, 4' diphenylmethanediisocyanate) 108-32-7(alkylene carbonate)
		Hazardous Ingredients and impurity	4, 4' diphenylmethanediisocyanate 30 to 50%

Notes: AECS*): Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
ISHA**): Industrial Safety and Health Act

4. First Aid Measures

Inhalation:	- Move to a place filled with fresh air and stay there at rest in a posture easy to breath. - Immediately consult a doctor. - When breathing is stopped, loosen clothes and establish an airway, then give artificial respiration. - When coughing or producing sputum persists, immediately consult a doctor.
Skin contact:	- Thoroughly wash with soap and a large volume of water. - Take off all the contaminated clothes. - When the skin irritates, rash develops or feeling sick, consult a doctor. - Thoroughly wash contaminated working clothes before using them again.
Eye contact:	- Even if the amount in contact with eyes is small, thoroughly wash the eyes with clean water for at least 15 minutes, and consult a doctor. - When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water. - When the eyes irritate, consult a doctor.
Ingestion:	- Immediately wash inside the mouth with water, and take in water or milk of 250ml to dilute the ingested matter. Do not forcibly vomit the diluted matter. - When becoming unconscious, do not take in anything through the mouth. - Immediately consult a doctor for treatment including washing stomach.

5. Fire Fighting Measures

- Suitable extinguishing media: Powdered dry chemical, CO2, foam, spray water
- Unsuitable extinguishing media: Water jet

Specific fire extinguishing method:

- Use CO2 or powdered dry chemical for initial fire fighting.
- When the fire spreads, extinguish it with a large amount of spray water.
- Wet the drums with spray water to prevent the drums from catching fire and blowing up.
- After the fire is put out, neutralize the spilt MDI.

Special protective equipment and precautions for fire-fighters:

- When fighting a fire, wear a self-contained breathing apparatus and other protection equipment, as hazardous MDI vapor can generate.
- Wear appropriate protective equipment such as protective glasses, gloves and masks.
- Fight a fire from windward side as much as practicable to avoid intake of toxic gas.

6. Accidental release measures

Personal precautions , protective equipment and emergency procedures:	Other than people wearing appropriate protection equipment, evacuate all people from the leakage. Secure ventilation of the place where leakage occurred.
Environmental precautions:	Do not release the spillage directly to rivers or sewage system. Neutralize spillage by dispersion with neutralizing agent, or absorb the spillage with soil/sand to recover the spillage as much as possible.
Methods and materials for containment and cleaning up:	Neutralize and decontaminate the floor from where spillage was removed. Do not seal up the container in which the spillage is recovered. Dispose of the container in accordance with cautions in Sec. 13.Disposal Procedures. Typical neutralizing agent: Water/Sodium Carbonate/Liquid detergent = 90 to 95/5 to 10/0.2 to 2 (wt.%)

7. Handling and Storage

Precautions for safe handling.

Technical measures	- Take countermeasures in Sect. 8. “Exposure Prevention and Protection! and wear protective equipment. - Install local exhaust equipment where the material is handled indoors. - When MDI is heated or powder is handled, wear protection equipment appropriate to avoid direct contact with skin.
Local/Total exhaust	- Install local/total exhaust equipment in accordance with Sect. 8. Exposure Prevention and Protection.

7. Handling and Storage **(continued)**

General cautions:	- Carefully read the MSDS before handling the material. - Do not touch, inhale or intake the material. - Carefully wash hands after handling. - Handle the material only outdoors or indoors provided with appropriate ventilation. - Do not take out contaminated working clothes from the work site. - Do not drink/eat foods or smoke while using the material.
Safe handling precautions:	- Be careful so that MDI will not cantact water to avoid reaction. - Always have sufficient number of protecting equipment and sufficient quantities of neutralization agent ready for emergency. - Handle the container with care to avoid over-turning or dropping.
Substances that should not be in contact with the material:	Refer to Sect. 10. Stability and Reactivity.

Conditions for sage storage, including any incompatibilities.

Technical handling:	- Indoor storage shall be of fireproofing construction and well ventilated. - Flooring material shall be non-absorbing type. - Appropriate light letting-in and lighting equipment shall be installed.
Appropriate storage site:	- Store the material in airtight containers and keep the containers in a well-ventilated and cooled place. - Store the containers in a lockable storage. - Displace vapor in the gaseous phase with nitrogen gas or dry air (due point to be -30 deg. C or lower) before storage. - Post caution signs such as “Flammable – Keep Fire Away” and “Unauthorized Personnel. Off limits.” .
Hazardous material when mixed	Refer to Sect. 10. Stability and Reactivity.
Packaging material	Use containers specified by the Fire Service Act and UN Transportation regulations.

8. Exposure Controls/Personal Protection

Appropriate engineering controls	- Facilities where the material is handled shall be of tightly sealed construction. Local exhaust equipment or other suitable means for ventilation shall be installed near the place where vapor or mist of the material is generated. - When handling the material, wear appropriate protection equipment. Install eye washing and body washing equipment near the place where the material is handled. - Flooring material shall be non-absorbing type.
Control Limit:	Not specified
Occupation expose limit values:	
- Japan Society for Occupational Health.	TWA (time-weighted average) 0.05mg/m3 (4.4'MDI) (2007) [8)]
- American Conference of Governmental Industrial Hygienists	TWA (time-weighted average) 0.005 ppm (0.051mg/m3) (4.4'MDI) (2007) [9)]
Individual protection measures,such as personal protective equipment:	
- For respiratory organ	Air-breathing apparatus JIS T 8155, Air-supplied respirator JIS T 8153
- For Hands	Rubber or plastic protective gloves (impermeable)
- For eyes	Protective glasses with side protective cover plates
- For skin and body	Long sleeve working clothes and safety shoes
Hygiene measures	- Wash hands thoroughly after handling. - Contaminated work clothing should not be allowed out of the workplace.

9. Physical/Chemical Properties

Appearance	Dark brown liquid
Odor	Almost no odor
pH	No data available
Boiling point	No data available
Flash point	230 deg. C [10)]
Explosion limits	No data available
Vapor pressure	0.001Pa (@25deg.C)
Vapor density (air = 1)	No data available
relative density	Approx. 1.23 (@25deg.C)
Solubility	Not soluble in water. Soluble in a number of organic solvents such as esters, ketone, and aromatic solvents.
Octanol/water partition coefficient	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity	270 mPa-s (@25deg.C) [10)]

10. Stability and Reactivity

Chemical Stability:	-	Chemically stable against light, heat and impact under normal handling conditions.
Reactivity:	-	As MDI is highly active, it tends to react with active hydrogen compounds such as water, alcohol and amines to generate heat.
	-	Coexistence with basic substances and certain metallic compounds can cause polymerization and heat generation.
	-	Reaction with water generates CO_2.
Possibility of hazardous reactions	-	Severely reacts with active hydrogen compounds such as water, alcohol and amines to generate heat, causing possible danger of explosion due to pressure increase.
Incompatible materials	-	Active hydrogen compounds such as water, alcohol and amines, and oxidizing agents
Hazardous decomposition products	-	Nitrogen compounds, CO

11. Toxicological Information

Acute toxicity (oral):	Based on “rat LD50 = 31,600 mg/kg (CICAD 272,000),” judged to be “Not classified”.
Acute toxicity:(dermal)	Based on “rabbit LD50 > 10,000 mg/kg (SIDS)” and “rabbit LD50≧94,000 mg/kg (RTECS),” judged to be “Not applicable” Skin contact to 4, 4’diphenylmethanediisocyanate can cause reddish swelling of skin. Eye contact to 4, 4’diphenylmethanediisocyanate causes acute pain, and can cause disturbance of vision unless it is removed immediately.
Acute toxicity (gases)	Since the material is a liquid, we judged the material to be “Not applicable”
Acute toxicity (vapors)	Since no information was available, we judged the material to be “Not classified”
Acute toxicity (dust, mist)	Base on description in EUROPIAN UNION RISK ASSESSMENT REPOST, VOLUME59 that the material harmful by inhalation, we judged the material to be “Category 4”.
Skin corrosion, irritation	Base on description in IARC 19 (1979) that the material irritates rabbit skin, we judged the material to be “Category 2”.
Serious eye damage/eye irritation	Based on description in IARC19(1979) that the material irritates rabbit skin, we judged the material to be “Category2A”.

11.	**Toxicological Information**	**(continued)**
	Respiratory sensitization	Based on the following facts, we judged the material to be “Category 1.” - Classified as “Air passage; Group 1 (Recommendation by the Society for Industrial Studies, Japan 2005)” by Japan Society for Occupational Health. - Classified as Sa (MAK/BAT, 2004) by DFG. - Listed as a “respiratory sensitization substance” by Japanese Society of Occupational and Environmental Allergy (its academic journal, 2004).
	Skin sensitization	Since CICAD (2007) states that the Mouse Ear Swelling Test (MEST) results show clear evidence of skin sensitization, we judged the material to be “Category 1.”
	Germ cell mutagenicity	Analysis results of chromosome/micronucleus in human peripheral blood, which is an in vivo mutagenicity test using cells of the body, and micronucleus tests results using red blood cells of a mouse has shown negative (DFGOT vol.8, 1997). Therefore we judged the material to be “Not classified”.
	Carcinogenicity	Since the material is classified as Group 3 (LARC 71, 1997) by IARC and as CBD (IRIS 1998) by EPA, we judged the material to be “Not classified”.
	Reproductive toxicity	Results of in-pregnancy exposure test using rats as per IARC 71(1999), IRIS (1998) and CICAD 27 (2000) showed no definitive reproductive toxicity at the dosage where general toxicity is found in the parent animal. Therefore we judged the material to be “Not classified”.
	Specific target organ toxicity (single exposure)	” Based on the descriptions in DFGOT (vol.8, 1997) and IARC71 (1997) that the material has airway irritation, we judged the material to be “Category 3 (airway irritation).”
	Specific target organ toxicity (repeated exposure)	The toxicity observed was not considered an organizational toxicity due to repeated dosage, but was considered local actions occurring when contact-exposed to the tissue. For GHS against the local actions, the material is covered as Class 3 in particular target organs/systemic toxicity (single exposure) and as Class 1 in respiratory sensitization. Therefore, as the material needs not be classified for repeated exposure, “Classification not possible” was selected.
	Aspiration hazard	Since no information was available, we judged the material to be “Classification not possible”.
12.	Ecological Information Ecotoxicity/Fish toxicity	TLm 48H Japanese rice fish (“Himedaka”) 3000ppm or higher
	Aquatic hazard (acute)	“Classification not possible” as no information is available
	Aquatic hazard (chronic)	“Classification not possible” as no information is available

13. Disposal Considerations

Residual Waste Disposal	- Have a waste disposer authorized by municipal governor undertake disposal of residual wastes. - Incinerate the waste at an appropriate facility. - When the waste disposer undertakes the task, be sure to have the disposer thoroughly understand hazardousness and toxicity of the residual wastes. - Wastes contaminated with MDI shall be detoxified in open system using neutralizing agent, then disposed of by an appropriate measure.
Contaminated Container/Package	- Containers shall be cleaned for recycling, or disposed of in appropriate manners in accordance with applicable laws and local municipality‘s regulations. - When disposing of an empty used container, remove the contents completely.

