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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL

Sixty-third Meeting
Montreal, 4-8 April 2011

PROJECT PROPOSALS: CHINA

This document consists of a note by the Secretariat, the summary of the overarching strategy of the HCFC phase-out management plan (HPMP) and the comments and recommendations of the Fund Secretariat on the following projects proposals:

Foam

- Sector plan for phase-out of HCFC-141b in the foam sector in China (phase I) IBRD
- Sector plan for phase-out of HCFCs in the extruded polystyrene foam sector (phase I) Germany/UNIDO
- Demonstration project for conversion from HCFC-22 to butane blowing technology in the manufacture of extruded polystyrene foam at Shanghai Xinzhao Plastic Enterprises Co. Ltd. Japan/UNIDO
- Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO₂ with methyl formate co-blowing technology in the manufacture of extruded polystyrene foam at Feiningger (Nanjing) UNDP

Refrigeration

- Sector plan for HCFC phase-out in the industrial and commercial refrigeration and air conditioning (ICR) sectors (Stage I for 2013 and 2015 compliance) UNDP
- HCFC-22 phase-out management plan for room air-conditioner manufacturing sector UNIDO
- Pilot project on HCFC management and phase-out in the refrigeration servicing sector Japan/UNEP

Solvent

- Demonstration project for conversion from HCFC-141b based technology to iso-paraffin and siloxane (KC-6) technology for cleaning in the manufacture of medical devices at Zhejiang Kindly Medical Devices Co. Ltd. Japan/UNDP

Pre-session documents of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol are without prejudice to any decision that the Executive Committee might take following issuance of the document.

Note by the Secretariat

1. At the 62nd Meeting, the Governments of Germany and Japan, and UNDP (the lead implementing agency for China), UNEP, UNIDO and the World Bank submitted the following documents for the consideration by the Executive Committee:

- (a) HCFC phase-out management plan (HPMP) for China: Overarching strategy summary (UNDP);
- (b) Sector plan for phase-out of HCFC-141b in the foam sector (phase I) (World Bank);
- (c) Sector plan for phase-out of HCFCs in the extruded polystyrene (XPS) foam sector (stage I) (Government of Germany with UNIDO as cooperating agency), and the following two demonstration projects in the XPS foam subsector:
 - (i) Demonstration project for conversion from HCFC-22 to butane blowing technology in the manufacture of XPS foam at Shanghai Xinzhao Plastic Enterprises Co. Ltd., (UNIDO in cooperation with the Government of Japan); and
 - (ii) Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO₂ with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd., (UNDP);
- (d) Sector plan for HCFC phase-out in the industrial and commercial refrigeration and air conditioning sectors (stage I) (UNDP);
- (e) HCFC-22 phase-out management plan for room air-conditioner manufacturing sector (UNIDO);
- (f) Pilot project on HCFC management and phase-out in the refrigeration servicing sector (UNEP in cooperation with the Government of Japan); and
- (g) Demonstration project for conversion from HCFC-141b based technology to iso-paraffin and siloxane (KC-6) technology for cleaning in the manufacture of medical devices at Zhejiang Kindly Medical Devices Co. Ltd., (UNDP in cooperation with the Government of Japan).

2. During the discussion on the sector plans for China at the 62nd Meeting, “it was noted that the projects would involve a significant financial commitment that was considerably higher than had been anticipated. The Committee had always worked on the principle of agreed incremental cost in assisting countries to make a transition to the most viable technologies available and had to ensure that funding was calculated on the basis of the most cost-effective technology. It also had to determine the extent to which the projects focused on the largest enterprises, an approach which had worked very well for Article 5 countries, including China. With regard to the methodology used to calculate the cost of the project, it would appear that some averages had been determined and that overall costs had been provided on that basis. The methodology used by the Committee in the past with more specific determination of incrementality and eligibility would be more appropriate. Concern was also expressed about the absence of strong justification for prioritizing sectors other than those involving HCFC-141b technology” (paragraph 152, UNEP/OzL.Pro/ExCom/62/62).

3. Based on the report of the contact group that was set up to discuss the issues raised on the sector plans for China, the Executive Committee, *inter alia*, noted with appreciation the submission by the Government of its overarching strategy for the HPMP and the accompanying sector plans and agreed that they formed a good basis for continuing to consider assistance for China at its 63rd Meeting. The Committee also noted the difficulties and challenges facing the Government and its industry to meet the 2013 and 2015 Montreal Protocol HCFC control targets, and requested that China and interested members of the Committee hold intersessional consultations with a view to facilitating discussions at the 63rd Meeting. Further, the Committee confirmed its commitment to provide Multilateral Fund assistance to China to ensure its compliance with the accelerated phase-out (decision 62/60).

4. In response to decision 62/60 bilateral and implementing agencies, assisting the Government of China in phasing out its HCFC consumption, resubmitted to the 63rd Meeting the overarching strategy summary of the HPMP together with the four sectoral phase-out plans and four demonstration projects. Also in response to decision 62/60, the Government of China offered to host intersessional consultations on the sector plans submitted in China and invited interested members of the Executive Committee, and representatives from the Fund Secretariat and the implementing agencies to attend a consultation meeting from 22 to 24 February 2011¹.

5. Since the 62nd Meeting, the Secretariat continued addressing the outstanding technical and cost related issues on the various sector phase-out plans with relevant bilateral and implementing agencies. The outcomes of the discussions have been incorporated in each sector plan as appropriate.

Outline of the document

6. The document first presents the overarching strategy summary containing comments and the recommendation of the Secretariat. It continues with the sector plans, each being presented separately, namely the polyurethane (PU) foam, the XPS foam (including two XPS foam demonstration projects), the industrial and commercial refrigeration and air conditioning (ICR), and the room air-conditioner manufacturing (RAC). The document then presents the demonstration project on HCFC management and phase-out in the refrigeration servicing², and ends with the demonstration project in the solvent sector. Each sector plan and demonstration project includes a summary of the proposal, a description of issues identified during project review, a summary of discussions between the Secretariat and relevant agencies, and, where applicable, the recommendation by the Secretariat.

General observations

7. At the 55th Meeting, the Executive Committee approved the preparation programme for the overall HCFC phase-out management plan (HPMP) for China (the total funding approved for the preparation of the HPMP and its component sectoral phase-out plans amounted to US \$4.1 million).

8. Since the approval of the funding for the preparation of the HPMP, the Government of China carried out an HCFC survey with assistance from the bilateral agency concerned, implementing agencies, relevant ministries and national industry associations and research institutes which covered all HCFC

¹ To facilitate the discussions of participants to the intersessional consultation meeting, the Fund Secretariat posted in its intranet site (http://intranet.unmfs.org/sites/China_HPMP/) the documents that relevant bilateral and implementing agencies had submitted on behalf of the Government of China for consideration by the Executive Committee at its 62nd Meeting.

² The Secretariat did not include the demonstration project on HCFC management and phase-out in the refrigeration servicing sector in document UNEP/OzL.Pro/ExCom/62/26 submitted to the 62nd Meeting, considering that only HCFC investment projects could be submitted outside an HPMP (decision 54/39). This issue was further explained in document UNEP/OzL.Pro/ExCom/62/10 on the overview of issues identified during project review.

producers and enterprises from each consumption sector. HCFC consumption was estimated through both top-down (sales data from producers, importers and exporters) and bottom-up (consumption sector survey), for each sector. The production and consumption of HCFCs after the year 2010 was forecast based on historical data and future growth predictions.

9. The four HCFC phase-out sector plans submitted on behalf of the Government of China have been based on existing alternative technologies and management frameworks. Each sector has developed its respective phase-out roadmap through extensive consultations with major stakeholders.

10. The PU foam plan was prepared based on the 2008 HCFC consumption and production data gathered during the preparation of the sector plan, which was the latest available data, while the other three sector plans were prepared using the preliminary 2009 HCFC data that became available when the Government of China prepared the overarching summary strategy. The Secretariat reviewed the four sector plans based on HCFC consumption data reported therein.

11. Following the submission of the summary strategy, the Government of China submitted its 2009 consumption and production data under Article 7 of the Montreal Protocol as shown in the Table below.

HCFC	2007	2008	2009
Metric tonnes			
HCFC-22	203,042.2	177,663.1	210,843.1
HCFC-141b	49,706.3	41,008.6	51,365.2
HCFC-142b	18,530.9	16,862.4	20,982.8
HCFC-123	356.8	371.3	310.2
HCFC-124	110.9	(27.7)	284.7
Total metric ton	271,747.1	235,877.8	283,785.9
ODP tonnes			
HCFC-22	11,167.3	9,771.5	11,596.4
HCFC-141b	5,467.7	4,511.0	5,650.2
HCFC-142b	1,204.5	1,096.1	1,363.9
HCFC-123	7.1	7.4	6.2
HCFC-124	2.4	(0.6)	6.3
Total ODP tonnes	17,849.1	15,385.3	18,622.9*

*Note: There is a difference of 38.3 ODP tonnes between the disaggregated HCFC consumption data (18,622.9 ODP tonnes) and the reported aggregated data (18,584.6 ODP tonnes), both reported under Article 7.

PROJECT DESCRIPTION

Overarching Strategy Summary

12. On behalf of the Government of China UNDP, as the lead implementing agency, has re-submitted to the 63rd Meeting a summary of the overarching strategy of the HCFC phase-out management plan (HPMP) for China.

Background

13. HCFCs, including HCFC-22, HCFC-123, HCFC-124, HCFC-141b, and HCFC-142b, are produced and consumed in China within 7 sectors. Based on the results of the HCFC survey conducted during the preparation of the HPMP, in 2009 total production and consumption amounted to 418,000 metric tonnes (mt) and 273,000 mt (28,201 ODP tonnes and 17,997 ODP tonnes) respectively.

Consumption sector

14. An overview of HCFC consumption in China is provided in Table 1. The six sectors consumed 273,312 mt (17,997 ODP tonnes) with the solvent sector being the smallest consumer and polyurethane (PU) foam sector being the largest.

Table 1. HCFC consumption by sector in 2009 (based on survey data)

HCFCs	Sector						
	RAC	ICR	Servicing	PU Foam	XPS Foam	Solvent	Sub-total
Metric tonnes	71,500	41,850	68,597	45,971	41,000	4,394	273,312
Percentage	26.16%	15.31%	25.10%	16.82%	15%	1.61%	100%
ODP tonnes	3,933	2,290	3,818	5,057	2,419	480	17,997
Percentage	21.85%	12.72%	21.21%	28.10%	13.44%	2.67%	100%

PU foam sector

15. The PU foam sector, which uses only HCFC-141b, comprises of a total of 3,500 enterprises the majority of which are small or medium sized enterprises (SMEs), with a total HCFC-141b consumption of 38,100 mt (4,191 ODP tonnes) in 2008 and 45,971 mt (5,057 ODP tonnes) in 2009, making it the largest HCFC-141b consuming sector.

Extruded polystyrene (XPS) foam sector

16. The growth rate in the XPS foam sector has exceeded 20 per cent annually over the past 5 years and is expected to remain high in the future. HCFC-22 and HCFC-142b (in a ratio of 1.00:0.67) are used as blowing agents in approximately 650 production lines found in 500 geographically dispersed enterprises. HCFC consumption in 2008 and 2009 was 34,900 and 41,000 mt respectively.

Room air conditioning sector

17. The current output of the RAC sector is about 75 million units annually, manufactured by about 30 large-scale enterprises operating nationally, with units being marketed in China for Article 5 and non-Article 5 countries. Units manufactured for Article 5 countries including China employ almost exclusively HCFC-22 as a refrigerant. In 2008 and 2009 HCFC-22 consumption in the RAC sector was 66,100 mt (3,635.5 ODP tonnes) and 71,500 mt (3,932.5 ODP tonnes) respectively (excluding the service demand).