14 Transport Information

International regulation:	For Air transportation, follow requirements of ICAO/IATA, and for sea transportation, follow requirements of IMDG.
UN Classification	Not applicable
UN Number	Not applicable
Domestic regulations:	
Land transportation	Follow transportation rules provided in Fire Service Act, Industrial Safety and Health Act, Road Trucking Vehicle Act, etc.
Sea transportation	Follow transportation rules provided in Ship Safety Act.
Air transportation	Follow transportation rules provided in Civil Aeronautics Act.
Special safety measures:	Prior to transportation, make sure that there is no leakage from the container and that signs and marking are properly placed. Load up the cargoes properly so that they will not be overturned, dropped, collapsed or damaged during transportation.
Fire Service Act:	As the material belongs to Hazardous material Group 4 the 4th Petroleum of Fire Service Act, follow the requirements of the law when selecting containers and loading the cargoes.
Emergency Measures Guide No.	171

15. Regulatory Information

Industrial Safety and Health Act Notifying substance (Article 57.2, enforcement order 18-2 Table 9)	4, 4’ diphenylmethanediisocyanate
Guidance/Transmittal Substance (Existing mutagenic chemical substance, etc.)	4, 4’ diphenylmethanediisocyanate
Labor Standards Act, Disease Chemical Substance (Article 75.2, enforcement regulation 35, Table 1-2-4)	4, 4’ diphenylmethanediisocyanate
Pollutant Release and Transfer Register Law (PRTR) Class 1 Designated Chemical Substance	4, 4’ diphenylmethanediisocyanate (No. 448)
Fire Service Act Hazardous material	Group 4 the 4th Petroleum, hazardous class III
Air Pollution Control Act Hazardous Air Pollutant (Article 2.13, Notice by Ministry of Environment)	4, 4’ diphenylmethanediisocyanate

16. Other Information

Reference List:

1) Urethane Materials Industry Association: Outline of Polyurethane Industries (2005)

2) Urethane Materials Industry Association: Polyurethane Material – Guidance to safe handling (2008)

3) Urethane Materials Industry Association: Control Guidance for transportation of polyol (2008)

4) The Chemical Society of Japan: Disaster-prevention Guideline for diphenylmethanediisocyanate (MDI) (1996)

5) M. H. Litch Field “Review of MDI Toxicity Studies” III ref.: 10844,7 (1991)

6) Health, Labor and Welfare Ministry, Kihatsu No. 315-2 (Heisei 5)

7) Japan Society for Occupational Health “Journal for Occupational Health” (2007)

8) IARC Monographs (2006)

9) “TVLs and BEIs” (2007) (ACGIH)

10) MDI and TDI: Safety, Health and Environment edited by D.S. Gilbert, etc.(2003)

Notes:
The text of this MSDS is prepared based on data, knowledge and information available at the time of preparation or revision. Therefore, the text is subject to change and supplementation whenever new knowledge and experiment results become available. Neither of the figures included in this MSDS such as and physicochemical properties are for guarantee.

Cautions recommended in this MSDS are subject to general handling. If specific and special handling procedures are required, determine appropriate safety standards/requirements for such specific and special handling of the material under the user's own responsibility.

ACHILLES CORPORATION

MATERIAL SAFETY DATA SHEET (MSDS)

MSDS No. May 31, 2012

1.	**Chemical Name and Company Information**	Product Name	:	Achilles Airlon-R, Component R (TS-300NF)
		Company Name	:	Achilles Corporation
		Address	:	22 Daikyo-cho, Shinjuku-ku, Tokyo, Japan
		Dept. in charge	:	Insulation Materials Sales
		Telephone Number	:	+81-3-5379-4574
		Facsimile Number	:	+81-3-5379-4909
		Emergency Telephone	:	+81-284-73-9326

2. Hazard Identification

GHS Classification:

Physical Hazard:

- Explosives	Not applicable
- Flammable gases	Not applicable
- Flammable aerosols	Not applicable
- Oxidized gases	Not applicable
- Gases under pressure	Not applicable
- Flammable liquids	Classification not possible
- Flammable solids	Not applicable
- Self-reactive substance and mixture	Not applicable
- Pyrophoric liquids	Not classified
- Pyrophoric solids	Not applicable
- Self-heating substances and mixture	Classification not possible
- Substance and mixtures which, in contact with water, emit flammable gases	Not applicable
- Oxidizing liquids	Not applicable
- Oxidizing solids	Not applicable
- Organic peroxides	Not applicable
- Corrosion to metals	Classification not possible

Health Hazards:

- Acute toxicity (oral)	Classification not possible
- Acute toxicity (dermal)	Classification not possible
- Acute toxicity (gases)	Not applicable
- Acute toxicity (vapors)	Classification not possible
- Acute toxicity (dust, mist)	Classification not possible
- Skin corrosion/irritation	Category 2
- Serious eye damage/eye irritation	Category 2
- Respiratory sensitization	Classification not possible
- Skin sensitization	Classification not possible
- Germ cell mutagenicity	Classification not possible
- Carcinogenicity	Classification not possible
- Reproductive toxicity	Classification not possible
- Specific target organ toxicity (single exposure)	Classification not possible
- Specific target organ toxicity (repeated exposure)	Category 2
- Aspiration hazard	Classification not possible

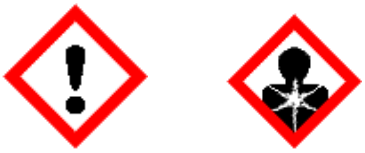
2. Hazard Identification (continued)

Environmental Hazards:

- Aquatic hazards (acute) Category 3
- Aquatic hazards (chronic) Category 3

Label elements:

Symbol:



Signal word: WARNING

Hazard Statement:

- Causes skin irritation
- Causes serious eye irritation
- May cause damage to organs through prolonged or repeated exposure
- Harmful to aquatic life
- Harmful to aquatic life with long lasting effects

Cautionary statements:

[Safety measures]

- Carefully read the MSDS before handling the material.
- Do not drink/eat foods or smoke while using this material.
- Do not take in, inhale, or let eyes and skin touch the material. Wear appropriate protective equipment such as protective glasses, gloves and masks while handling the material.
- Carefully wash hands after handling.
- Avoid inhalation of vapor.
- Do not take out contaminated working clothes from the work site.
- Avoid exposure of the material to environment.
- Do not use the material near a fire source.

[First aid]

- Inhalation: Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Ingestion: Immediately wash inside the mouth with water. Do not forcibly vomit.
- Eye contact: Thoroughly wash the eyes with clean water. When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When eye irritation persists, consult a doctor.
- Skin contact: Thoroughly wash with soap and a large volume of water. Immediately take off the contaminated clothing.
- When irritation to skin persists, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.
- In case of exposure or possible exposure to the material, seek medical assistance.
- When feeling physically sick, consult a doctor.
- In case of fire, initially extinguish it with either dry powder, CO2 or foam extinguisher. When the fire spreads, extinguish it with a large amount of spray water.
- In case of leakage, first collect the spill into a container as much as possible. Prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal.

[Storage]

- Store the material in airtight containers and keep the containers in a well-ventilated and locked storage at around 20 deg. C.
- When stored outdoors, cover the containers with waterproof sheets to prevent infiltration of rainwater.
- Keep fire away from the storage area.

[Disposal]

- Have a waste disposer authorized by municipal governor undertake disposal of recovered material and its container.

3.	**Composition / Information on Ingredients**	Pure or Mixture	Mixture
		Components and contained amount	Polyol 65 to 75 % Trichloropropylphosphate 15 to 25% Amine catalyst 7% or smaller Others 10% or smaller
		AECS*) No.	Existing or nondisclosure
		Hazardous Ingredients and impurity	Amine catalyst, Trichloropropylphosphate

Notes: AECS*): Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
ISHA**): Industrial Safety and Health Act

4. First Aid Measure

Inhalation:
- Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Immediately consult a doctor.
- When breathing is stopped, loosen clothes and establish an airway, then give artificial respiration.
- When coughing or producing sputum persists, immediately consult a doctor.

Skin contact:
- Thoroughly wash with soap and a large volume of water.
- Take off all the contaminated clothes.
- When the skin irritates, rash develops or feeling sick, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.

Eye contact:
- Even if the amount in contact with eyes is small, thoroughly wash the eyes with clean water for at least 15 minutes, and consult a doctor.
- When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When eye irritation persists, consult a doctor.

Ingestion:
- Immediately wash inside the mouth with water, and take in water or milk of 250ml to dilute the ingested matter. Do not forcibly vomit the diluted matter.
- When becoming unconscious, do not take in anything through the mouth.
- Immediately consult a doctor for treatment including washing stomach.

5. Fire-Fighting Measure

Suitable extinguishing media : Powdered dry chemical, CO_2, foam, spray water

Specific fire extinguishing method:
- Use CO_2 or powdered dry chemical for initial fire fighting.
- When the fire spreads, extinguish it with a large amount of spray water.
- Wet the drums with spray water to prevent the drums from catching fire and blowing up.

Special protective equipment and precautions for fire-fighters s:
- When fighting a fire, wear a self-contained breathing apparatus and other protection equipment, as hazardous vapor can generate.
- Wear appropriate protective equipment such as protective glasses, gloves and masks.
- Fight a fire from windward side as much as practicable to avoid intake of toxic gas.