Industrial and commercial refrigeration and air conditioning (ICR) sector

18. The ICR industry includes a number of sub-sectors and comprises of more than 1,000 geographically dispersed enterprises of various sizes. It uses HCFC-22, HCFC-123 and HCFC-142b with HCFC-22 accounting for 99 per cent of the sector's consumption. In 2008 and 2009 HCFC consumption amounted to 40,630 mt and 41,850 mt respectively.

Solvent sector

19. The solvent sector in China consumes mostly HCFC-141b and a small amount of HCFC-225. There are about 400 enterprises the majority of which have a low level of consumption. Total consumption of HCFCs in 2008 and 2009 was 4,105 mt and 4,394 mt respectively.

Servicing sector

20. Service demand for HCFC-based refrigeration and air-conditioning equipment will increase with the increase in inventory. The estimated servicing consumption of HCFCs in 2009 was over 60,000 mt.

21. A summary of HCFC consumption by substance can be found in Table 2.

Table 2. HCFC consumption by substance in 2009

HCFC	HCFC-22	HCFC-141b	HCFC-142b	HCFC-123	HCFC-124	HCFC-225	Total
Metric tonnes	200,559	50,323	21,811	298	279	42	273,312
Percentage	73.38%	18.41%	7.98%	0.11%	0.1%	0.02%	100.00%
ODP tonnes	11,031	5,535	1,418	6	6	1	17,997
Percentage	61.29%	30.76%	7.88%	0.03%	0.03%	0.01%	100.00%

HCFC consumption baseline

22. Based on the 2009 HCFC consumption of 17,997 ODP tonnes (HCFC survey) and the 2010 forecasted consumption of 20,200 ODP tonnes (based on the average growth rate in the last 5 to 10 years and the trend in the first half of 2010), the HCFC consumption baseline has been estimated at 19,100 ODP tonnes.

Production sector

23. The actual HCFC production capacity in China was close to 1 million metric tonnes. In 2009 about 418,000 mt (28,201 ODP tonnes) of HCFCs were produced, including HCFC-22 (15 manufacturers), HCFC-141b (8 manufacturers), HCFC-142b (12 manufacturers), HCFC-123 (2 manufacturers), and HCFC-124 (2 manufacturers). In 2010, HCFC production has been estimated at 31,737 ODP tonnes based on the growth trends during the first six months of 2010, as shown in Table 3. Therefore, the HCFC production baseline has been estimated at approximately 30,000 ODP tonnes.

Table 3. Historical and forecast HCFC production (including exports)

HCFC	2007 (mt)	2008 (mt)	2009 (mt)	2009 (ODP)	2010 (mt)	2010 (ODP)*
HCFC-22	297,677	263,745	298,559	16,421	336,00	18,480
HCFC-141b	86,837	81,298	91,880	10,107	104,000	11,440
HCFC-142b	22,994	22,724	24,890	1,618	27,000	1,755
HCFC-123	2,072	2,558	2,238	45	2,500	50
HCFC-124	398	365	474	10	545	12
Total	409,978	370,690	418,041	28,201**	470,045	31,737

* Forecasted production.

** The production data reported under Article 7 is 28,475.9 ODP tonnes for 2009.

Phase-out targets and strategy

24. The main objectives of the overarching strategy are to: articulate an overview of the national plan to phase out HCFCs; define the short-term and long-term phase-out strategies and policies; prioritize sectors for phase-out; and formulate an action plan to ensure China's compliance with the 2013 and 2015 control measures.

25. The Government of China will control and phase out HCFCs by substance, sector, step by step. Total emission control and quota management of HCFC production and consumption will be enforced. Policy implementation will be strengthened in order to restrict the growth of HCFC production capacity, establish the production capacity of alternatives through a series of key projects, focus on the management of servicing to restrain its excessive growth, and control production, import and export at the national level. Priority will be given to high ODP/high emission rate technologies that are easy to substitute.

26. In order to meet up to the 10 per cent reduction target in 2015, about 20 per cent of the baseline level of consumption will be eliminated in the PU foam sector, 10 per cent in the XPS foam, RAC, and ICR sectors, and 8 per cent in the solvent sector. Efforts will also be made in the servicing sector to reduce the leakage of refrigerants and avoid unnecessary servicing consumption. In the consumption sector the domestic market quota will be frozen at the baseline of the domestic consumption level in 2013 and will be reduced to 90 per cent of the baseline consumption level by 2015. HCFC production in 2011 and 2012 will continue to increase, and in 2013 will be frozen at the baseline level of 30,000 ODP tonnes; 3,000 ODP tonnes will be phased out to meet the 10 per cent reduction target in 2015. The amount of HCFCs to be phased out in each sector to comply with the overall Montreal Protocol targets for HCFCs in 2013 and 2015 are shown in Table 4.

Table 4. 2013 and 2015 HCFC reduction targets by sector (ODP tonnes)

Levels of reduction	Consumption sectors						Production sector
	PU foam	XPS	RAC	ICR	Solvent	Total	
2013 control target	645	338	176	228	30	1,417	
2015 control target	970	254	411	236	39	1,910	3,000
Total	1,615	592	587	464	69	3,327	3,000

27. In the servicing sector, actions will be taken with respect to HCFCs including those to establish management policies in the maintenance industry, eliminate unnecessary maintenance demand, enhance equipment installation and maintenance to reduce leakage, carry out recycling and reuse activities when servicing large- and medium-size equipment, destroy HCFCs which cannot be recovered or recycled to reduce HCFC emission. It is estimated that the maximum allowable HCFC consumption in the servicing sector in 2013 will be about 4,300 ODP tonnes. The HCFC consumption in 2015 will be controlled at the same level for this sector.

Technology selection

28. Based on a number of selection criteria including ozone and climate benefits, safety and costs, the technologies selected by the six consumption sectors and the production sector are outlined in Table 5.

Table 5. Technology selections by consumption sector

Sector	HCFC used	Alternative technology or action
PU foam	HCFC-141b	- Cyclopentane - Water blown - Other potential environmentally friendly technology
XPS foam	HCFC-142b HCFC-22	- CO ₂ (with small amounts of HFC-152a to improve foam properties) - Hydrocarbon
RAC	HCFC-22	- HFC-410A before 2013 - HC and other low GWP alternatives after 2013 for 2015 target
ICR	HCFC-22 (99%) HCFC-123, HCFC-142b	- Ammonia - CO ₂ - Other environmentally friendly technologies - HFC-32 in SMEs - HFC-410A and HFC-134a (stage I)
Solvent	HCFC-141b	- No clean technology - Water-based and semi-aqueous cleaning technologies - ODS-free organic solvent cleaning technology
Service and others	HCFC-22 HCFC-142b (tobacco, blends)	- Training service sector to avoid unnecessary service - Training to improve service quality - Construct facilities for recovery/recycling of HCFCs from scrapped equipment
Production		Based on production capacity building for alternatives and the principle of synchronizing the phase-out of production and consumption, HCFC production lines to be shut down gradually. Sectors with high ODP value benefit and causing other environmental harm should be phased out first taking into consideration the phase-out schedule in the consumption sector

29. Conversions in the RAC sector are limited by the existing alternative technologies and the tight phase-out schedule. However for stage 1 of the HPMP, substitutes using low-global warming potential (GWP) will account for 60 per cent of the total conversion. In the ICR sector, the moderate-GWP alternative such as HFC-32 will be encouraged for medium and small sized commercial air-conditioners. The Government of China will actively explore the possibilities for using low-GWP technologies but since this will require some time, some projects under the sector plan (in stage 1) will have to choose matured technologies such as HFC-410A and HFC-134a.

Estimated costs

30. Table 6 presents the HCFC consumption limits and phase-out requirements by sector with the costs requested from the Multilateral Fund for the 2013 and 2015 control targets. China estimates that it will have to phase out 1,467 ODP tonnes of HCFCs to meet the freeze and an additional 1,910 ODP tonnes to meet the 10 per cent reduction for a total phase-out of 3,377 ODP tonnes during 2010-2015. In stage I of the HPMP, the phase-out of HCFCs in the XPS and PU foam subsectors will be 23 and 30 per cent of the baseline respectively (phase-out being expressed as a percentage of the sector baseline i.e., the maximum allowable consumption for 2013).

Table 6. Tonnage and costs requested to meet 2013 and 2015 control measures overall and by sub-sector

Level	2013 (ODP)		2015 (ODP)		% by sector	2010-2015			Business Plan 2011-2014	
	Maximum allowable level	Phase-out by sector	Maximum allowable level	Phase-out by sector		Cost requested ('000 US\$)	Phase-out	% of sector baselines	Value (\$000)	ODP
National level	19,100	NA	17,190	NA	NA	TBD	3,377			
Sector level										
PU Foam	5,310	645	4,340	970	50.80%	122,199	1,615	30%	66,212	783
XPS Foam	2,540	338	2,286	254	13.30%	103,000	592	23%	19,428	230
Room AC	4,109	176	3,698	411	21.50%	168,623	587	14%	92,428	355
ICR	2,360	228	2,124	236	12.40%	137,780	464	20%	52,961	204
Solvents	493	30	454	39	2%	TBD	69	14%	28,683	41
Servicing	4,288	50	4,288	0	0	TBD	50	1%	12,727	139
Demonstration									15,146	28
TOTAL (Consumption)	19100	1,467	17,190	1,910	100%	TBD	3,377	18%	287,585	1,780
TOTAL (Production)	30,000		27,000	3,000		TBD			140,032	4,500

31. Table 6 also shows the level of funding and tonnage in the business plans. The summary indicates that China is seeking significantly more funding and tonnage for the four sectors than allocated in the business plan. The amount of funding in the proposal submitted to the 62nd Meeting (US \$531,602,000) is significantly higher than the total allocated for all sectors in the business plan (US \$427,617,000). Also no values were provided in the summary of the overarching strategy for either the production sector, the solvent sector, or the refrigeration servicing sector for which the business plan allocations are US \$140,032,000, US \$28,683,000, and US \$12,727,000 respectively. It should be noted that the actual funding requests for a portion of the amount (US \$92,883,000) requested in principle at the 62nd Meeting for the four sector plans will not be submitted in the context of the 2010-2014 business plan but in the 2015-2017 triennium for tonnage that could be associated with phase-out required after the 2015 control measures.

Regulatory and policy framework

32. The Regulation on ozone-depleting substances management was issued in 2010 by the State Council and came into force on June 1, 2010. It includes 38 articles that focus on life cycle management of ozone-depleting substances (ODS). It clarifies the target and task of ODS management, establishes the system of gross control and quota management of ODS, and stipulates the legal responsibilities with respect to illegal production, consumption and import or export behaviour. The Government of China will build on its existing policy framework to ensure full compliance with its phase-out targets by formulating corresponding law and regulations by the following actions:

- establishing and perfecting the relevant laws and regulations;
- bring HCFC sectors into the Cleaner Production Audit System;
- development of the technical guidelines for recycling HCFCs;
- control capacity for HCFC production and encourage alternative products and technologies;
- establishing and perfecting the dynamic registration system for production, consumption, import and export and emission data;
- research into and establishment of relevant economic policy and environmental protection investment mechanism;
- research, development and promotion of alternative product and technologies;

- public information, awareness and education; and,
- decree timely bans for the phase-out HCFCs used in different sectors/product.