6. Accidental Release Measures

Personal precautions , protective equipment and emergency procedures:	Other than people wearing appropriate protection equipment, evacuate all people from the leakage. Secure ventilation of the place where leakage occurred.
Environmental precautions:	Do not release the spillage directly to rivers or sewage system.
Methods and materials for containment and cleaning up:	- When a large amount is spilled, prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal. - Dispose of the container used for collection of spillage in accordance with cautions in Sec. 13.Disposal Procedures.

7. Handling and Storage

Precautions for safe handling:

Technical measures	- Take countermeasures in Sect. 8. “Exposure Prevention and Protection! and wear protective equipment. - Install local exhaust equipment where the material is handled indoors.
Local/Total exhaust	- Install local/total exhaust equipment in accordance with Sect. 8. “Exposure Prevention and Protection.”
General cautions:	- Carefully read the MSDS before handling the material. - Do not touch, inhale or intake the material. - Carefully wash hands after handling. - Handle the material only outdoors or indoors provided with appropriate ventilation. - Do not take out contaminated working clothes from the work site. - Do not drink/eat foods or smoke while using the material.
Safe handling precautions:	- Always have sufficient number of protecting equipment and sufficient quantities of neutralization agent ready for emergency. - Handle the container with care to avoid over-turning or dropping.
Substances that should not be in contact with the material:	Refer to Sect. 10.”Stability and Reactivity.”

Conditions for safe storage , including any incompatibilities:

Technical handling:	- Indoor storage shall be of fireproofing construction and well ventilated. - Flooring material shall be non-absorbing type. - Appropriate light letting-in and lighting equipment shall be installed.

7 Handling and Storage (continued)

Conditions for safe storage , including any incompatibilities:

Appropriate storage site:	- Store the material in airtight containers and keep the containers in a well-ventilated and cooled place. - Store the containers in a lockable storage. - Displace vapor in the gaseous phase with nitrogen gas or dry air (due point to be -30 deg. C or lower) before storage. - Post caution signs such as “Flammable – Keep Fire Away” and “Unauthorized Personnel. Off limits.” .
Hazardous material when mixed	Refer to Sect. 10. “Stability and Reactivity.”
Packaging material	Use containers specified by the Fire Service Act and UN Transportation regulations.

8 Exposure Controls/Personal Protection:

Appropriate engineering controls	- Facilities where the material is handled shall be of tightly sealed construction. Local exhaust equipment or other suitable means for ventilation shall be installed near the place where vapor or mist of the material is generated. - When handling the material, wear appropriate protection equipment. Install eye washing and body washing equipment near the place where the material is handled. - Flooring material shall be non-absorbing type.
Individual protection measures,such as personal protective equipment:	
For respiratory organ	Air-breathing apparatus JIS T 8155, Air-supplied respirator JIS T 8153
For Hands	Rubber or plastic protective gloves (impermeable)
For eyes	Protective glasses with side protective cover plates
For skin and body	Long sleeve working clothes and safety shoes
Hygiene measures:	- Carefully wash hands after handling. - Do not take out contaminated working clothes form the work site.

9. Physical/Chemical Properties

Appearance	Light brown liquid
Odor	Amine –like odor
pH	8 to 9
Boiling point	No data available
Flash point	Cannot be measured
Explosion limits	No data available
Vapor pressure	No data available
Vapor density (air = 1)	No data available
relative density	Approx. 1.07 (@25deg.C)
Solubility	Soluble in a number of organic solvents such as alcohol, methylene chloride, esters, ketone, and aromatic solvents.
Octanol/water partition coefficient	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity	250 to 500mPa-s (@25deg.C)

10. Stability and Reactivity

Chemical stability:
- Chemically stable against light, heat and impact under normal handling conditions.

Reactivity:
- Reacts with strong oxidants. Danger.

11. Toxicological Information

Data on the material not available

Acute toxicity(oral):

"Classification not possible" as no information available.
However, the material contains 2% of Component B (oral toxicity test using rats: LD50>600mg/kg) corresponding to Category 4, 1.3% 0f Component C (oral toxicity test using rats: LD50 = 14,800mg/kg (0.9%) and LD50 = 1700mg/kg (0.4%)) corresponding to Category 5, and 20% or more of trichloropropylphosphate corresponding to Category 4.
Trichloropropylphosphate, tested as per OECD oral toxicity test using rats (female), show LD50 = 1,078 mg/kg.

Acute toxicity:(dermal)

"Classification not possible" as no information available.
However, the material contains 2% of Component B (percutaneous toxicity test using rats: LD50>600mg/kg) corresponding to Category 3 and 20% or more of trichloropropylphosphate corresponding to Category 4.

Trichloropropylphosphate shows the following percutaneous toxicity test results:
- Rats : LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 2,000mg/kg [5),6)]
- Rabbits: LD50 = 1,260, 1,230-3,240mg/kg.[6)]

Acute toxicity (gases)

Since the material is a liquid, we judged the material to be "Not applicable".

11. Toxicological Information (continued)

Acute toxicity (vapors)	"Classification not possible" as no information available. However, the material contains 2% of Component B (inhalation toxicity test using rats: LD50>2,204mg/liter) corresponding to Category 3 and 20% or more of trichloropropylphosphate corresponding to Category 3.
Acute toxicity (dust, mist)	"Classification not possible" as no information available.
Skin corrosion, irritation	Base on description on each component, we judged the material to be "Category 2". The material contains Component B (corrosive) corresponding to Category 1A and Component C (mild skin irritation) corresponding to Category 3.
Serious eye damage/eye irritation	Base on description on each component, we judged the material to be "Category 2". The material contains Component B (serious injury) corresponding to Category 1A, Component C (severe eye irritation) corresponding to Category 2, and trichloropropylphosphate corresponding to Category 2B.
Respiratory sensitization	"Classification not possible" as no information available.
Skin sensitization	"Classification not possible" as no information available.
Germ cell mutagenicity	"Classification not possible" as no information available.
Carcinogenicity	"Classification not possible" as no information available.
Reproductive toxicity	"Classification not possible" as no information available.
Specific target organ toxicity (single exposure)	"Classification not possible" as no information available.

11. Toxicological Information (continued)

Specific target organ toxicity (repeated exposure)	Base on description on each component, we judged the material to be "Category 2". The material contains 20% of trichloropropylphosphate corresponding to Category 2. Trichloropropylphosphate shows NAOEL of 10,600ppm at the oral dosages of 4,200, 6,600, 10,600, and 16,600ppm in the 15-day repeated dosage test using rats in accordance with OECD 407[5)]. It also shows NAOEL of 800 to 7,500ppm at the oral dosages of 800, 2,500, 7,500, and 20,000ppm in the 90-day repeated dosage test using rats in accordance with OECD 408[5)]. It also shows NAOEL of 750 mg/kg/day at the oral dosages of 190, 300, 480, and 750mg/kg/day (4,200, 6,600, 10,600 and 16,600ppm) in the 14-day repeated dosage test using rats. The 13-week repeated dosage test using rats was conducted at the oral dosages of 36, 114, 340, and 909mg/kg/day (800,2,500, 7,500, and 20,000ppm), but the test results are not available. The 7-day repeated dosage test using rats was conducted at the dosages of 1, 10, 100, and 1,000mg/kg/day but no adverse effect was observed. It also shows NAOEL of 100 mg/kg/day at the oral dosages of 10, 100, and 1,000mg/kg/day in the 28-day repeated dosage test using rats. It also shows NAOEL of 800ppm (male) and 7,500ppm (female) in the 90-day repeated dosage test using rats (both male and female).
Aspiration hazard	"Classification not possible" as no information available.

12. Ecological Information

Ecotoxicity/Fish toxicity	Component A LC50: 28.7 ppm (“Himedaka” 96 hours)
Aquatic hazard (acute)	Based on description on each component, we judged the material to be “Category 3”. Fish (Brachydanio rerio) LC50 (96hr) = 56.2mg/liter [5)] Fish (Lepomis macrochirus) LC50 (96hr) = 180mg/liter[5)] Fish (Pimephales promelas) LC50 (96hr) = 98mg/liter[5)] Fish according to OECD (Poecilia reticulate) LC50 (96hr) = 30 mg/liter[5)] Fish (Fathead minnow) LC50 (96hr) = 51mg/liter[5)] Fish (Bluegill sunfish) LC50 (96hr) = 180mg/liter[6)] Shellfish according to OECD 202 (Daphnia magna) EC 50 (48 hr) = 65 to 335mg/liter, 63mg/liter[5)] Shellfish according to OECD(Daphnia magna) LC 50 (48hr) = 131mg/liter[5),6)] Algae (Scenedesmus subspicatus) EC 50 (72hr) = 45mg/liter[5)] Algae according to OECD 201(Scenedesmus subspicatus) EC 50 (96hr) = 41 to 55mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 57 to 97mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 73mg/liter[5),6)]
Aquatic hazard (chronic)	Based on description on each component, we judged the material to be “Category 3”.

13. Disposal Considerations

Residual Waste Disposal	- Have a waste disposer authorized by municipal governor undertake disposal of residual wastes. - When the waste disposer undertakes the task, be sure to have the disposer thoroughly understand hazardousness and toxicity of the residual wastes.
Contaminated Container/Package	- Containers shall be cleaned for recycling, or disposed of in appropriate manners in accordance with applicable laws and local municipality‘s regulations. - When disposing of an empty used container, remove the contents completely.

14. Transport Information

International regulation:	For Air transportation, follow requirements of ICAO/IATA, and for sea transportation, follow requirements of IMDG.
UN Classification	Not applicable
UN Number	Not applicable

14. Transport Information (**continued)**

Domestic regulations:

Land transportation	Follow transportation rules provided in Fire Service Act, Industrial Safety and Health Act, Road Trucking Vehicle Act, etc.
Sea transportation	Follow transportation rules provided in Ship Safety Act.
Air transportation	Follow transportation rules provided in Civil Aeronautics Act.
Special safety measures:	Prior to transportation, make sure that there is no leakage from the container and that signs and marking are properly placed. Load up the cargoes properly so that they will not be overturned, dropped, collapsed or damaged during transportation.
Fire Service Act:	As the material belongs to Hazardous material Group 4 the 4th Petroleum of Fire Service Act, follow the requirements of the law when selecting containers and loading the cargoes.
Emergency Measures Guide No.	171

15 Regulatory Information

Controlled substance by Foreign Exchange Law and Foreign Trade Law	: Trichloropropylphosphate is a substance controlled as a Catch All regulated substance.