33. China has approved policies and regulations on HCFCs including: a licensing system for HCFCs on 6 February 2004; the establishment, reconstruction and expansion of HCFC production projects on 25 December 2008; control of the establishment of new manufacturing facilities using HCFCs on 13 October 2009; and licensing of mixtures containing HCFCs on 29 December 2009. There was no indication if the HCFC control measures agreed by the Parties to the Montreal Protocol in 2007 have been implemented.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

34. The Secretariat raised several issues with respect to the overarching strategy in the document presented to the 63rd Meeting (UNEP/OzL.Pro/ExCom/63/26). Those issues are discussed in details in that document and are summarized below:

- (a) The need for a prioritization of high ODP HCFCs;
- (b) Funding for more than 10 per cent of the baseline;
- (c) The extent to which there would be a synchronized production/consumption phase-out;
- (d) The absence of comprehensive HCFC data on cut-off dates, foreign ownership and export to non-Article 5 countries;
- (e) The lack of information on co-financing;
- (f) The lack of information on the costs for the production sector; and
- (g) Whether the summary report would be sufficient in the absence of a full HCFC phase-out management plan (HPMP) pursuant to decision 54/39.

35. The Government of China plans to submit its HPMP to the last meeting of the Executive Committee in 2011 once 2010 Article 7 data is available and the actual HCFC baseline can be established.

RECOMMENDATIONS

36. The Executive Committee may wish to consider the above in its ongoing deliberations on the submissions of the Government of China for HCFC phase-out.

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS
China

(I) PROJECT TITLE	AGENCY
HCFC Foam Sectoral Plan	World Bank/IBRD

(II) LATEST ARTICLE 7 DATA	Year: 2009	18,584.6 (ODP tonnes)
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(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)							Year: 2009			
Chemical	Aerosol	Foam	Fire fighting	Refrigeration		Solvent	Process agent	Lab Use	Total sector consumption	
				Manufacturing	Servicing					
HCFC-123				4.0	2.0				6.0	
HCFC-124					6.1				6.1	
HCFC-133										
HCFC-141b		5,056.8				465.9			5,535.7	
HCFC-142										
HCFC-142b		1,066.0		2.0	349.8				1,417.7	
HCFC-22		1,353.0		6,221.6	3,456.2				11,030.8	
HCFC-225ca						1.0			1.0	
HCFC-225cb						0.0			0.0	

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	To be determined	Starting point for sustained aggregate reductions:	n/a
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	0	Remaining:	

(V) BUSINESS PLAN		2010	2011	2012	2013	2014	Total
IBRD	ODS phase-out (ODP tonnes)	331.2		427.6	12.3	12.3	783.3
	Funding (US \$)	27,996,235		36,143,701	1,036,206	1,036,206	66,212,349

(VI) PROJECT DATA			2010	2011	2012	2013	2014	2015	Total
Montreal Protocol consumption limits			n/a	n/a	n/a	baseline	baseline	baseline - 10%	
Maximum allowable consumption (ODP tonnes)			n/a	n/a	n/a	19,100.0	19,100.0	17,190.0	
Project Costs requested in principle(US\$) *	World Bank / IBRD	Project costs		32,000,000	30,000,000	45,000,000	15,200,000		122,199,000
		Support costs		2,400,000	2,250,000	3,375,000	1,140,000		9,164,925
Total project costs requested in principle (US \$)				32,000,000	30,000,000	45,000,000	15,200,000		122,199,000
Total support costs requested in principle (US \$)				2,400,000	2,250,000	3,375,000	1,140,000		9,164,925
Total funds requested in principle (US \$)				34,400,000	32,250,000	48,375,000	16,340,000		131,363,925

(VII) Request for funding for the first tranche (2010)			
Agency	Funds requested (US \$)	Support costs (US \$)	ODS phase-out (ODP tonnes)
World Bank / IBRD	32,000,000	2,400,000	

Funding request:	Approval of funding for the first tranche (2010) as indicated above
Secretariat's recommendation:	Pending

* As originally submitted

PROJECT DESCRIPTION

37. On behalf of the Government of China, the World Bank has re-submitted to the 63rd Meeting a sector plan to phase-out HCFC-141b in the foam sector (Foam Sector Plan), at a total cost of US \$207,351,000. Of this amount, the Government is requesting US \$122,199,000 plus agency support costs of US \$9,164,925 for the World Bank as originally submitted. The sector plan will phase out 1,615 ODP tonnes (14,685 mt) of HCFC-141b by 2015 with funding from the Multilateral Fund equivalent to 1,373 ODP tonnes (12,482 mt).

Polyurethane (PU) foam sector in China

38. Of the total 2008 consumption of HCFC-141b of 4,415.3 ODP tonnes (40,139 mt), 4,191 ODP tonnes (38,100 mt) were used for the manufacturing of polyurethane (PU) foams. The reduction in production and consumption levels of HCFC-141b shown in 2008, relates to the global financial crisis. According to the industrial survey, a 10 per cent annual growth rate is expected in the foam sector, which is consistent with the national economic development policy of China. On this basis, the 2008-2012 expected levels of HCFC-141b consumption in China are shown in Table 1.

Table 1. HCFC consumption in the PU foam sector in China

HCFC-141b	2008	2009	2010	2013	2015	Baseline*
ODP tonnes	4,191	5,057	5,563	5,310	4,340	5,310
Metric tonnes (mt)	38,100	45,971	50,568	48,270	39,450	48,270

*Estimated baseline for the PU foam

39. The Foam Sector Plan categorizes the foam enterprises according to their HCFC consumption, namely large size enterprises, an annual consumption of over 8.3 ODP tonnes (75.0 mt); medium size enterprises with a consumption between 2.8 and 8.3 ODP tonnes (25 to 75 mt); and small size enterprises with a consumption below 2.8 ODP tonnes (25 mt). There are also a few super large enterprises with an HCFC-141b consumption of 55.0 ODP tonnes (500 mt) or more. The PU foam sector, one of the largest HCFC consumption sectors in China, comprises of about 3,500 small and medium size enterprises (SMEs), which usually have limited technical and management capacity and limited access to new technologies. There are only a small number of large enterprises which account for about 76.2 per cent of the total HCFC-141b consumption in the sector. Small enterprises constitute the largest group within the PU foam sector but account for a smaller part of the total consumption. Only a small number of enterprises (i.e., 1.2 per cent of the overall production), were established after 21 September 2007.

40. The PU foam production in China is unevenly distributed among various applications (Table 2) including: insulation foam for refrigerators and freezers; refrigerated trucks and reefers; small electric appliance; solar water heaters; pipe insulation; foam panels; spray foam; foam applications for the automobile sector; and other smaller applications (i.e., structural foam, filling material, shoe soles).

Table 2. HCFC-141b consumption by foam sub-sectors in 2008

Sub-sector	ODP tonnes	Metric tonnes
Refrigerators and freezers	330	3,000
Refrigerated trucks and reefers	649	5,900
Small electrical appliances	231	2,100
Solar water heaters	517	4,700
Pipe insulation	374	3,400
Foam panels	748	6,800
Spray foam	781	7,100
Foam applications for the automobile sector	154	1,400
Others (structural foam, filling material, shoe soles)	407	3,700
Total	4,191	38,100

Phase-out strategy in the foam sector

41. Based on the CFC phase-out experience, the Government of China is proposing to implement the HCFC phase-out in the PU foam sector through a national-level sector approach in order to deliver technical and financial assistance to foam enterprises in a timely and efficient manner. In order to ensure compliance with the 2013 and 2015 control measures, the Foam Sector Plan will focus on converting the larger HCFC-141b consuming enterprises. Lessons learned from the conversion of these enterprises would serve as demonstration cases that will be disseminated to the SMEs. Assistance would also be provided to foam systems houses to develop ODS-free technology. Priority is given to alternative foam blowing agents with low global warming potential (GWP). Private-public partnership schemes will be created to foster and promote the overall HCFC phase-out programme, particularly in SMEs. For each foam sub-sector, phase-out activities are prioritized according to the viability of the selected alternatives; the technical, financial and management capacity of the enterprises in the sub-sector concerned; and the availability of cost-effective options.

42. Based on the above criteria and on a comparative analysis of alternative technologies in the different foam subsectors, it was concluded that under phase I of the Foam Sector Plan priority should be given to the following three subsectors:

- (a) Refrigerator and freezer sub-sector, with a total estimated consumption of 381.1 ODP tonnes (3,465.0 mt) used by 40 enterprises with a production output of 55 million units. China has the largest refrigerator and freezer production in the world and in 2008 this industry grew by 25 per cent. HCFC-141b will be replaced by hydrocarbon-based technology;
- (b) Refrigerated trucks and reefers, with a total estimated consumption of 749.7 ODP tonnes (6,815 mt) used by 50 enterprises with a production output of 110,000 refrigerated vehicles in 2008. HCFC-141b will be replaced by cyclopentane technology;
- (c) Small electrical appliances (i.e., electric water heaters, disinfecting cabinets, stew pots), with a total estimated consumption of 266.9 ODP tonnes (2,426.0 mt) used by 50 enterprises with an annual production output of 200,000 units by the larger enterprises. HCFC-141b will be replaced by hydrocarbon-based pre-blended polyols for SMEs and water-blown technology for applications where PU foam is used as a filling material;
- (d) Other sub-sector, with a total estimated consumption of 217.7 ODP tonnes (1,979.0 mt) used by several SMEs, with low profits and scattered distribution throughout the country.

43. In addition, large enterprises in the solar water heater sub-sector, where conversion to hydrocarbon technology is financially viable, will also be considered at this stage of the Foam Sector Plan (Table 3). The remaining sub-sectors are to be addressed after 2015.

Table 3. Priority subsectors covered under phase I of the Foam Sector Plan

Subsector	No. of enterprises	HCFC-141b to be phased-out	
		mt	ODP tonnes
Refrigerators and freezers	40	3,465.0	381.2
Refrigerated trucks and reefers	50	6,815.0	749.7
Small household appliances	50	2,426.0	266.9
Other sub-sectors*	**	1,979.0	217.7
Total	140	14,685.0	1,615.4

* HCFC-141b to be phased out from large enterprises in other sub-sectors (i.e., solar water heaters, pipe insulation).

** Estimated number of enterprises, excluding those in other sub-sectors, to be covered under phase I of the Foam Sector Plan.

44. The Government of China will issue policies and regulations supporting the activities proposed in the Foam Sector Plan, such as controls for production, import/export, consumption, safety management, environmental labelling, and technical standards. It proposes to establish a production quota system to curb the supply of HCFCs by early 2013, which is critical for ensuring sustainable phase-out of HCFCs particularly in the foam sector. In addition, a ban on the use of HCFC-141b used for the production of insulation foam for refrigerators, freezers, refrigerated trucks, reefers, and small household appliances will be put in place by 1 January 2015. The Government is also considering submitting the HCFC production phase-out sector plan, including HCFC-141b, to the Executive Committee in 2011. The production phase-out schedule will take into account the effort being made to control the consumption sector. The import and export of HCFC-141b will also be strictly controlled and monitored.

Cost analysis

45. The calculation of the total incremental cost of the Foam Sector Plan is based on the introduction of hydrocarbon and water-blown technologies, and takes into account the size of the enterprises, installation date, baseline equipment (including age), foreign ownership and export component. Cost effectiveness (in terms of US\$/kg HCFC-141b) is calculated based on the sub-sector cost and the 2008 HCFC-141b consumption for each sub-sector. The cost-effectiveness for the entire Foam Sector Plan is calculated as the weighted cost-effectiveness of all sub-sectors (i.e., integral skin and rigid foam).

46. Conversion cost for enterprises selecting cyclopentane technology, will depend on the actual situation and location of each of the enterprises. The conditions will differ from one enterprise to another and while some enterprises might only need to retrofit their existing foaming equipment, others may have to replace existing units with new equipment. Other restrictions might be the location of the enterprise, which might not allow for the installation of storage tanks, and/or could have limitations on delivering hydrocarbon by trucks. In other cases, the relatively small size of the enterprises might not justify installation of hydrocarbon storage facilities, premixing units, and other equipment. For enterprises with a low pressure foaming machine in the baseline that are unable to convert replacement of the equipment is proposed, while for enterprises with a high pressure foaming machine, and are able to convert, equipment retrofitting is proposed. The capacity to supply hydrocarbon-based pre-blended systems particular for SMEs will be established.