16 Other Information

Reference List:

1) Urethane Materials Industry Association: Outline of Polyurethane Industries (2005)

2) Urethane Materials Industry Association: Polyurethane Material – Guidance to safe handling (2008)

3) Urethane Materials Industry Association: Control Guidance for transportation of polyol (PPG) (2008)

4) Environmental Health Criteria No.209 (1998)

5) International Uniform Chemical Information Database (2008)

6) Organization for Economic Cooperation and Development Screening Information Data Set

Notes:

The text of this MSDS is prepared based on data, knowledge and information available at the time of preparation or revision. Therefore, the text is subject to change and supplementation whenever new knowledge and experiment results become available. Neither of the figures included in this MSDS such as and physicochemical properties are for guarantee.

Cautions recommended in this MSDS are subject to general handling. If specific and special handling procedures are required, determine appropriate safety standards/requirements for such specific and special handling of the material under the user's own responsibility.

ACHILLES CORPORATION

MATERIAL SAFETY DATA SHEET (MSDS)

MSDS No. May 31, 2012

1.	**Chemical Name and Company Information**	Product Name	:	Achilles Airlon-R, Component R (TS-350NF)
		Company Name	:	Achilles Corporation
		Address	:	22 Daikyo-cho, Shinjuku-ku, Tokyo, Japan
		Dept. in charge	:	Insulation Materials Sales
		Telephone Number	:	+81-3-5379-4574
		Facsimile Number	:	+81-3-5379-4909
		Emergency Telephone	:	+81-284-73-9326

2. Hazard Identification

GHS Classification:

Physical Hazard:

- Explosives	Not applicable
- Flammable gases	Not applicable
- Flammable aerosols	Not applicable
- Oxidized gases	Not applicable
- Gases under pressure	Not applicable
- Flammable liquids	Classification not possible
- Flammable solids	Not applicable
- Self-reactive substance and mixture	Not applicable
- Pyrophoric liquids	Not classified
- Pyrophoric solids	Not applicable
- Self-heating substances and mixture	Classification not possible
- Substance and mixtures which, in contact with water, emit flammable gases	Not applicable
- Oxidizing liquids	Not applicable
- Oxidizing solids	Not applicable
- Organic peroxides	Not applicable
- Corrosion to metals	Classification not possible

Health Hazards:

- Acute toxicity (oral)	Classification not possible
- Acute toxicity (dermal)	Classification not possible
- Acute toxicity (gases)	Not applicable
- Acute toxicity (vapors)	Classification not possible
- Acute toxicity (dust, mist)	Classification not possible
- Skin corrosion/irritation	Category 2
- Serious eye damage/eye irritation	Category 2
- Respiratory sensitization	Classification not possible
- Skin sensitization	Classification not possible
- Germ cell mutagenicity	Classification not possible
- Carcinogenicity	Classification not possible
- Reproductive toxicity	Classification not possible
- Specific target organ toxicity (single exposure)	Classification not possible
- Specific target organ toxicity (repeated exposure)	Category 2
- Aspiration hazard	Classification not possible

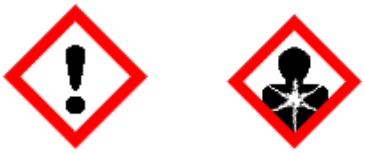
2. Hazard Identification (continued)

Environmental Hazards:

- Aquatic hazards (acute) Category 3
- Aquatic hazards (chronic) Category 3

Label elements:

Symbol:



Signal word: WARNING

Hazard Statement:

- Causes skin irritation
- Causes serious eye irritation
- May cause damage to organs through prolonged or repeated exposure
- Harmful to aquatic life
- Harmful to aquatic life with long lasting effects

Cautionary statements:

[Safety measures]

- Carefully read the MSDS before handling the material.
- Do not drink/eat foods or smoke while using this material.
- Do not take in, inhale, or let eyes and skin touch the material. Wear appropriate protective equipment such as protective glasses, gloves and masks while handling the material.
- Carefully wash hands after handling.
- Avoid inhalation of vapor.
- Do not take out contaminated working clothes from the work site.
- Avoid exposure of the material to environment.
- Do not use the material near a fire source.

[First aid]

- Inhalation: Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Ingestion: Immediately wash inside the mouth with water. Do not forcibly vomit.
- Eye contact: Thoroughly wash the eyes with clean water. When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When eye irritation persists, consult a doctor.
- Skin contact: Thoroughly wash with soap and a large volume of water. Immediately take off the contaminated clothing.
- When irritation to skin persists, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.
- In case of exposure or possible exposure to the material, seek medical assistance.
- When feeling physically sick, consult a doctor.
- In case of fire, initially extinguish it with either dry powder, CO2 or foam extinguisher. When the fire spreads, extinguish it with a large amount of spray water.
- In case of leakage, first collect the spill into a container as much as possible. Prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal.

[Storage]

- Store the material in airtight containers and keep the containers in a well-ventilated and locked storage at around 20 deg. C.
- When stored outdoors, cover the containers with waterproof sheets to prevent infiltration of rainwater.
- Keep fire away from the storage area.

[Disposal]

- Have a waste disposer authorized by municipal governor undertake disposal of recovered material and its container.

3.	**Composition / Information on Ingredients**	Pure or Mixture	Mixture
		Components and contained amount	Polyol 60 to 70 % Trichloropropylphosphate 15 to 25% Amine catalyst 5% or smaller 1-(2-methoxy-2-methylethoxy)-2-propanol,dipropyleneglycolmonomethylether 5 to 10 % Others 10% or smaller
		AECS*) No.	Existing or nondisclosure
		Hazardous Ingredients and impurity	Amine catalyst, Trichloropropylphosphate 1-(2-methoxy-2-methylethoxy)-2-propanol,dipropyleneglycolmonomethylether

Notes: AECS*): Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
ISHA**): Industrial Safety and Health Act

4. First Aid Measure

Inhalation:
- Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Immediately consult a doctor.
- When breathing is stopped, loosen clothes and establish an airway, then give artificial respiration.
- When coughing or producing sputum persists, immediately consult a doctor.

Skin contact:
- Thoroughly wash with soap and a large volume of water.
- Take off all the contaminated clothes.
- When the skin irritates, rash develops or feeling sick, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.

Eye contact:
- Even if the amount in contact with eyes is small, thoroughly wash the eyes with clean water for at least 15 minutes, and consult a doctor.
- When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When eye irritation persists, consult a doctor.

Ingestion:
- Immediately wash inside the mouth with water, and take in water or milk of 250ml to dilute the ingested matter. Do not forcibly vomit the diluted matter.
- When becoming unconscious, do not take in anything through the mouth.
- Immediately consult a doctor for treatment including washing stomach.

5. Fire-Fighting Measure

Suitable extinguishing media : Powdered dry chemical, CO_2, foam, spray water

Specific fire extinguishing method:
- Use CO_2 or powdered dry chemical for initial fire fighting.
- When the fire spreads, extinguish it with a large amount of spray water.
- Wet the drums with spray water to prevent the drums from catching fire and blowing up.

Special protective equipment and precautions for fire-fighters s:
- When fighting a fire, wear a self-contained breathing apparatus and other protection equipment, as hazardous vapor can generate.
- Wear appropriate protective equipment such as protective glasses, gloves and masks.
- Fight a fire from windward side as much as practicable to avoid intake of toxic gas.

6. Accidental Release Measures

Personal precautions , protective equipment and emergency procedures:	Other than people wearing appropriate protection equipment, evacuate all people from the leakage. Secure ventilation of the place where leakage occurred.
Environmental precautions:	Do not release the spillage directly to rivers or sewage system.
Methods and materials for containment and cleaning up:	- When a large amount is spilled, prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal. - Dispose of the container used for collection of spillage in accordance with cautions in Sec. 13.Disposal Procedures.

7. Handling and Storage

Precautions for safe handling:

Technical measures	- Take countermeasures in Sect. 8. “Exposure Prevention and Protection! and wear protective equipment. - Install local exhaust equipment where the material is handled indoors.
Local/Total exhaust	- Install local/total exhaust equipment in accordance with Sect. 8. “Exposure Prevention and Protection.”
General cautions:	- Carefully read the MSDS before handling the material. - Do not touch, inhale or intake the material. - Carefully wash hands after handling. - Handle the material only outdoors or indoors provided with appropriate ventilation. - Do not take out contaminated working clothes from the work site. - Do not drink/eat foods or smoke while using the material.
Safe handling precautions:	- Always have sufficient number of protecting equipment and sufficient quantities of neutralization agent ready for emergency. - Handle the container with care to avoid over-turning or dropping.
Substances that should not be in contact with the material:	Refer to Sect. 10.”Stability and Reactivity.”

Conditions for safe storage , including any incompatibilities:

Technical handling:	- Indoor storage shall be of fireproofing construction and well ventilated. - Flooring material shall be non-absorbing type. - Appropriate light letting-in and lighting equipment shall be installed.

7 Handling and Storage (continued)

Conditions for safe storage , including any incompatibilities:

Appropriate storage site:	- Store the material in airtight containers and keep the containers in a well-ventilated and cooled place. - Store the containers in a lockable storage. - Displace vapor in the gaseous phase with nitrogen gas or dry air (due point to be -30 deg. C or lower) before storage. - Post caution signs such as “Flammable – Keep Fire Away” and “Unauthorized Personnel. Off limits.” .
Hazardous material when mixed	Refer to Sect. 10. “Stability and Reactivity.”
Packaging material	Use containers specified by the Fire Service Act and UN Transportation regulations.

8 Exposure Controls/Personal Protection:

Appropriate engineering controls	- Facilities where the material is handled shall be of tightly sealed construction. Local exhaust equipment or other suitable means for ventilation shall be installed near the place where vapor or mist of the material is generated. - When handling the material, wear appropriate protection equipment. Install eye washing and body washing equipment near the place where the material is handled. - Flooring material shall be non-absorbing type.
Individual protection measures,such as personal protective equipment:	
For respiratory organ	Air-breathing apparatus JIS T 8155, Air-supplied respirator JIS T 8153
For Hands	Rubber or plastic protective gloves (impermeable)
For eyes	Protective glasses with side protective cover plates
For skin and body	Long sleeve working clothes and safety shoes
Hygiene measures:	- Carefully wash hands after handling. - Do not take out contaminated working clothes form the work site.