47. The capital costs associated with the conversion from HCFC-141b to hydrocarbons include hydrocarbon storage systems; replacement or retrofit of existing foaming dispenser including jigs and fixtures; installation of safety related equipment; and training, technology transfer, trials, and certification.

The capital costs for super large enterprises are specific to each enterprise considering the size of the operation and the equipment in the baseline. Due to safety restriction, HFC-245fa technology is recommended for the spray foam, foam applications for the automotive industry and other foam applications. The capital costs for the introduction of HFC-based technology are associated with the pre-mixing unit and installation of a chiller. There are no capital costs associated with the introduction of water-blown technology (some costs may be incurred for minor modifications, adjustments of tanks, production trial, and training). The conversion of systems houses for the manufacturing of hydrocarbon-based pre-blended polyols will require installation of hydrocarbon storage systems, premixing systems with pumps and tanks, enhanced ventilation and safety related systems, construction modification, trials, safety audits and training. Table 4 presents a summary of the capital costs associated with the Foam Sector Plan.

Table 4. Capital costs associated with the overall Foam Sector Plan in China

Sub-sector	Super large		Large		Medium		Small	Polyol center	Total
	Replace	Retrofit	Replace	Retrofit	Replace	Retrofit	Replace		
Number of enterprises									
Refrigerator and freezers	0	0	12	3	15	5	5	1	41
Refrigerated trucks/reefers	4	1	0	0	8	2	30	1	46
Small household appliances	0	0	6	2	24	6	12	1	51
Solar water heaters	0	0	11	4	36	14	203	10	278
Pipe insulation	0	0	11	4	51	19	168	8	261
Panels	0	0	9	3	45	15	210	10	292
Spray foam				10		225	225		460
Automobile foam						20	20		40
Others				4		50	50		104
Total enterprises	4	1	49	30	179	356	923	31	1,573
Cost (000 US\$)									
Unitary cost (hydrocarbon)	5,874.0	5,049.0	1,125.0	944.0	670.0	529.0	286.0	547.8	15,024.8
Refrigerator and freezers	-	-	13,500.0	2,832.0	10,050.0	2,645.0	1,430.0	547.8	31,004.8
Refrigerated trucks/reefers	23,496.0	5,049.0	-	-	5,360.0	1,058.0	8,580.0	547.8	44,090.8
Small household appliances	-	-	6,750.0	1,888.0	16,080.0	3,174.0	3,432.0	547.8	31,871.8
Solar water heaters	-	-	12,375.0	3,776.0	24,120.0	7,406.0	58,058.0	5,478.00	111,213.0
Pipe insulation	-	-	12,375.0	3,776.0	34,170.0	10,051.0	48,048.0	4,382.40	112,802.4
Panels	-	-	10,125.0	2,832.0	30,150.0	7,935.0	60,060.0	5,478.00	116,580.0
Unitary cost (HFC-245fa)				165.0		88.0	88.0		341.0
Spray foam				1,650.0		19,800.0	19,800.0		41,250.0
Automobile foam						1,760.0	1,760.0		3,520.0
Others				660.0		4,400.0	4,400.0		9,460.0
Total cost (000' US\$)	23,496.0	5,049.0	41,625.0	14,582.0	109,880.0	55,584.0	204,138.0	16,434.00	470,788.0

48. Incremental operating costs have been calculated as follows: US \$2.88/kg for cyclopentane technology, US \$9.43/kg for HFC-245fa technology and US \$5.25/kg for water-blown technology. Applying these values, the total operating costs are US \$208,416,000. The total capital and incremental costs by sub-sector are summarized in Table 5.

Table 5. Capital and operating costs associated with the overall Foam Sector Plan in China

Subsector	HCFC-141b (mt)	Costs (US\$)			CE (US \$/kg)
		Capital	Operating	Total	
Refrigerator and freezers	3,465	31,007	11,529	42,536	12.28
Refrigerated trucks/reefers	6,815	44,090	21,832	65,922	9.67
Small household appliances	2,426	31,871	8,581	40,452	16.67
Solar water heaters	5,429	111,213	22,932	134,145	24.71
Pipe insulation	3,927	112,802	18,721	131,523	33.49
Panels	7,854	116,579	28,449	145,028	18.47
Spray	8,201	41,250	77,335	118,585	14.46
Foam for automobiles	1,617	3,520	11,194	14,714	9.10
Other applications	4,366	9,460	30,224	39,684	9.09
Total	44,100	501,792	230,797	732,589	16.61

49. In support to the conversion of the enterprises, the Foam Sector Plan includes technical assistance (i.e., training, public awareness) and policy and regulation activities. Workshops will be organized to inform foam enterprises in the three selected sub-sectors and systems houses about the objectives of the Foam Sector Plan, the project cycles (submission of applications for grant funds to implementation arrangement and schedule), project supervision, commissioning and reporting requirements. A series of public awareness activities on the urgent need to phase out HCFCs and the future regulatory measures to eliminate the use of HCFCs will be carried out with target groups including consumers and manufacturers. Training activities will be conducted to increase technical capacity of local authorities. Capacity building of customs officers will also be carried out in order to ensure effective control of import and export of HCFC-141b and products containing HCFC-141b. The total estimated cost of these activities is US \$9,780,000 (equivalent to 8 per cent of the total funding of the Foam Sector Plan).

50. Of the overall costs of the Foam Sector Plan the Government of China is requesting US \$122,199,000 (i.e., US \$112,419,000 for investment activities and US \$9,780,000 for technical assistance activities) to meet the 2013 and 2015 phase-out targets (phase I). Funding distribution between phase I and phase II is shown in Table 6.

Table 6. Funding distribution of phase I and phase II of the Foam Sector Plan

Description	Phase I	Phase II	Total
Consumption (mt)	12,482	31,618	44,100
Consumption (ODP tonnes)	1,373	3,478	4,851
Total cost (US \$)	207,351,000	525,236,000	732,587,000
Costs from the Multilateral Fund (US \$)	122,199,000	309,540,000	431,739,000
Counterpart funding (US \$)	85,152,000	215,696,000	300,848,000

Implementation arrangements

51. A project management office (PMO) with full responsibility to implement phase I of the Foam Sector Plan will be established. It will include staff and experts from the PMO for the CFC phase-out plan. The PMO will be responsible for all day-to-day functions including coordination, preparation, implementation, and review of the work programme and relevant reports, procurement, financial management, project information management, and supervision and evaluation of conversion projects. A project operations manual will be developed by the PMO.

52. The World Bank will provide experience of alternative technologies, review the phase-out project proposals and phase-out contracts, review and clear terms of reference for all technical assistance

activities, field visits to beneficiary enterprises, and discuss with FECO and relevant stakeholders on addressing issues that may arise during project implementation. Supervision missions will be carried out every year to follow up with FECO. The World Bank will carry out verification of the HCFC-141b phase-out targets for 2013, 2014, and 2015.

53. The World Bank will sign a Grant Agreement with the Ministry of Finance to channel grant funds from the Multilateral Fund to China. The Ministry of Finance will appoint FECO to implement the Foam Sector Plan and to allow FECO to establish a project account for the Multilateral Fund grant funds. To channel resources to beneficiary enterprises, FECO will sign phase-out contracts with individual foam enterprises. Beneficiary foam enterprises will be responsible for implementing their own phase-out activities and are required to submit implementation progress reports to relevant authorities. They also will be required to allow and facilitate visits and inspections from FECO, local Environmental Protection Bureaus and the World Bank.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

HCFC consumption and phase-out scenario

54. Further to the submission of the Foam Sector Plan, the Government of China submitted a summary of the overarching strategy. The 2009 level of HCFC-141b consumption in the polyurethane foam sector reported in the overarching strategy is 436.8 ODP tonnes (3,971 mt) higher than the consumption in the Foam Sector Plan (i.e., over 8 per cent higher). Moreover, the baseline consumption estimated in the Foam Sector Plan of 17,417 ODP tonnes is 1,683 ODP tonnes lower than the estimate in the summary of the overarching strategy (19,100 ODP tonnes). The explanation provided in the summary is that the data in the Foam Sector Plan was based on information available before May 2010. The World Bank indicated that while the Foam Sector Plan has since been updated with the latest information presented in the HPMP, the total proposed amount of HCFC-141b to be captured by the Foam Sector Plan remains unchanged.

55. To meet the 2013 and 2015 HCFC control levels, the Government of China proposes to reduce HCFC consumption from the forecasted 2012 consumption of 19,446 ODP tonnes, and not from the latest reported consumption (16,587 ODP tonnes for 2009 as quoted in the PU Foam Sector Plan project proposal submitted by the World Bank) or the estimated baseline (17,417 ODP tonnes). This approach represents a departure from the policies and guidelines of the Multilateral Fund. The World Bank indicated that the calculation reflects best estimates of the total amount of HCFCs to be phased out taking into account the rise in HCFC consumption expected to accompany forecasted gross domestic product (GDP) growth in China. In addition to the funding obtained from the Multilateral Fund, which China fully agrees is determined by the baseline (i.e. average of 2009 and 2010 consumption), China will have to make great efforts to control the HCFC-141b consumption growth rate (5 per cent for 2011 and 3 per cent only for 2012) with an estimated GDP growth of about 10 per cent. Thus, what is required for meeting phase-out obligations and what can be funded by the Multilateral Fund is not necessarily the same, particularly given recent decisions adopted by the Executive Committee.

56. Considering that 1,615 ODP tonnes (14,685 mt) of HCFCs would be phased out through the Foam Sector Plan (i.e., 1,373 ODP tonnes to be deducted from the starting point, and an additional 242 ODP tonnes will be phased out without assistance from the Fund), only an additional 83 ODP tonnes of HCFCs would need to be phased out from other manufacturing sectors. The basis for this calculation is presented below:

- (a) The estimated HCFC baseline consumption for compliance is 17,417 ODP tonnes. Accordingly, 1,742 ODP tonnes of HCFC would need to be phased out to meet the 2013 and 2015 phase-out targets;
- (b) The Executive Committee has approved several HCFC demonstration and investment projects with a total consumption of 44 ODP tonnes;
- (c) Deducting the amounts of HCFCs to be phased out from the Foam Sector Plan and from approved projects (a total of 1,659 ODP tonnes) leaves an additional 83 ODP tonnes of HCFCs that would need to be phased out from other manufacturing sectors.

57. In addressing the above issue, the World Bank indicated the Government of China fully agrees that the HCFC baseline for compliance determines the HCFC consumption eligible for Multilateral Fund funding. HCFC-141b consumption will continue to grow after 2010 as only a small portion of the HCFC consumption can be addressed between 2011 and 2013. Therefore, in order to ensure that China meets the first two Protocol milestones, the amount of HCFC to be phased out would need to take into account estimated HCFC-141b consumption growth and China's GDP growth. The enterprises to be converted in phase II of the Foam Sector Plan (i.e., after 2014) were expected grow at a 7 to 10 per cent growth in HCFC-141b consumption compared to a consumption growth of only 3 to 5 per cent in enterprises covered by phase I. The resulting estimated extra national consumption to be phased out at China's own cost would require strong policy actions, such as the control of HCFC-141b supply through production quotas. Close cooperation with the foam industry through technical support would also be necessary to ensure that HCFC-141b consumption stays within the agreed levels. The policy and technical assistance activities proposed in the Foam Sector Plan addressed those issues. The World Bank acknowledged that the phase-out impact of foam demonstration projects is to be deducted from the Foam Sector Plan's aggregate HCFC consumption level.

58. The World Bank also indicated that the 1,615.4 ODP tonnes (14,685.0 mt) of HCFC-141b consumption to be phased out was calculated from the forecasted level of HCFC consumption in 2012. The HCFC-141b consumption in the three priority sectors (refrigerators and freezers; reefer vehicle and container; and small electrical appliances) is estimated to be around 1,386.8 ODP tonnes (12,607 mt) in 2012. The remaining consumption of 228.6 ODP tonnes (2,078 mt) of HCFC-141b to be phased out will be addressed through contracts with about 20 large enterprises in the pipe insulation, solar water heater and foam panels sub-sectors.

Method used and assumptions made to obtain data

59. The level of HCFC-141b consumption in the Foam Sector Plan was calculated on the basis of the enterprises surveyed, which were chosen from the Chinese Foam Association members' list according to geographic distribution, foam application and size of the company, with a focus on enterprises that had not been funded under CFC phase-out. Consumption was also calculated based on a review by sub-sector experts and regional reports presented at a workshop, and reported data on the consumption of polymeric methylene diphenyl diisocyanate (MDI) presented by a consultant. However, there is no evidence or data from the surveys to substantiate either the HCFC-141b consumption or its sectoral distribution. Further, there is no statistical relationship between MDI consumption and HCFC-141b consumption, since MDI is used in many types of polyurethane foam regardless of blowing agent. In addressing this issue, the World Bank indicated that the actual HCFC-141b consumption in a sector as large as the foam sector in China could only be deduced from a combination of various sources of information. With regard to the foam sector survey, even though it only covered 222 enterprises, of which 102 were funded for CFC phase-out, the enterprises represented a broad spectrum of the industry and over 15 per cent of the overall consumption in the foam sector. The other main sources of information were: HCFC-141b production and

domestic sales of HCFC-141b; the amount of HCFC-141b consumption remaining once consumption in the solvent sector had been deducted from overall consumption; and data from polyol suppliers on the blowing agents used by various types of foam producers.

Review of technologies

60. The total cost of phasing out 44,100 tonnes of HCFC-141b used in the polyurethane foam sector in China has been estimated at US \$732,587,000, with a cost-effectiveness value of US \$16.61/kg. The total cost of phase I of the Foam Sector Plan is also estimated to be US \$207,351,000 to phase out 12,482 tonnes of HCFC-141b (at US \$16.61/kg). Since the threshold value for rigid PU foam for use of low global warming potential (GWP) technologies is US \$9.79/kg, US \$122,199,000 is being requested from the Multilateral Fund and the remaining US \$85,122,000 would be provided from sources outside the Fund. The high cost of the overall plan is due largely to the selection of hydrocarbon technology in a large number of small and medium size enterprises (with HCFC-141b consumption below 50 tonnes). Much of this cost, including the country's funding contribution, could be reduced by introducing other more cost-effective technologies. This also influences the strategies and the prioritization of projects to be converted. It is noted that the only two technologies proposed in the Foam Sector Plan are hydrocarbons (blended at the foam manufacturing enterprises, except for small enterprises where hydrocarbon-based pre-blended systems will be provided), and HFC for a limited number of enterprises.

61. The World Bank indicated that the selection of hydrocarbon technology was based on the following: the substitute technology should be mature and generally accepted by the industry; the blowing agent should be available in sufficient quantities and at a reasonable price on the local market; and, in line with the central policy objective of the Government of China to mitigate climate impacts, a low carbon solution takes priority (which is also in line with decision XIX/6 of the Parties). While the up-front investment cost could be higher, hydrocarbon technology meets the above criteria. Given the very limited time frame for implementation, the Government does not see any other viable option at this point.

62. In the past, the cut-off for applying hydrocarbon technology has been 50 tonnes of ODS consumption, as enterprises with consumption below this level are usually not cost-effective (in a few cases consumption in the range of 30-50 tonnes has been accommodated). It is still expected that for conversion to hydrocarbon technology the minimum level of consumption of 50 tonnes will be observed. The World Bank indicated that the 50 mt was calculated based on economic rate of return only. With the Parties' decision that climate impacts should be taken into account and considering the cost of CO₂ reductions under an alternative scenario, a lower cut-off volume is justified. Conversion of 2.8 ODP tonnes (25 mt) of HCFC-141b foam to hydrocarbon technology would result in an estimated annual reduction of 19,000 tonnes CO₂-equivalent. With an investment of US \$900,000 at 10 per cent interest and a payback time of 5 years, the annual cost is approximately US \$240,000. The cost per ton of CO₂-equivalent is US \$12.5. This very simplified calculation shows that, even down to a consumption of 2.2 ODP tonnes (20 mt) of HCFC-141b, investment in hydrocarbon seems justified from a climate perspective. With the potential for HC preblended polyols, the threshold could go as low as 1.1 ODP tonnes (10 mt) of HCFC-141b. The World Bank further argued that the burden of lower cost-effectiveness would be borne by the enterprises or other sources of funds, not by the Multilateral Fund. The total HCFC consumption that small enterprises accounted for in the foam sector also meant that they had to be included in order to meet the 2013 and 2015 compliance targets.

63. The selection procedure for alternative technologies should also consider the potential for using recent developments in technologies that could be particularly important for small and medium sized enterprises. Among these technologies is methyl formate, which can be used pre-blended, in-line blended and direct-injected into the mix-head, making it a more versatile process. It has also a lower cost than HCFC-141b (US \$1.65/kg compared to US \$1.84/kg for HCFC-141b), and has a low GWP. The

demonstration project approved by the Executive Committee for the use of methyl formate as a blowing agent in Article 5 countries has been completed (a report is presented in document UNEP/OzL.Pro/ExCom/62/9). This technology is established in commercial polyurethane production in various countries in the world. Substantial amounts of methyl formate (5,000 tonnes/year) are manufactured by one of the leading chemical manufacturing companies in Asia, Feicheng Acid Chemicals Co. Ltd. in Shandong Province. Also Yantai Wanhua Polyurethanes, a leading manufacturer of MDI and rigid and flexible foam systems is a trade partner to Australian Urethanes Systems, the sole distributor of the ecomate (i.e., methyl formate) blowing agent in Australia, New Zealand, and the Asia Pacific region, including China and India. In regard to the selection of cyclopentane technology in the reefer container sub-sector, it was noted that, on the basis of thermal conductivity alone, both methyl formate and HFCs are superior to cyclopentane as alternative blowing agents to HCFC-141b.

64. The World Bank indicated that both China and the Bank fully agreed with the Secretariat that there should be a cost-effective phase-out and use of low carbon substitutes for HCFC-141b. Some zero ODP blowing agent technologies (i.e., HFCs) have indeed been tried by the industry during the last two years. HFC-365mfc/HFC-227ea can be used with the same foaming equipment in the baseline without any modification. However, since the price of HFC-365mfc/HFC-227ea is about 5-6 times higher than that of HCFC-141b, the replacement is only limited to those cases where overseas end-users specified HFC-365mfc/HFC-227ea as the blowing agent. The HCFC phase-out strategy is therefore limiting the use of HFCs only to those applications where there are no other solutions available. While the experts recognized that methyl formate deserved full consideration as a potential substitute, their reasons for not choosing methyl formate were: the fact that it is as yet untested and unproven; the need for safety measures to deal with flammability; the lack of information in the public domain on methyl formate preblended polyols; concerns about foam stability and insulation performance; and the wide range of foam applications, not all of which would be suitable for methyl formate as the blowing agent. Without more testing and information on the performance of methyl formate blown foam over time, and more information on how flammability questions can be addressed, the foam industry in China would not be willing to adopt methyl formate as a substitute, and would stick to HCFC-141b. The World Bank indicated that the systems houses (Feicheng Acid Chemicals Co. Ltd and Yantai Wanhua Polyurethanes) are well known to Foreign Economic Cooperation Office of the Ministry of Environment Protection. One of the systems houses did not want to provide information due to a confidentiality agreement with the technology provider. The other company does not work with methyl formate.

Enterprise selection

65. The levels of consumption in the 140 companies included in phase I of the Foam Sector Plan range from less than 20 tonnes to over 500 tonnes (five enterprises). Given that the phase-out strategy depends almost exclusively on the use of hydrocarbon technologies, this approach implies a counterpart contribution of over 40 per cent of the total estimated funding. On this important issue the World Bank indicated that, based on the survey, while the majority of companies in the three main subsectors chosen for phase I were larger companies, there were still a number of smaller companies. Such enterprises would be supported through provincial support centers for the use of hydrocarbon pre-blended polyols. With regard to cost-effectiveness, even with consumption of only 1.1 ODP tonnes (10 mt) of HCFC-141b, hydrocarbon technology remained an attractive solution from a climate perspective.

66. The information presented in the project document did not seem to indicate that the micro-scale enterprises, which account for half of the estimated 3,500 PU foam enterprises in the country and possibly between 10 and 15 per cent of the annual HCFC-141b consumption, had been incorporated into the Foam Sector Plan. The World Bank responded that HCFC-141b consumption control and phase-out in the small and micro-scale enterprises (which represent about 88 per cent of the 3,500 enterprises but less than 10 per cent of the HCFC-141b consumption) would be subject to HCFC-141b production control and

other policies that would be issued during phase I. While the present calculation used in the Foam Sector Plan for these enterprises is based on HFC and water-blown technologies, there are no appropriate alternative technologies at this time to deal with these small users. Therefore, the only associated project costs would be technical support for conversion, and incentives for the use of pre-blended polyols from systems houses, as well as training workshops.

Cost-related issues

67. The calculations of eligible costs are based on assumptions and averages that are not normally used to assess the incremental cost to be paid by the Multilateral Fund. Given the magnitude of the project, and the substantial amount of project preparation funds approved for the Foam Sector Plan, the chosen approach seems unreliable, as recognized in the project document, i.e., “based on the survey, the following assumptions are made: large size companies would have at least 2 foaming units, 1 of 150 kg/min and 1 of 80 kg/min; medium size companies would also have on average two units, one of 80 kg/min and one of 40 kg/min. The assumptions are very simplified, as the size of foaming units would depend on type and size of products produced. For the smaller companies, it is assumed that retrofitting to hydrocarbon is not possible and the existing foaming unit would have to be replaced by a new high pressure foaming unit of 40 kg/min”. The overall calculation of the total incremental cost of the Foam Sector Plan (US \$732,587,000) has been based on these very broad assumptions. The assumption that all enterprises in a given size range are identical appears to be incorrect for the following reasons: a medium company making, for example, refrigerators will not have the same requirements as a medium company making small household appliances. The range of a medium size company is between 25 and 75 mt /year. However, the requirements of a 25 mt /year company will not be the same as those of a 75 mt /year company.

68. The World Bank indicated that, with over 3,500 foam companies and a consumption of over 4,400 ODP tonnes (40,000 mt) of HCFC-141b, the chosen approach was the best way to calculate the phase-out cost to China and the Multilateral Fund, unless one simply used an average cost-effectiveness based on historical CFC cost-effectiveness. The approach had been used successfully for other sector plans in the past, and the cost calculation was supported by experience in the implementation of individual projects, the CFC Foam Sector Plan, and information from over 200 foam companies covered by the survey. The World Bank acknowledged the Secretariat’s concern that the approach might be too simplistic, which is why conservative assumptions had been used for both the number of foaming units and production lines.