9. Physical/Chemical Properties

Appearance	Light brown liquid
Odor	Amine –like odor
pH	8 to 9
Boiling point	No data available
Flash point	Cannot be measured
Explosion limits	No data available
Vapor pressure	No data available
Vapor density (air = 1)	No data available
relative density	Approx. 1.08 (@25deg.C)
Solubility	Soluble in a number of organic solvents such as alcohol, methylene chloride, esters, ketone, and aromatic solvents.
Octanol/water partition coefficient	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity	250 to 500mPa-s (@25deg.C)

10. Stability and Reactivity

Chemical stability:
- Chemically stable against light, heat and impact under normal handling conditions.

Reactivity:
- Reacts with strong oxidants. Danger.

11. Toxicological Information

Data on the material not available

Acute toxicity(oral):

"Classification not possible" as no information available.
However, the material contains 2% of Component B (oral toxicity test using rats: LD50>600mg/kg) corresponding to Category 4, 1.3% 0f Component C (oral toxicity test using rats: LD50 = 14,800mg/kg (0.9%) and LD50 = 1700mg/kg (0.4%)) corresponding to Category 5, and 15% or more of trichloropropylphosphate corresponding to Category 4.
Trichloropropylphosphate, tested as per OECD oral toxicity test using rats (female), show LD50 = 1,078 mg/kg.

Acute toxicity:(dermal)

"Classification not possible" as no information available.
However, the material contains 2% of Component B (percutaneous toxicity test using rats: LD50>400mg/kg) corresponding to Category 3 and 15% or more of trichloropropylphosphate corresponding to Category 4.

Trichloropropylphosphate shows the following percutaneous toxicity test results:
- Rats : LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 2,000mg/kg [5),6)]
- Rabbits: LD50 = 1,260, 1,230-3,240mg/kg.[6)]

Acute toxicity (gases)

Since the material is a liquid, we judged the material to be "Not applicable".

11. Toxicological Information (continued)

Acute toxicity (vapors)	"Classification not possible" as no information available. However, the material contains 2% of Component B (inhalation toxicity test using rats: LD50>2,204mg/liter) corresponding to Category 3 and 15% or more of trichloropropylphosphate corresponding to Category 3.
Acute toxicity (dust, mist)	"Classification not possible" as no information available.
Skin corrosion, irritation	Base on description on each component, we judged the material to be "Category 2". The material contains Component B (corrosive) corresponding to Category 1A and Component C (mild skin irritation) corresponding to Category 3.
Serious eye damage/eye irritation	Base on description on each component, we judged the material to be "Category 2". The material contains Component B (serious injury) corresponding to Category 1A, Component C (severe eye irritation) corresponding to Category 2, and trichloropropylphosphate corresponding to Category 2B.
Respiratory sensitization	"Classification not possible" as no information available.
Skin sensitization	"Classification not possible" as no information available.
Germ cell mutagenicity	"Classification not possible" as no information available.
Carcinogenicity	"Classification not possible" as no information available.
Reproductive toxicity	"Classification not possible" as no information available.
Specific target organ toxicity (single exposure)	"Classification not possible" as no information available. However, the material contains 10% or less of Component D (respiratory irritation) corresponding to Category 3

11. Toxicological Information (continued)

Specific target organ toxicity (repeated exposure)	Base on description on each component, we judged the material to be "Category 2". The material contains 15% of trichloropropylphosphate corresponding to Category 2. Trichloropropylphosphate shows NAOEL of 10,600ppm at the oral dosages of 4,200, 6,600, 10,600, and 16,600ppm in the 15-day repeated dosage test using rats in accordance with OECD 407[5)]. It also shows NAOEL of 800 to 7,500ppm at the oral dosages of 800, 2,500, 7,500, and 20,000ppm in the 90-day repeated dosage test using rats in accordance with OECD 408[5)]. It also shows NAOEL of 750 mg/kg/day at the oral dosages of 190, 300, 480, and 750mg/kg/day (4,200, 6,600, 10,600 and 16,600ppm) in the 14-day repeated dosage test using rats. The 13-week repeated dosage test using rats was conducted at the oral dosages of 36, 114, 340, and 909mg/kg/day (800,2,500, 7,500, and 20,000ppm), but the test results are not available. The 7-day repeated dosage test using rats was conducted at the dosages of 1, 10, 100, and 1,000mg/kg/day but no adverse effect was observed. It also shows NAOEL of 100 mg/kg/day at the oral dosages of 10, 100, and 1,000mg/kg/day in the 28-day repeated dosage test using rats. It also shows NAOEL of 800ppm (male) and 7,500ppm (female) in the 90-day repeated dosage test using rats (both male and female).
Aspiration hazard	"Classification not possible" as no information available.

12. Ecological Information

Ecotoxicity/Fish toxicity	Component A LC50: 28.7 ppm (“Himedaka” 96 hours) Component D LC50:10,000mg/L or more(“Fathead minnow”96hours)
Aquatic hazard (acute)	Based on description on each component, we judged the material to be “Category 3”. Fish (Brachydanio rerio) LC50 (96hr) = 56.2mg/liter [5)] Fish (Lepomis macrochirus) LC50 (96hr) = 180mg/liter[5)] Fish (Pimephales promelas) LC50 (96hr) = 98mg/liter[5)] Fish according to OECD (Poecilia reticulate) LC50 (96hr) = 30 mg/liter[5)] Fish (Fathead minnow) LC50 (96hr) = 51mg/liter[5)] Fish (Bluegill sunfish) LC50 (96hr) = 180mg/liter[6)] Shellfish according to OECD 202 (Daphnia magna) EC 50 (48 hr) = 65 to 335mg/liter, 63mg/liter[5)] Shellfish according to OECD(Daphnia magna) LC 50 (48hr) = 131mg/liter[5),6)] Algae (Scenedesmus subspicatus) EC 50 (72hr) = 45mg/liter[5)] Algae according to OECD 201(Scenedesmus subspicatus) EC 50 (96hr) = 41 to 55mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 57 to 97mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 73mg/liter[5),6)]
Aquatic hazard (chronic)	Based on description on each component, we judged the material to be “Category 3”. Component D: Large water flea NOAEL/22d:0.5mg/liter or more (reproductive test)

13. Disposal Considerations

Residual Waste Disposal	- Have a waste disposer authorized by municipal governor undertake disposal of residual wastes. - When the waste disposer undertakes the task, be sure to have the disposer thoroughly understand hazardousness and toxicity of the residual wastes.
Contaminated Container/Package	- Containers shall be cleaned for recycling, or disposed of in appropriate manners in accordance with applicable laws and local municipality‘s regulations. - When disposing of an empty used container, remove the contents completely.

14. Transport Information

International regulation:	For Air transportation, follow requirements of ICAO/IATA, and for sea transportation, follow requirements of IMDG.
UN Classification	Not applicable
UN Number	Not applicable

14. Transport Information (**continued)**

Domestic regulations:

Land transportation	Follow transportation rules provided in Fire Service Act, Industrial Safety and Health Act, Road Trucking Vehicle Act, etc.
Sea transportation	Follow transportation rules provided in Ship Safety Act.
Air transportation	Follow transportation rules provided in Civil Aeronautics Act.
Special safety measures:	Prior to transportation, make sure that there is no leakage from the container and that signs and marking are properly placed. Load up the cargoes properly so that they will not be overturned, dropped, collapsed or damaged during transportation.
Fire Service Act:	As the material belongs to Hazardous material Group 4 the 4th Petroleum of Fire Service Act, follow the requirements of the law when selecting containers and loading the cargoes.
Emergency Measures Guide No.	171

15 Regulatory Information

Controlled substance by Foreign Exchange Law and Foreign Trade Law	: Trichloropropylphosphate is a substance controlled as a Catch All regulated substance.

16 Other Information

Reference List:

1) Urethane Materials Industry Association: Outline of Polyurethane Industries (2005)

2) Urethane Materials Industry Association: Polyurethane Material – Guidance to safe handling (2008)

3) Urethane Materials Industry Association: Control Guidance for transportation of polyol (PPG) (2008)

4) Environmental Health Criteria No.209 (1998)

5) International Uniform Chemical Information Database (2008)

6) Organization for Economic Cooperation and Development Screening Information Data Set

Notes:

The text of this MSDS is prepared based on data, knowledge and information available at the time of preparation or revision. Therefore, the text is subject to change and supplementation whenever new knowledge and experiment results become available. Neither of the figures included in this MSDS such as and physicochemical properties are for guarantee.

Cautions recommended in this MSDS are subject to general handling. If specific and special handling procedures are required, determine appropriate safety standards/requirements for such specific and special handling of the material under the user's own responsibility.