69. The method for calculating eligible incremental costs described in the project document mixes replacement with retrofit. That method cannot be used, as there has been difficulty in discriminating between replacement and retrofit costs. Therefore, the incremental cost calculation should be based on retrofits of the foam machines irrespective of their origin. Based on information from various foam equipment manufacturers given to the Secretariat’s consultants, the maximum cost for retrofitting a foam dispenser to the use of hydrocarbon is about 50 per cent of the cost of a new machine with a pentane add-on and the cost of installation. The World Bank indicated that the cost of retrofitting all foaming equipment had been calculated as part of preparation for the Foam Sector Plan, and showed that the overall cost to China for phase I would be lower. However, using the retrofitting cost would still put overall costs over the cost-effectiveness threshold of US \$9.79/kg agreed by the Executive Committee. Retrofitting costs had also been investigated as part of the preparation of the demonstration projects. Any retrofit costs would include a fixed cost for travelling and work on site, independent of the size of the foaming unit, and a variable cost related to the specific foaming machine. A flat rate of 50 per cent was not consistent with the information available to the Chinese foam team and the World Bank.

70. Except for super-large and large enterprises, the majority of foam enterprises rely on pre-blended polyols rather than in-house pre-blending. In China, nearly 57 per cent of total polyurethane blowing agent consumption is pre-blended. Given the opportunity, enterprises would prefer to continue with the same manufacturing process using pre-blended systems, thus avoiding pre-blending *in situ*. However, the Foam Sector Plan has given only limited consideration to this fact, and to the presence of 66 system houses in China (as listed in the document). For instance, the cost calculation is based on providing premixing facilities at every medium and large size enterprise introducing hydrocarbon technology, and every enterprise introducing HFC-245fa technology. Where facilities are available, the eligible project cost ought to be based on the use of pre-blended systems. The World Bank indicated that setting up hydrocarbon premixing facilities at the 66 system houses would certainly not be a cost-effective approach during phase I of the HCFC phase-out. There was, however, some risk attached to assuming the feasibility of pre-blended polyols with hydrocarbons at the country level. At the enterprise level, the cost of pre-blending was higher than in-house blending for single companies using different formulations, and high transportation costs made pre-blending an even less attractive option. Furthermore, the 66 systems houses in China are oriented towards small enterprises, and their production capacity is limited to the extent that they cannot meet the needs of medium and large size enterprises. If those larger enterprises choose a systems house approach, more systems houses will be required. As for HFC-245fa, it is intentionally avoided when selecting alternative technologies because of its high GWP. Only some enterprises in the spray foam subsector employ HFC-245fa for safety reasons.

71. The estimated cost for the conversion of the five super large enterprises is exceedingly high (US \$3,399,000 for an enterprise where 5 foam units will be retrofitted, to US \$5,874,000 for an enterprise where 10 new foaming units are requested). The number of equipment items being requested for the conversion to hydrocarbon technology is excessive and cannot be justified. These include, among others: 6 storage tanks and 5 pre-mixers with 10 buffer tanks and 10 new foaming machines for each company (at a cost of US \$300,000 for each foam dispenser). With regard to the tanks, it is stated that as hydrocarbons are available in China and can be delivered to companies within a week or so, it is suggested that hydrocarbon tanks to be provided by the project should be sufficiently large for holding three months supply. As the hydrocarbon is readily available, one would expect at most monthly supply, thereby reducing the proliferation of tanks on the premises with corresponding risk reduction. Similarly, the need for 5 pre-mixers appears to imply one pre-mixer for each tank without taking into account the output of a pre-mixer in a situation where only one type of foam formulation is premixed. In such a situation, the estimates for levels show that one pre-mixer would suffice. As previously mentioned, without a detailed description of these super large plants, the eligible incremental costs cannot be assessed.

72. The World Bank reviewed the information from the available super large companies, and indicated that there were 4 reefer companies with consumption between 77.0 and 231.0 ODP tonnes (700 and 2,100 mt) of HCFC-141b as well as another company with a consumption of 88.0 ODP tonnes (800 mt). Those super large companies had between 10 and 20 high pressure foaming units, with between 6 and 10-300 kg/min units. The World Bank agreed with the Secretariat that all high pressure units should be retrofitted. The Secretariat's information on Yangzhou is correct, but as seen from the survey, only with a HCFC-141b consumption of 30 mt /year. The Bank also fully agrees with the Secretariat that the hydrocarbon storage tanks should be larger tanks, with the number depending on several factors. As noted by the Secretariat, supply of hydrocarbon should be simple; however, for larger companies with a consumption of between 77 and 231 ODP tonnes (700 and 2100 mt) of HCFC-141b, the logistics and plant lay-out is more complicated. On the pre-mixers, the World Bank agrees with the Secretariat's observation. The number of premixing units would be plant-specific and can only be decided upon actual design of the conversion. The conversion in itself will be complicated due to the volume of business and the cost of interruption. While fewer pre-mixing stations might be possible, their capacity may have to be

increased, which might end up being more costly. While some cost adjustments could be made, the overall cost for that group of companies reflects the investments needed and should remain as is.

73. The requested amount of incremental operating cost (IOC) for the use of hydrocarbon in the three sub-sectors for the whole range of HCFC-141b consumption (from small to super large enterprises) is based on US \$2.88/kg of HCFC phased out, and not on US \$1.60/kg as decided by the Executive Committee (decision 60/44 f(v)). The World Bank reported that it had calculated incremental operating costs to indicate the full cost to China, which exceeded the threshold, but the overall funding of the project was based on the cost-effectiveness threshold of 9.79 US\$/kg (when low-GWP alternatives are used).

Cost-effectiveness

74. It is noted that the level of funding requested for the implementation of the Foam Sector Plan is based on the cost-effectiveness threshold for rigid PU foam of US \$9.79/kg (including the additional 25 per cent for the introduction of low-GWP technologies). In analyzing the unit costs as proposed in the original proposal for the conversion of the “typical” production lines to hydrocarbon technologies (with either new or retrofitted foam units), it is noted that the cost effectiveness is below US \$9.79/kg only in a very few cases. For small enterprises, the average cost effectiveness is almost three times over the threshold, while for enterprises with consumption below 1 metric tonne, the cost effectiveness exceeds the threshold more than 30 times. Accordingly, major counterpart funding would have to be provided at the enterprise level; for low and medium sized enterprises, the counterpart contribution could be between 50 and 97 per cent of the total cost (Table 7). Based on this analysis, it is clearly demonstrated that hydrocarbon technology might be a cost-effective technology only in enterprises with large consumption of HCFCs (at least 75 tonnes).

Table 7. Cost/benefit analysis of the use of hydrocarbon technologies

Description*	Large new	Large retrofit	Medium new	Medium retrofit	Small new
Total cost/line (US\$)	1,119,800	855,800	671,000	458,700	282,700
Consumption (tonne/yr)					
Low	75	75	25	25	1
High	130	130	75	75	25
Average	110	110	35	35	10
CE US\$/kg					
Low	14.93	11.41	26.84	18.35	282.7
High	8.61	6.58	8.95	6.12	11.31
Average	10.18	7.78	19.17	13.11	28.27

* Large enterprises: consumption > 75 tonnes; medium enterprises: consumption <75 and >25 tonnes; small enterprises: consumption < 25 tonnes. New relates to providing a new foaming unit while retrofit relates to retrofitting the foam unit in the baseline.

75. The World Bank believes that the HCFC phase-out strategy adopted for the foam sector is consistent with the guidance provided by the Parties and the Executive Committee, as it addresses the climate aspect while avoiding reliance on HFCs. The three subsectors are targeted for the same reason, as the alternative technology to HFCs is well-established, it is proven technology, and it is available in China (hydrocarbon). The Government of China also recognizes that some companies will have to provide co-financing. While it is an overall implementation concern, it does not impact the Multilateral Fund funding requested, which remains limited within the threshold as decided by the Executive Committee.

Alternative cost-effective approach

76. The Secretariat further reviewed the Foam Sector Plan in light of the World Bank's responses to the issues raised on the Plan, and the additional information provided on 81 of the 222 enterprises surveyed during its preparation. From a review of the additional information on the enterprises surveyed, the following observations were made:

- (a) Seventy-eight (of the 81 enterprises) reported a total HCFC-141b consumption of 12,311.4 mt (1,354.2 ODP tonnes) in 2008. The consumption by these enterprises ranged from 1.2 mt (0.1 ODP tonne) to 2,127.6 mt (234.0 ODP tonnes). Three enterprises did not report consumption of HCFC-141b;
- (b) The 13 largest enterprises, including the five manufacturers of reefers, had a total consumption of 7,967.3 mt (876.4 ODP tonnes), i.e. accounted for 65 per cent of the total consumption of HCFC-141b of the 78 enterprises surveyed;
- (c) Twenty enterprises have non-Article 5 capital ownership ranging from 5 to 100 per cent. The total amount of HCFCs used in 2008 by these enterprises was 864.2 mt (95.1 ODP tonnes), or 23.3 per cent of the total consumption by all enterprises surveyed;
- (d) Twenty-nine enterprises manufacturing refrigerators and freezers, electric water heaters, reefer containers and, to a lesser extent, solar powered water heaters, export between 2 and 100 per cent of their total production to other countries there is no indication on the level of export to non-Article 5 countries;
- (e) Given the level of information provided, the requirements for the conversion of the super large and large enterprises (with HCFC-141b consumption over 75 mt) manufacturing insulation foam for reefers, refrigerators and freezers, small household appliances and pipe insulation, and the medium sized manufacturers of refrigerators/freezers (with a consumption between 25 mt and 75 mt), could not be better assessed;
- (f) Only 18 small (consumption below 25 mt) and 18 medium sized (consumption between 25 and 75 mt) enterprises were surveyed, even though such enterprises represent more than 75 per cent of all those in the country. The level of information provided was not sufficient to assess the incremental costs associated with the conversion of these enterprises.

77. Given the scale of conversion activity, lack of baseline information on the foam producing SMEs, the disparities in the technical capacities between the large scale enterprises on the one hand and the SMEs on the other as well as the limited time available to achieve the required HCFC-phase-out targets, the Secretariat concluded that the most appropriate, cost-effective, timely approach to meet the 2013 and 2015 phase-out targets in the PU foam sector, should be the conversion to hydrocarbon technology of 78 mainly "super large and large" enterprises manufacturing insulation foam for reefers, refrigerators and freezers (also including all medium-sized enterprises), refrigerated trucks, water heaters and pipe insulation, with a total HCFC-141b consumption of over 13,250 mt (2008), as shown in Table 8. This approach also has the advantage of enabling China in the interim, drawing from the sector management funds built into the programme, to get a better understanding of the SME subsector and as well as to undertake awareness activities that could better prepare the subsector for cost-effective HCFC phase-out. The 2008 consumption of 13,250 mt targeted to be phased out will reach 17,340 mt (1,907.4 ODP tonnes) by 2012 based on the growth rate of the industry as forecast by the Government of China.

Table 8. Foam enterprises to be converted before 2015

Enterprises	No of enterprises	HCFC consumption (mt)				
		2008	2009	2010	2011	2012
Reefers	5	6,299.6	6,929.6	7,622.6	8,003.7	8,243.8
Large refrigerators/freezers	15	2,183.0	2,401.3	2,641.4	2,773.5	2,856.7
Medium refrigerators/freezers	25	796.6	876.3	963.9	1,012.1	1,042.4
Large refrigerated trucks	10	1,009.0	1,109.9	1,220.9	1,281.9	1,320.4
Large water heaters	8	841.4	925.5	1,018.1	1,069.0	1,101.1
Large pipe insulation	15	2,123.0	2,335.3	2,568.8	2,697.3	2,778.2
Total	78	13,252.6	14,577.9	16,035.7	16,837.5	17,342.6

78. In addition to phasing out over 17,300 mt of HCFC-141b, the proposed phase-out approach has the added advantages of converting only 78 enterprises (rather than the 140 originally proposed, plus the conversion of a large number of small enterprises to phase-out an additional 1,979 mt in the “other” (undefined) sector) and introducing only one technology, i.e., hydrocarbon³.