ACHILLES CORPORATION

MATERIAL SAFETY DATA SHEET (MSDS)

MSDS No. May 16, 2012

1.	**Chemical Name and Company Information**	Product Name	:	Achilles Airlon-FR-NF, Component R (TZ-305NFA)
		Company Name	:	Achilles Corporation
		Address	:	22 Daikyo-cho, Shinjuku-ku, Tokyo, Japan
		Dept. in charge	:	Insulation Materials Sales
		Telephone Number	:	+81-3-5379-4574
		Facsimile Number	:	+81-3-5379-4909
		Emergency Telephone	:	+81-284-73-9326

2. Hazard Identification

GHS Classification:

Physical Hazard:

- Explosives	Not applicable
- Flammable gases	Not applicable
- Flammable aerosols	Not applicable
- Oxidized gases	Not applicable
- Gases under pressure	Not applicable
- Flammable liquids	Not classified
- Flammable solids	Not applicable
- Self-reactive substance and mixture	Not applicable
- Pyrophoric liquids	Not classified
- Pyrophoric solids	Not applicable
- Self-heating substances and mixtures	Classification not possible
- Substance and mixtures which, in contact with water, emit flammable gases	Not applicable
- Oxidizing liquids	Not applicable
- Oxidizing solids	Not applicable
- Organic peroxides	Not applicable
- Corrosion to metals	Classification not possible

Health Hazards:

- Acute toxicity (oral)	Classification not possible
- Acute toxicity (dermal)	Classification not possible
- Acute toxicity (gases)	Not applicable
- Acute toxicity (vapors)	Classification not possible
- Acute toxicity (dust, mist)	Classification not possible
- Skin corrosion/irritation	Category 2
- Serious eye damage/eye irritation	Category 1
- Respiratory sensitization	Classification not possible
- Skin sensitization	Classification not possible
- Germ cell mutagenicity	Classification not possible
- Carcinogenicity	Classification not possible
- Reproductive toxicity	Category 1
- Specific target organ toxicity (single exposure)	Not classified
- Specific target organ toxicity (repeated exposure)	Category 2
- Aspiration hazard	Classification not possible

2. Hazard Identification (continued)

Environmental Hazards:

- Aquatic hazards (acute) — Classification not possible
- Aquatic hazards (chronic) — Classification not possible

Label elements:

Symbol:

Signal word : DANGER

Hazard Statement:

- Causes skin irritation
- Causes serious eye damage
- May damage fertility or the unborn child
- May cause damage to organs through prolonged or repeated exposure

Cautionary statements:

[Safety measures]

- Carefully read the MSDS before handling the material.
- Do not drink/eat foods or smoke while using this material.
- Do not take in, inhale, or let eyes and skin touch the material. Wear appropriate protective equipment such as protective glasses, gloves and masks while handling the material.
- Carefully wash hands after handling.
- Avoid inhalation of vapor.
- Do not take out contaminated working clothes from the work site.
- Avoid exposure of the material to environment.
- Do not use the material near a fire source.

[First aid]

- Inhalation: Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Ingestion: Immediately wash inside the mouth with water. Do not forcibly vomit.
- Eye contact: Thoroughly wash the eyes with clean water. When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- Skin contact: Thoroughly wash with soap and a large volume of water. Immediately take off the contaminated clothing.
- Thoroughly wash contaminated working clothes before using them again.
- In case of exposure or possible exposure to the material, seek medical assistance.
- When feeling physically sick, consult a doctor.
- In case of fire, initially extinguish it with either dry powder, CO_2 or foam extinguisher. When the fire spreads, extinguish it with a large amount of spray water.
- In case of leakage, first collect the spill into a container as much as possible. Prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal.

[Storage]

- Store the material in airtight containers and keep the containers in a well-ventilated and locked storage at around 20 deg. C.
- When stored outdoors, cover the containers with waterproof sheets to prevent infiltration of rainwater.
- Keep fire away from the storage area.

[Disposal]

- Have a waste disposer authorized by municipal governor undertake disposal of recovered material and its container.

-

3.	**Composition / Information on ingredients**	Pure or Mixture	Mixture
		Components and contained amount	Polyol 55 to 65 % Trichloropropylphosphate 20 to 30% Amine catalyst 10% or smaller Others 10% or smaller
		AECS*) No.	Existing or nondisclosure
		ISHA**) No.	Existing
		Hazardous Ingredients and impurity	Amine catalyst, Trichloropropylphosphate

Notes: AECS*): Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
ISHA**): Industrial Safety and Health Act

4. First Aid Measures

Inhalation:
- Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Immediately consult a doctor.
- When breathing is stopped, loosen clothes and establish an airway, then give artificial respiration.
- When coughing or producing sputum persists, immediately consult a doctor.

Skin contact:
- Thoroughly wash with soap and a large volume of water.
- Take off all the contaminated clothes.
- When the skin irritates, rash develops or feeling sick, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.

Eye contact:
- Even if the amount in contact with eyes is small, thoroughly wash the eyes with clean water for at least 15 minutes, and consult a doctor.
- When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When eye irritation persists, consult a doctor.

Ingestion:
- Immediately wash inside the mouth with water, and take in water or milk of 250ml to dilute the ingested matter. Do not forcibly vomit the diluted matter.
- When becoming unconscious, do not take in anything through the mouth.
- Immediately consult a doctor for treatment including washing stomach.

5. Fire Fighting Measures
- Suitable extinguishing media: Powdered dry chemical, CO_2, foam, spray water
- Unsuitable extinguishing media: Water jet

Specific fire extinguishing method:
- Use CO_2 or powdered dry chemical for initial fire fighting.
- When the fire spreads, extinguish it with a large amount of spray water.
- Wet the drums with spray water to prevent the drums from catching fire and blowing up.

Special protective equipment and precautions for fire-fighters :
- When fighting a fire, wear a self-contained breathing apparatus and other protection equipment, as hazardous vapor can generate.
- Wear appropriate protective equipment such as protective glasses, gloves and masks.
- Fight a fire from windward side as much as practicable to avoid intake of toxic gas.

6. Accidental release measures

Personal precautions , protective equipment and emergency procedures:	Other than people wearing appropriate protection equipment, evacuate all people from the leakage. Secure ventilation of the place where leakage occurred.
Environmental precautions:	Do not release the spillage directly to rivers or sewage system.
Methods and materials for containment and cleaning up:	- When a large amount is spilled, prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal. - Dispose of the container used for collection of spillage in accordance with cautions in Sec. 13.Disposal Procedures.

7. Handling and Storage

Precautions for safe handling:

Technical measures	- Take countermeasures in Sect. 8. “Exposure Prevention and Protection! and wear protective equipment. - Install local exhaust equipment where the material is handled indoors.
Local/Total exhaust	- Install local/total exhaust equipment in accordance with Sect. 8. “Exposure Prevention and Protection.”
General cautions:	- Carefully read the MSDS before handling the material. - Do not touch, inhale or intake the material. - Carefully wash hands after handling. - Handle the material only outdoors or indoors provided with appropriate ventilation. - Do not take out contaminated working clothes from the work site. - Do not drink/eat foods or smoke while using the material.
Safe handling precautions:	- Always have sufficient number of protecting equipment and sufficient quantities of neutralization agent ready for emergency. - Handle the container with care to avoid over-turning or dropping.
Substances that should not be in contact with the material:	Refer to Sect. 10.”Stability and Reactivity.”

Conditions for safe storage , including any incompatibilities:

Technical handling:	- Indoor storage shall be of fireproofing construction and well ventilated. - Flooring material shall be non-absorbing type. - Appropriate light letting-in and lighting equipment shall be installed.

7.	**Handling and Storage**	**(continued)**
	Conditions for safe storage , including any incompatibilities:	
	Appropriate storage site:	- Store the material in airtight containers and keep the containers in a well-ventilated and cooled place. - Store the containers in a lockable storage. - Displace vapor in the gaseous phase with nitrogen gas or dry air (due point to be -30 deg. C or lower) before storage. - Post caution signs such as “Flammable – Keep Fire Away” and “Unauthorized Personnel. Off limits.” .
	Hazardous material when mixed	Refer to Sect. 10. “Stability and Reactivity.”
	Packaging material	Use containers specified by the Fire Service Act and UN Transportation regulations.
8.	**Exposure Controls/Personal Protection:**	
	Appropriate engineering controls	- Facilities where the material is handled shall be of tightly sealed construction. Local exhaust equipment or other suitable means for ventilation shall be installed near the place where vapor or mist of the material is generated. - When handling the material, wear appropriate protection equipment. Install eye washing and body washing equipment near the place where the material is handled. - Flooring material shall be non-absorbing type.
	Individual protection measures,such as personal protective equipment:	
	- For respiratory organ	Air-breathing apparatus JIS T 8155, Air-supplied respirator JIS T 8153
	- For Hands	Rubber or plastic protective gloves (impermeable)
	- For eyes	Protective glasses with side protective cover plates
	- For skin and body	Long sleeve working clothes and safety shoes
	Hygiene measures:	- Carefully wash hands after handling. - Do not take out contaminated working clothes form the work site.

9. Physical/Chemical Properties

Appearance	Dark red liquid
Odor	Amine –like odor
pH	8 to 9
Boiling point	Approx. 160deg.C
Flash point	Cannot be measured
Explosion limits	No data available
Vapor pressure	No data available
Vapor density (air = 1)	No data available
Relative density	Approx. 1.15 (@25deg.C)
Solubility	Soluble in a number of organic solvents such as alcohol, methylene chloride, esters, ketone, and aromatic solvents.
Octanol/water partition coefficient	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity	500 to 1200 m･Pa-s (@25deg.C)

10. Stability and Reactivity

Chemical Stability: - Chemically stable against light, heat and impact under normal handling conditions.

Reactivity: - Reacts with strong oxidants. Danger.

11. Toxicological Information

Data on the material not available

Acute toxicity (oral):

"Classification not possible" as no information available.
However, the material contains less than 30% of trichloropropylphosphate corresponding to Category 4.
Trichloropropylphosphate, tested as per OECD oral toxicity test using rats (female), show LD50 = 1,078 mg/kg.

Acute toxicity:(dermal)

"Classification not possible" as no information available.
However, the material contains 3% of Component B corresponding to Category 3 and less than 30% of trichloropropylphosphate corresponding to Category 4.

Trichloropropylphosphate shows the following percutaneous toxicity test results:

- Rats : LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 2,000mg/kg [5),6)]
- Rabbits: LD50 = 1,260, 1,230-3,240mg/kg.[6)]

Acute toxicity (gases)

Since the material is a liquid, we judged the material to be "Not applicable"

Acute toxicity (vapors)

"Classification not possible" as no information available.
However, the material contains less than 30% of trichloropropylphosphate corresponding to Category 3.

Acute toxicity (dust, mist)

"Classification not possible" as no information available.

11. Toxicological Information **(continued)**

Skin corrosion, irritation	Base on description on each component, we judged the material to be "Category 2". The material contains Component B (severe skin burns) corresponding to Category 1A and Component C,D,E,F (mild skin irritation) corresponding to Category 3.
Serious eye damage/eye irritation	Base on description on each component, we judged the material to be "Category 1". The material contains Component B (serious eye damage) corresponding to Category 1, Component D,E,F(severe eye irritation) corresponding to Category 2, Component C corresponding to Category 2B and Component G corresponding to Category 2A.
Respiratory sensitization	"Classification not possible" as no information available.
Skin sensitization	"Classification not possible" as no information available.
Germ cell mutagenicity	"Classification not possible" as no information available.
Carcinogenicity	"Classification not possible" as no information available.
Reproductive toxicity	Base on description on each component, we judged the material to be "Category 1".
Specific target organ toxicity (single exposure)	Base on description on each component, we judged the material to be "Not Classified".
Specific target organ toxicity (repeated exposure)	Base on description on each component, we judged the material to be "Category 2". The material contains 10% or more of trichloropropylphosphate corresponding to Category 2.
Aspiration hazard	"Classification not possible" as no information available.