79. From the information provided in the Foam Sector Plan and complemented with data from the 81 surveyed enterprises, the Secretariat was able to calculate the total amount of HCFC-141b used by each group of enterprises (i.e., reefers, insulation foam for refrigeration equipment, pipe insulation) including ineligible consumption due to the foreign ownership component of some enterprises or enterprises that were established after the 21 September 2007 cut-off date.

80. Given the number of enterprises to be converted, the limited description of the baseline equipment provided in the Foam Sector Plan, and based on the large number of projects for the introduction of hydrocarbon technology in large enterprises so far approved under the Multilateral Fund, the Secretariat proposed for each group of enterprises the costs of all items of equipment required for the conversion of similar size enterprises, *inter alia*, hydrocarbon storage and blending system; foaming equipment including retrofit of moulds, jigs and conveyors; and safety equipment. Operating costs were calculated based on the difference in price and amounts required between the blowing agents (US \$1.83/kg for HCFC-141b and US \$1.99/kg for cyclopentane). As per the guidelines of the Multilateral Fund, the proposed costs for the conversion were adjusted, as appropriate, to make deductions for the foreign ownership component of some enterprises and export of refrigerators and freezers to non-Article 5 countries and funding for enterprises established after the 21 September cut-off date. Based on this approach, the total estimated cost for the conversion of the 78 foam enterprises was determined as presented in Tables 9 and 10.

Table 9. Incremental cost analysis for the conversion of five enterprises manufacturing reefers

Description	Qing Dao Mashiji	Shang Hai Zhongji	Qing Dao Zhongji Reefer	Shang Hai Shengshi	One additional
HCFC consumption (mt)	1,136	1,617	2,128	719	700
Costs (US\$)					
HC storage/blending	582,000	776,000	970,000	388,000	388,000
Retrofit of foaming unit	900,000	1,200,000	1,500,000	600,000	600,000
Safety equipment	414,000	534,000	672,000	276,000	276,000
Technical support	130,000	130,000	130,000	100,000	100,000
Subtotal cost	2,026,000	2,640,000	3,272,000	1,364,000	1,364,000
Contingencies (10%)	202,600	264,000	327,200	136,400	136,400
Total capital cost	2,228,600	2,904,000	3,599,200	1,500,400	1,500,400
Operating cost	(237,098)	(337,588)	(444,128)	(150,108)	(146,125)

³ Hydrocarbon technology is very well established, widely used throughout the world, and cost-effective for the size and characteristics of the enterprises under consideration.

Description	Qing Dao Mashiji	Shang Hai Zhongji	Qing Dao Zhongji Reefer	Shang Hai Shengshi	One additional
Total project cost	1,991,502	2,566,412	3,155,072	1,350,292	1,354,275
Foreign ownership	(1,991,502)	(128,321)	-	(1,188,257)	-
Eligible incremental cost	-	2,438,091	3,155,072	162,035	1,354,275

Table 10. Incremental cost analysis for the conversion of enterprises manufacturing insulation foam for refrigerators, refrigerated trucks, water heaters and pipe

Description	Large refrigerators	Medium refrigerators	Refrigerated trucks	Water heaters	Pipe insulation
Number of enterprises					
Surveyed	13	9	3	4	6
Not surveyed	2	16	7	4	9
Ineligible	(1)	(1)		(4)	
Total eligible	14	24	10	5	15
HCFC consumption (mt)					
In surveyed enterprises	1,893	221	302	421	849
In non-surveyed enterprises	290	576	707	420	1,274
Ineligible (*)	(108)	(33)	-	(359)	-
Eligible consumption	2,074	764	1,009	482	2,123
Total costs (US\$)					
HC storage/ blending	147,000	75,000	142,000	142,000	142,000
Foaming equipment	270,000	110,000	255,000	255,000	255,000
Safety equipment	172,000	101,800	166,800	166,800	166,800
Technical support	50,000	30,000	50,000	50,000	50,000
Subtotal cost	639,000	316,800	613,800	613,800	613,800
Contingencies (10%)	63,900	31,680	61,380	61,380	61,380
Total capital cost/enterprise	702,900	348,480	675,180	675,180	675,180
Total capital cost	9,840,600	8,363,520	6,751,800	3,072,069	9,823,869
Total operating cost	-	-	(210,691)	-	(443,176)
Total project cost	9,840,600	8,363,520	6,541,109	3,072,069	9,380,693
Export adjustment (10%) (**)	(984,060)	(836,352)			
Grand total cost	8,856,540	7,527,168	6,541,109	3,072,069	9,380,693
Summary					
Total number of enterprises	15	25	10	8	15
Total HCFC consumption (mt)	2,183	797	1,009	841	2,123
Total project cost (US\$)	8,856,540	7,527,168	6,541,109	3,072,069	9,380,693

(*) Ineligible consumption due to foreign ownership or enterprises established after the cut-off date of 21 September 2007.

(**) 21 per cent export to non Article 5 countries by large and medium sized refrigeration manufacturing enterprises.

81. An additional US \$403,700 is proposed for hydrocarbon storage and blending systems and know-how required for the introduction of hydrocarbon based-pre-blended polyols in one systems house.

82. Based on the approach suggested by the Secretariat, the total eligible incremental cost for the conversion of the 78 foam enterprises and one systems house was estimated at US \$42,890,752. In addition to technical support at the enterprise level (including technology transfer and training) an additional US \$4,290,000 (i.e., 10 per cent of the total cost) was proposed for programme management, including awareness creation, monitoring and supervision, resulting in a total cost of US \$47,180,752 as shown in the Table 11.

Table 11. Total cost of stage I of the polyurethane foam sector in China

Foam enterprises	No. of enterprises	Cost (US\$)
Reefers	5	7,109,473
Large refrigerators/freezers	15	8,856,540
Medium refrigerators/freezers	25	7,527,168
Large refrigerated trucks	10	6,541,109
Large water heaters	8	3,072,069
Large pipe insulation	15	9,380,693
Subtotal manufacturing	78	42,487,052
Systems houses	1	403,700
Total incremental cost		42,890,752
Monitoring and supervision		4,290,000
Total incremental cost		47,180,752

83. In responding to the above suggestion by the Secretariat, the World Bank provided the following comments:

- (a) The Government of China and the national foam and chemical industry have jointly developed the overall strategy for phasing out HCFC-141b in the polyurethane foam sector. Policies, investment activities and technical assistance programmes have been proposed for meeting the 2013 and 2015 reduction targets and for ensuring a sustainable phase-out. The submission is the result of a thorough and exhaustive sub-sector level analysis of HCFC-141b consumption by sub-sector, viable and efficient alternative technologies, sustainability of phase-out, policies, regulations and enforcement, and implementability of actions within the limited timeframe available. It also reflects long and intensive consultations with the foam industry in China including foam manufacturers, polyol suppliers and chemical suppliers;
- (b) It is important to consider that the foam industry does not see any benefits in changing over to a new blowing agent. Without strong policies and regulations, foam enterprises will not sign phase-out contracts. Conversion to a new blowing agent is time consuming, expensive and requires substantive internal resources. As only retrofitting of existing foaming equipment is covered, conversion will stop of production for several months depending on the changes needed. In some cases, even relocation might be required for the use of hydrocarbon. Furthermore, all substitutes, including cyclopentane will result in higher production cost due to cost of chemicals and higher energy consumption. In order to ensure a level play field, enterprises are in favour of a clear cut-off date on a sub-sector level. The quality of the products manufactured using substitutes need to be confirmed. While cyclopentane is a well proven substitute, the enterprises will still have to ensure that the quality of the foam blown with hydrocarbon meets the national standards and the requirements of the customers. All these factors have been taken into consideration when developing the polyurethane foam strategy;
- (c) In developing the HCFC-141b phase-out strategy in China, strategies and experiences by non-Article 5 countries have been studied and used. While some non-Article 5 countries have stopped all use of HCFC-141b for foam production by a certain date, others have addressed the phase-out through specific schedules for each sub-sector. In all cases, a cut-off date for phase-out in a given foam sub-sector was established. China has adopted a similar approach;

- (d) The Secretariat’s proposal to address only the larger HCFC using companies was indeed considered and discussed in detail with the foam industry during the development of the phase-out plan. While this project-by-project approach might be an attractive approach, the reluctance of the companies to participate will be an issue. Another concern is the sustainability of the phase-out. While one could monitor the companies receiving funding, there are no guarantees that other HCFC-141b based enterprises in the same sub-sector might not take over their business during the conversion period, resulting in no real reduction of HCFC-141b at the end of the day;
- (e) As learned from the ODS phase-out activities, it is critical to address an ODS using sector through a sector level approach. The phase-out has to be supported by implementable and enforceable policies so that the 2013 and 2015 targets can be met and a sustainable phase-out achieved. Policies and regulations are the key instruments, in combination with the right financial incentives, to ensure that the phase-out is achieved as planned.
- (f) The impact of non-Article 5 ownerships and exports to non-Article 5 countries has been addressed on a sector level. The amount identified as ineligible for funding was extrapolated from the surveys as 2,203 mt;
- (g) Based on the above considerations, the Government of China does not agree with the approach and the cost suggested by the Secretariat. However, the World Bank and the Government of China will explore how to take into account the Secretariat’s cost template within the Government’s existing strategy.

Impact on the climate

84. The replacement of HCFC-141b used in the manufacturing of polyurethane foam products in China by hydrocarbon CO₂ blowing agent would avoid the emission of 10,211,819 tonnes of CO₂-equivalent into the atmosphere (Table 12).

Table 12. Impact on the climate

Substance	GWP	Tonnes/year	CO ₂ -eq (tonnes/year)
Before conversion			
HCFC-141b	713	14,577.9*	10,394,043
After conversion			
Hydrocarbon	25	7,289.0	182,224
Net impact			(10,211,819)

(*) Based on the 2009 HCFC-141b consumption

RECOMMENDATIONS

85. The Executive Committee might wish to consider the sector plan for phase-out of HCFC-141b in the foam sector in China in light of the Secretariat’s comments contained in document UNEP/OzL.Pro/ExCom/63/26.

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS

China

(I) PROJECT TITLE		AGENCY	
HCFC XPS Foam Sectoral Plan		Germany, UNIDO	
(II) LATEST ARTICLE 7 DATA		Year: 2009	18,584.6 (ODP tonnes)

(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)							Year: 2009		
Chemical	Aerosol	Foam	Fire fighting	Refrigeration		Solvent	Process agent	Lab Use	Total sector consumption
				Manufacturing	Servicing				
HCFC-123				4.0	2.0				6.0
HCFC-124					6.1				6.1
HCFC-133									
HCFC-141b		5,056.8				465.9			5,535.7
HCFC-142									
HCFC-142b		1,066.0		2.0	349.8				1,417.7
HCFC-22		1,353.0		6,221.6	3,456.2				11,030.8
HCFC-225ca						1.0			1.0
HCFC-225cb						0.0			0.0

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	To be determined	Starting point for sustained aggregate reductions:	n/a
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	0.0	Remaining:	n/a

(V) BUSINESS PLAN		2010	2011	2012	2013	2014	Total
Germany	ODS phase-out (ODP tonnes)	15.0	15.0	17.8	1.1	1.1	50.0
	Funding (US \$)	1,268,035	1,268,035	1,502,699	93,866	93,866	4,226,500
UNIDO	ODS phase-out (ODP tonnes)	0	16.2	18.6	18.6	18.6	72.2
	Funding (US \$)	0	1,372,741	1,575,975	1,575,975	1,575,975	6,100,665