12. Ecological Information

Ecotoxicity/Fish toxicity	Component G LC50: 28.7 ppm (“Himedaka” 96 hours)
Aquatic hazard (acute)	“Classification not possible” as no information available. However, the material contains Component G corresponding to Category 3. Trichloropropylphosphate shows the following aquatic environment toxicity test results: Fish (Brachydanio rerio) LC50 (96hr) = 56.2mg/liter [5)] Fish (Lepomis macrochirus) LC50 (96hr) = 180mg/liter[5)] Fish (Pimephales promelas) LC50 (96hr) = 98mg/liter[5)] Fish according to OECD (Poecilia reticulate) LC50 (96hr) = 30 mg/liter[5)] Fish (Fathead minnow) LC50 (96hr) = 51mg/liter[5)] Fish (Bluegill sunfish) LC50 (96hr) = 180mg/liter[6)] Shellfish according to OECD 202 (Daphnia magna) EC 50 (48 hr) = 65 to 335mg/liter, 63mg/liter[5)] Shellfish according to OECD(Daphnia magna) LC 50 (48hr) = 131mg/liter[5),6)] Algae (Scenedesmus subspicatus) EC 50 (72hr) = 45mg/liter[5)] Algae according to OECD 201(Scenedesmus subspicatus) EC 50 (96hr) = 41 to 55mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 57 to 97mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 73mg/liter[5),6)]
Aquatic hazard (chronic)	“Classification not possible” as no information available.

13. Disposal Considerations

Residual Waste Disposal	- Have a waste disposer authorized by municipal governor undertake disposal of residual wastes. - When the waste disposer undertakes the task, be sure to have the disposer thoroughly understand hazardousness and toxicity of the residual wastes.
Contaminated Container/Package	- Containers shall be cleaned for recycling, or disposed of in appropriate manners in accordance with applicable laws and local municipality‘s regulations. - When disposing of an empty used container, remove the contents completely.

14. Transportation Information

International regulation:	For Air transportation, follow requirements of ICAO/IATA, and for sea transportation, follow requirements of IMDG.
UN Classification	Not applicable
UN Number	Not applicable
Domestic regulations:	
Land transportation	Follow transportation rules provided in Fire Service Act, Industrial Safety and Health Act, Road Trucking Vehicle Act, etc.
Sea transportation	Follow transportation rules provided in Ship Safety Act.
Air transportation	Follow transportation rules provided in Civil Aeronautics Act.
Special safety measures:	Prior to transportation, make sure that there is no leakage from the container and that signs and marking are properly placed. Load up the cargoes properly so that they will not be overturned, dropped, collapsed or damaged during transportation.
Fire Service Act:	As the material belongs to Hazardous material Group 4 the 4th Petroleum of Fire Service Act, follow the requirements of the law when selecting containers and loading the cargoes.
Emergency Measures Guide No.	171

15. Regulatory Information

Controlled substance by Foreign Exchange Law and Foreign Trade Law	: Trichloropropylphosphate is a substance controlled as a Catch All regulated substance.
Fire Service Act	Group 4 the 3th Petroleum

16. Other Information

Reference List:

1) Urethane Materials Industry Association: Outline of Polyurethane Industries (2005)

2) Urethane Materials Industry Association: Polyurethane Material – Guidance to safe handling (2008)

3) Urethane Materials Industry Association: Control Guidance for transportation of polyol (PPG) (2008)

4) Environmental Health Criteria No.209 (1998)

5) International Uniform Chemical Information Database (2008)

6) Organization for Economic Cooperation and Development Screening Information Data Set

Notes:

The text of this MSDS is prepared based on data, knowledge and information available at the time of preparation or revision. Therefore, the text is subject to change and supplementation whenever new knowledge and experiment results become available. Neither of the figures included in this MSDS such as and physicochemical properties are for guarantee.

Cautions recommended in this MSDS are subject to general handling. If specific and special handling procedures are required, determine appropriate safety standards/requirements for such specific and special handling of the material under the user's own responsibility.

ACHILLES CORPORATION

MATERIAL SAFETY DATA SHEET (MSDS)

MSDS No. July 2, 2012

1.	**Chemical Name and Company Information**	Product Name	:	Achilles Airlon-FR-NF, Component R (TZ-305NFS)
		Company Name	:	Achilles Corporation
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2. Hazard Identification

GHS Classification:

Physical Hazard:

- Explosives	Not applicable
- Flammable gases	Not applicable
- Flammable aerosols	Not applicable
- Oxidized gases	Not applicable
- Gases under pressure	Not applicable
- Flammable liquids	Not classified
- Flammable solids	Not applicable
- Self-reactive substance and mixture	Not applicable
- Pyrophoric liquids	Not classified
- Pyrophoric solids	Not applicable
- Self-heating substances and mixtures	Classification not possible
- Substance and mixtures which, in contact with water, emit flammable gases	Not applicable
- Oxidizing liquids	Not applicable
- Oxidizing solids	Not applicable
- Organic peroxides	Not applicable
- Corrosion to metals	Classification not possible

Health Hazards:

- Acute toxicity (oral)	Classification not possible
- Acute toxicity (dermal)	Classification not possible
- Acute toxicity (gases)	Not applicable
- Acute toxicity (vapors)	Classification not possible
- Acute toxicity (dust, mist)	Classification not possible
- Skin corrosion/irritation	Category 2
- Serious eye damage/eye irritation	Category 1
- Respiratory sensitization	Classification not possible
- Skin sensitization	Classification not possible
- Germ cell mutagenicity	Classification not possible
- Carcinogenicity	Classification not possible
- Reproductive toxicity	Category 1
- Specific target organ toxicity (single exposure)	Not classified
- Specific target organ toxicity (repeated exposure)	Category 2
- Aspiration hazard	Classification not possible

2. Hazard Identification (continued)

Environmental Hazards:

- Aquatic hazards (acute) — Classification not possible
- Aquatic hazards (chronic) — Classification not possible

Label elements:

Symbol:

Signal word : DANGER

Hazard Statement:

- Causes skin irritation
- Causes serious eye damage
- May damage fertility or the unborn child
- May cause damage to organs through prolonged or repeated exposure

Cautionary statements:

[Safety measures]

- Carefully read the MSDS before handling the material.
- Do not drink/eat foods or smoke while using this material.
- Do not take in, inhale, or let eyes and skin touch the material. Wear appropriate protective equipment such as protective glasses, gloves and masks while handling the material.
- Carefully wash hands after handling.
- Avoid inhalation of vapor.
- Do not take out contaminated working clothes from the work site.
- Avoid exposure of the material to environment.
- Do not use the material near a fire source.

[First aid]

- Inhalation: Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Ingestion: Immediately wash inside the mouth with water. Do not forcibly vomit.
- Eye contact: Thoroughly wash the eyes with clean water. When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- Skin contact: Thoroughly wash with soap and a large volume of water. Immediately take off the contaminated clothing.
- Thoroughly wash contaminated working clothes before using them again.
- In case of exposure or possible exposure to the material, seek medical assistance.
- When feeling physically sick, consult a doctor.
- In case of fire, initially extinguish it with either dry powder, CO_2 or foam extinguisher. When the fire spreads, extinguish it with a large amount of spray water.
- In case of leakage, first collect the spill into a container as much as possible. Prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal.

[Storage]

- Store the material in airtight containers and keep the containers in a well-ventilated and locked storage at around 20 deg. C.
- When stored outdoors, cover the containers with waterproof sheets to prevent infiltration of rainwater.
- Keep fire away from the storage area.

[Disposal]

- Have a waste disposer authorized by municipal governor undertake disposal of recovered material and its container.

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3.	**Composition / Information on ingredients**	Pure or Mixture	Mixture
		Components and contained amount	Polyol 55 to 65 % Trichloropropylphosphate 20 to 30% Amine catalyst 10% or smaller Others 10% or smaller
		AECS*) No.	Existing or nondisclosure
		ISHA**) No.	Existing
		Hazardous Ingredients and impurity	Amine catalyst, Trichloropropylphosphate

Notes: AECS*): Act on the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
ISHA**): Industrial Safety and Health Act

4. First Aid Measures

Inhalation:
- Move to a place filled with fresh air and stay there at rest in a posture easy to breath.
- Immediately consult a doctor.
- When breathing is stopped, loosen clothes and establish an airway, then give artificial respiration.
- When coughing or producing sputum persists, immediately consult a doctor.

Skin contact:
- Thoroughly wash with soap and a large volume of water.
- Take off all the contaminated clothes.
- When the skin irritates, rash develops or feeling sick, consult a doctor.
- Thoroughly wash contaminated working clothes before using them again.

Eye contact:
- Even if the amount in contact with eyes is small, thoroughly wash the eyes with clean water for at least 15 minutes, and consult a doctor.
- When contact lenses are worn, remove them if not difficult to do so, and continue washing the eyes with water.
- When eye irritation persists, consult a doctor.

Ingestion:
- Immediately wash inside the mouth with water, and take in water or milk of 250ml to dilute the ingested matter. Do not forcibly vomit the diluted matter.
- When becoming unconscious, do not take in anything through the mouth.
- Immediately consult a doctor for treatment including washing stomach.

5. Fire Fighting Measures
- Suitable extinguishing media: Powdered dry chemical, CO_2, foam, spray water
- Unsuitable extinguishing media: Water jet

Specific fire extinguishing method:
- Use CO_2 or powdered dry chemical for initial fire fighting.
- When the fire spreads, extinguish it with a large amount of spray water.
- Wet the drums with spray water to prevent the drums from catching fire and blowing up.

Special protective equipment and precautions for fire-fighters :
- When fighting a fire, wear a self-contained breathing apparatus and other protection equipment, as hazardous vapor can generate.
- Wear appropriate protective equipment such as protective glasses, gloves and masks.
- Fight a fire from windward side as much as practicable to avoid intake of toxic gas.

6. Accidental release measures

Personal precautions , protective equipment and emergency procedures:	Other than people wearing appropriate protection equipment, evacuate all people from the leakage. Secure ventilation of the place where leakage occurred.
Environmental precautions:	Do not release the spillage directly to rivers or sewage system.
Methods and materials for containment and cleaning up:	- When a large amount is spilled, prevent the spillage from flowing into drainage trenches, etc. by embanking the spillage with soil/sand or equivalent. Dispose of the recovered spill in accordance with cautions for disposal. - Dispose of the container used for collection of spillage in accordance with cautions in Sec. 13.Disposal Procedures.

7. Handling and Storage

Precautions for safe handling:

Technical measures	- Take countermeasures in Sect. 8. “Exposure Prevention and Protection! and wear protective equipment. - Install local exhaust equipment where the material is handled indoors.
Local/Total exhaust	- Install local/total exhaust equipment in accordance with Sect. 8. “Exposure Prevention and Protection.”
General cautions:	- Carefully read the MSDS before handling the material. - Do not touch, inhale or intake the material. - Carefully wash hands after handling. - Handle the material only outdoors or indoors provided with appropriate ventilation. - Do not take out contaminated working clothes from the work site. - Do not drink/eat foods or smoke while using the material.
Safe handling precautions:	- Always have sufficient number of protecting equipment and sufficient quantities of neutralization agent ready for emergency. - Handle the container with care to avoid over-turning or dropping.
Substances that should not be in contact with the material:	Refer to Sect. 10.”Stability and Reactivity.”

Conditions for safe storage , including any incompatibilities:

Technical handling:	- Indoor storage shall be of fireproofing construction and well ventilated. - Flooring material shall be non-absorbing type. - Appropriate light letting-in and lighting equipment shall be installed.

7.	**Handling and Storage**	**(continued)**
	Conditions for safe storage , including any incompatibilities:	
	Appropriate storage site:	- Store the material in airtight containers and keep the containers in a well-ventilated and cooled place. - Store the containers in a lockable storage. - Displace vapor in the gaseous phase with nitrogen gas or dry air (due point to be -30 deg. C or lower) before storage. - Post caution signs such as “Flammable – Keep Fire Away” and “Unauthorized Personnel. Off limits.” .
	Hazardous material when mixed	Refer to Sect. 10. “Stability and Reactivity.”
	Packaging material	Use containers specified by the Fire Service Act and UN Transportation regulations.
8.	**Exposure Controls/Personal Protection:**	
	Appropriate engineering controls	- Facilities where the material is handled shall be of tightly sealed construction. Local exhaust equipment or other suitable means for ventilation shall be installed near the place where vapor or mist of the material is generated. - When handling the material, wear appropriate protection equipment. Install eye washing and body washing equipment near the place where the material is handled. - Flooring material shall be non-absorbing type.
	Individual protection measures,such as personal protective equipment:	
	- For respiratory organ	Air-breathing apparatus JIS T 8155, Air-supplied respirator JIS T 8153
	- For Hands	Rubber or plastic protective gloves (impermeable)
	- For eyes	Protective glasses with side protective cover plates
	- For skin and body	Long sleeve working clothes and safety shoes
	Hygiene measures:	- Carefully wash hands after handling. - Do not take out contaminated working clothes form the work site.

9. Physical/Chemical Properties

Appearance	Dark red liquid
Odor	Amine –like odor
pH	8 to 9
Boiling point	Approx. 160deg.C
Flash point	Cannot be measured
Explosion limits	No data available
Vapor pressure	No data available
Vapor density (air = 1)	No data available
Relative density	Approx. 1.15 (@25deg.C)
Solubility	Soluble in a number of organic solvents such as alcohol, methylene chloride, esters, ketone, and aromatic solvents.
Octanol/water partition coefficient	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity	500 to 1200 m･Pa-s (@25deg.C)

10. Stability and Reactivity

Chemical Stability: - Chemically stable against light, heat and impact under normal handling conditions.

Reactivity: - Reacts with strong oxidants. Danger.

11. Toxicological Information

Data on the material not available

Acute toxicity (oral):

"Classification not possible" as no information available.
However, the material contains less than 30% of trichloropropylphosphate corresponding to Category 4.
Trichloropropylphosphate, tested as per OECD oral toxicity test using rats (female), show LD50 = 1,078 mg/kg.

Acute toxicity:(dermal)

"Classification not possible" as no information available.
However, the material contains 3% of Component B corresponding to Category 3 and less than 30% of trichloropropylphosphate corresponding to Category 4.

Trichloropropylphosphate shows the following percutaneous toxicity test results:

- Rats : LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 5,000mg/kg [4),5)]
- Rabbits: LD50 ≧ 2,000mg/kg [5),6)]
- Rabbits: LD50 = 1,260, 1,230-3,240mg/kg.[6)]

Acute toxicity (gases)

Since the material is a liquid, we judged the material to be "Not applicable"

Acute toxicity (vapors)

"Classification not possible" as no information available.
However, the material contains less than 30% of trichloropropylphosphate corresponding to Category 3.

Acute toxicity (dust, mist)

"Classification not possible" as no information available.

11. Toxicological Information **(continued)**

Skin corrosion, irritation	Base on description on each component, we judged the material to be "Category 2". The material contains Component B (severe skin burns) corresponding to Category 1A and Component C,D,E,F (mild skin irritation) corresponding to Category 3.
Serious eye damage/eye irritation	Base on description on each component, we judged the material to be "Category 1". The material contains Component B (serious eye damage) corresponding to Category 1, Component D,E,F(severe eye irritation) corresponding to Category 2, Component C corresponding to Category 2B and Component G corresponding to Category 2A.
Respiratory sensitization	"Classification not possible" as no information available.
Skin sensitization	"Classification not possible" as no information available.
Germ cell mutagenicity	"Classification not possible" as no information available.
Carcinogenicity	"Classification not possible" as no information available.
Reproductive toxicity	Base on description on each component, we judged the material to be "Category 1".
Specific target organ toxicity (single exposure)	Base on description on each component, we judged the material to be "Not Classified".
Specific target organ toxicity (repeated exposure)	Base on description on each component, we judged the material to be "Category 2". The material contains 10% or more of trichloropropylphosphate corresponding to Category 2.
Aspiration hazard	"Classification not possible" as no information available.

12. Ecological Information

Ecotoxicity/Fish toxicity	Component G LC50: 28.7 ppm (“Himedaka” 96 hours)
Aquatic hazard (acute)	“Classification not possible” as no information available. However, the material contains Component G corresponding to Category 3. Trichloropropylphosphate shows the following aquatic environment toxicity test results: Fish (Brachydanio rerio) LC50 (96hr) = 56.2mg/liter [5)] Fish (Lepomis macrochirus) LC50 (96hr) = 180mg/liter[5)] Fish (Pimephales promelas) LC50 (96hr) = 98mg/liter[5)] Fish according to OECD (Poecilia reticulate) LC50 (96hr) = 30 mg/liter[5)] Fish (Fathead minnow) LC50 (96hr) = 51mg/liter[5)] Fish (Bluegill sunfish) LC50 (96hr) = 180mg/liter[6)] Shellfish according to OECD 202 (Daphnia magna) EC 50 (48 hr) = 65 to 335mg/liter, 63mg/liter[5)] Shellfish according to OECD(Daphnia magna) LC 50 (48hr) = 131mg/liter[5),6)] Algae (Scenedesmus subspicatus) EC 50 (72hr) = 45mg/liter[5)] Algae according to OECD 201(Scenedesmus subspicatus) EC 50 (96hr) = 41 to 55mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 57 to 97mg/liter[5)] Algae according to OECD 201(Scenedesmus capricornutum) EC 50 (96hr) = 73mg/liter[5),6)]
Aquatic hazard (chronic)	“Classification not possible” as no information available.

13. Disposal Considerations

Residual Waste Disposal	- Have a waste disposer authorized by municipal governor undertake disposal of residual wastes. - When the waste disposer undertakes the task, be sure to have the disposer thoroughly understand hazardousness and toxicity of the residual wastes.
Contaminated Container/Package	- Containers shall be cleaned for recycling, or disposed of in appropriate manners in accordance with applicable laws and local municipality‘s regulations. - When disposing of an empty used container, remove the contents completely.

14. Transportation Information

International regulation:	For Air transportation, follow requirements of ICAO/IATA, and for sea transportation, follow requirements of IMDG.
UN Classification	Not applicable
UN Number	Not applicable
Domestic regulations:	
Land transportation	Follow transportation rules provided in Fire Service Act, Industrial Safety and Health Act, Road Trucking Vehicle Act, etc.
Sea transportation	Follow transportation rules provided in Ship Safety Act.
Air transportation	Follow transportation rules provided in Civil Aeronautics Act.
Special safety measures:	Prior to transportation, make sure that there is no leakage from the container and that signs and marking are properly placed. Load up the cargoes properly so that they will not be overturned, dropped, collapsed or damaged during transportation.
Fire Service Act:	As the material belongs to Hazardous material Group 4 the 4th Petroleum of Fire Service Act, follow the requirements of the law when selecting containers and loading the cargoes.
Emergency Measures Guide No.	171

15. Regulatory Information

Controlled substance by Foreign Exchange Law and Foreign Trade Law	: Trichloropropylphosphate is a substance controlled as a Catch All regulated substance.
Fire Service Act	Group 4 the 3th Petroleum

16. Other Information

Reference List:

1) Urethane Materials Industry Association: Outline of Polyurethane Industries (2005)

2) Urethane Materials Industry Association: Polyurethane Material – Guidance to safe handling (2008)

3) Urethane Materials Industry Association: Control Guidance for transportation of polyol (PPG) (2008)

4) Environmental Health Criteria No.209 (1998)

5) International Uniform Chemical Information Database (2008)

6) Organization for Economic Cooperation and Development Screening Information Data Set

Notes:

The text of this MSDS is prepared based on data, knowledge and information available at the time of preparation or revision. Therefore, the text is subject to change and supplementation whenever new knowledge and experiment results become available. Neither of the figures included in this MSDS such as and physicochemical properties are for guarantee.

Cautions recommended in this MSDS are subject to general handling. If specific and special handling procedures are required, determine appropriate safety standards/requirements for such specific and special handling of the material under the user's own responsibility.