(VI) PROJECT DATA			2010	2011*	2012*	2013*	2014	2015	Total
Montreal Protocol consumption limits			n/a	n/a	n/a	baseline	baseline	baseline – 10%	
Maximum allowable consumption (ODP tonnes)			n/a	n/a	n/a	19,100.0	19,100.0	17,190.0	
Project Costs requested in principle(US\$)	Germany	Project costs		1,680,000	1,680,000	1,980,000	660,000		6,000,000
		Support costs		187,600	187,600	221,100	73,700		670,000
	UNIDO	Project costs		27,160,000	27,160,000	32,010,000	10,670,000		97,000,000
		Support costs		2,037,000	2,037,000	2,400,750	800,250		7,275,000
Total project costs requested in principle (US \$)						28,840,000	28,840,000	33,990,000	103,000,000
Total support costs requested in principle (US \$)						2,224,600	2,224,600	2,621,850	7,945,000
Total funds requested in principle (US \$)						31,064,600	31,064,600	36,611,850	110,945,000

* Funding originally requested for 2010 to 2012 has been shifted to 2011 to 2013

(VII) Request for funding for the first tranche (2010)			
Agency	Funds requested (US \$)	Support costs (US \$)	ODS phase-out (ODP tonnes)
Germany	1,680,000	187,600	
UNIDO	27,160,000	2,037,000	
Funding request:	Approval of funding for the first tranche (2010) as indicated above		
Secretariat's recommendation:	Individual consideration		

**PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT
CHINA**

PROJECT TITLE(S)**BILATERAL/IMPLEMENTING AGENCY**

(a)	Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO ₂ with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd.	UNDP
(b)	Demonstration project for conversion from HCFC-22 to butane blowing technology in the manufacture of XPS foam at Shanghai Xinzhaio Plastic Enterprises Co., Ltd.	UNIDO and Japan

NATIONAL CO-ORDINATING AGENCY	Foreign Economic Cooperation Office, Ministry of Environmental Protection
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LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT**A: ARTICLE-7 DATA (ODP TONNES, 2009, AS OF OCTOBER 2010)**

HCFCs	18,584.6	
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B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, 2009, AS OF OCTOBER 2010)

(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)					Year: 2009				
Chemical	Aerosol	Foam	Fire fighting	Refrigeration		Solvent	Process agent	Lab Use	Total sector consumption
				Manufacturing	Servicing				
HCFC-123				4.0	2.0				6.0
HCFC-124					6.1				6.1
HCFC-133									
HCFC-141b		5,056.8				465.9			5,535.7
HCFC-142									
HCFC-142b		1,066.0		2.0	349.8				1,417.7
HCFC-22		1,353.0		6,221.6	3,456.2				11,030.8
HCFC-225ca						1.0			1.0
HCFC-225cb						0.0			0.0

CURRENT YEAR BUSINESS PLAN ALLOCATIONS		Funding US \$	Phase-out ODP tonnes
	(a)	500,000	4.3
	(b)	2,075,000	4.5

PROJECT TITLE:	(a)	(b)
ODS use at enterprise (ODP tonnes):	12.3	13.9
ODS to be phased out (ODP tonnes):	12.3	7
Project duration (months):	18 months	18
Initial amount requested (US \$):	1,973,300	1,750,020
Final project costs (US \$):		
Incremental Capital Cost:	1,533,000	1,452,400
Contingency (10%):	153,000	120,240
Incremental Operating Cost:	328,476	177,380
Total Project Cost:	2,014,766	1,750,020
Local ownership (%):	100%	100%
Export component (%):	0	0
Requested grant (US \$):	1,973,300	1,750,020
Cost-effectiveness (US \$/kg)	9.63	13.81
Implementing agency support cost (US \$): (UNDP)	147,998	
(UNIDO)		56,252
(Japan)		120,000
Total cost of project to Multilateral Fund (US \$):	2,121,298	1,936,272
Status of counterpart funding (Y/N):	Yes	Letters of commitment received
Project monitoring milestones included (Y/N):	Y	Y
SECRETARIAT'S RECOMMENDATION	Pending	Pending

PROJECT DESCRIPTION

86. On behalf of the Government of China the Government of Germany, as the lead implementing agency for the extruded polystyrene (XPS) foam sub-sector, has re-submitted to the 63rd Meeting the HCFC phase-out management plan for the XPS foam sector (XPS Foam Plan) in China, at a total cost of US \$144,770,399 (based on a full conversion of the enterprises). Of this amount, the Government is requesting US \$103,000,000 plus agency support costs of US \$7,945,000 (US \$6,000,000 plus agency support costs of US \$670,000 for the Government of Germany and US \$97,000,000 plus agency support costs of US \$7,275,000 for UNIDO), as originally submitted. The sector plan will phase out 592.0 ODP tonnes (10,031 metric ton (mt)) of HCFC-142b and HCFC-22 by 2015.

87. Four weeks after the XPS Sector Plan was submitted, UNDP and UNIDO also submitted the following two demonstration projects related to the XPS foam sub-sector, for which preparation funds were approved at the 60th Meeting (these two projects were also re-submitted to the 63rd Meeting):

- (a) Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO₂ with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd., at a total cost of US \$1,973,300 plus agency support costs of US \$147,998 for UNDP; and
- (b) Demonstration project for conversion from HCFC-22 to butane blowing technology in the manufacture of XPS foam at Shanghai Xinzhao Plastic Enterprises Co., Ltd., at a total cost of US \$1,750,020 plus agency support costs of US \$120,000 for Japan and US \$56,252 for UNIDO.

88. To have a comprehensive understanding of the XPS sector in China, this document presents both demonstration projects submitted by UNDP and UNIDO and the XPS Foam Sector Plan.

Background

89. The XPS Foam Sector Plan is part of the overall effort of the Government of China to meet the 2013 and 2015 HCFC phase-out compliance targets. It aims to ensure compliance with interim consumption reduction targets at the sector level through an appropriate policy and regulatory framework, coordinated technical assistance and investment activities, and to establish an effective implementation mechanism to support the long-term phase-out of HCFCs in the sector beyond 2015. The State Council of China approved the ODS Management Regulation with effect from June 2010 to support the first stage of HCFC phase-out. Based on the regulation, the consumption quota will be further developed to facilitate the control of HCFC consumption in all sectors including the XPS foam sector.

XPS foam sector in China

90. The XPS sector uses both HCFC-22 (60 per cent) and HCFC-142b (40 percent). The total HCFC consumption in XPS applications (measured in ODP tonnes) represents about 14 per cent of HCFC consumption in China. Given the commensurate growth in HCFC consumption in the XPS sector and the expected peak in consumption at a level of 2,878 ODP tonnes (48,776 mt) in 2012, a reduction of 338.0 ODP tonnes of HCFCs would be required to meet the 2013 control level and further 254.0 ODP tonnes to meet the 2015 control level respectively.

91. According to the HCFC survey, the demand for XPS-based foam products has been growing at a rate of 20 per cent and is expected to continue to grow at a rate of 10 per cent annually. Almost all the XPS foam produced in China is for the domestic market and is mainly used as insulation material in

buildings and cold storage, and in the roadbed of high-speed railways, airport runway and to outdoor mobile communication rooms. Given the volume of XPS foam products, transportation costs are high and thus almost every province and region has several small-and-medium sized XPS foam producers, resulting in about 500 XPS foam enterprises with 647 XPS production lines. The vast majority of XPS enterprises are categorized as small and medium sized enterprises (SMEs), privately owned with short business track records, insufficient financial and talent accumulation and lacking fully implemented management systems. Table 1 shows the distribution of the enterprises according to the level of HCFC consumption.

Table 1. Distribution of XPS foam enterprises according to their level of consumption (2008)

Consumption at the enterprise (mt)	Number of enterprises	% of total enterprises	Subtotal consumption (mt)	% of total consumption
Less than 50	357	71.4	8,520	24.4
Between 50 and 200	117	23.4	14,180	40.6
Over 200	26	5.2	12,200	35.0
Total	500	100.0	34,900	100.0

92. The XPS foam enterprises tend to use equipment manufactured in China. Normally two extruders are installed in series⁴. The production capacity is usually 300-400 kg/h. The injection pumps of the blowing agent are normally plunger pumps and blowing agent leakage occurring easily. There are over eight manufacturers of XPS production lines in China as shown in Table 2.

Table 2. Manufacturers of XPS production lines in China

Name of suppliers	Production lines sold
Shanghai Xinzhao Plastic Enterprise Co., Ltd	300
Feininger (Nanjing) Energy Saving Technology Co., Ltd	250
Shanghai Jwell Machinery Co., Ltd	200
Qingdao Deyili Plastic Machinery Co., Ltd	75
Shandong Tongjia Machinery Co., Ltd	56
Beijing Fuxing Wang China Extrusion Equipment Ltd	25
Tianjin Tiande Rubber and Plastic Machinery Co., Ltd	15
Other	50
Total	971

Technology selection

93. Following consideration of alternative technologies, CO₂ (80 per cent of the enterprises) and hydrocarbons (20 per cent of the enterprises) had been selected as replacements for HCFC-142b/HCFC-22 blowing agent. These technologies are already established in the XPS foam industry in several countries.

Phase-out strategy

94. The Government of China plans to target 40 larger XPS foam enterprises (with annual HCFC consumption over 100 mt) during phase I of the XPS Foam Sector Plan, as these companies consume more than 40 per cent of the total HCFC consumption in the XPS foam sector. The experiences gained and lessons learned from these conversions will be transferred to the smaller companies in phase II.

⁴ The first extruder is a single screw extruder with the screw diameter of 120-135 mm and length-diameter ratio (L/D) of 30-32 and in a few enterprises the first extruder has twin screws with the screw diameter of 70-92 mm. The second extruder is, with rare exceptions, a single screw extruder with the screw diameter of 150 mm, L/D of 34-35.

Cost of the XPS Foam Sector Plan

95. According to the HCFC survey, there are 54 large enterprises with 108 production lines, with a total consumption of 13,552 mt (i.e., an average consumption of 251 mt/enterprise). Through phase I of the XPS Foam Sector Plan, 40 enterprises manufacturing in 43 workshops (enterprises with more than four production lines operate in two workshops) will be converted to CO₂ and hydrocarbon technologies as shown in Table 3.

Table 3. XPS foam enterprises to be converted in phase II

Number of XPS lines	Percentage	Number of workshops		
		CO ₂ technology	HC technology	Total
1 line	31%	11	3	14
2 lines	52%	18	4	22
3 lines	17%	6	1	7
Total	100%	35	8	43

96. The introduction of the CO₂ or hydrocarbon alternative technologies requires installation storage tank and accessory, retrofit of extruder and die; installation of safety equipment (ventilation system, gas detector system, explosion proof electrical components, fire-proof components and static prevention components), civil work, technical and safety training; and technology transfer, trials, product testing and safety certification. The capital costs for the conversion to CO₂ technology at the enterprise level have been estimated at US \$1,426,590 for one production line, US \$2,566,630 for two production lines, and US \$3,715,580 for three production lines, while for the conversion to hydrocarbon technology the estimated costs are US \$1,253,340 for one line, US \$2,265,780 for two lines, and US \$3,268,980 for three lines. Incremental operating costs⁵ have been estimated at US \$2.89/kg for CO₂ technology and US \$1.43/kg for hydrocarbon technology.

97. The total incremental costs for HCFC phase-out in the XPS foam sector is US \$94,800,000. An additional US \$8,200,000 is being requested for technical assistance, including project management unit, training workshops, technical consultant services, the establishment of a technical support system, revision of technical standards and formulation, public awareness activities and further strengthening of the policy and regulatory framework. The costs are calculated on the basis of the established threshold of US\$8.22/kg plus a 25 per cent increase due to the introduction of low GWP alternative technologies.

Co-financing

98. The sector plan proposal states that the required conversion costs exceed the funds requested due to cost-effectiveness limitations. Additional co-financing to cover the difference for any new equipment will be sought from private companies. The Government of Germany has also approached KfW Bankengruppe, a German development bank, for the provision of preferential debt funding in cooperation with local banks. However it has been indicated that co-financing opportunities are at this stage still uncertain, and are not a reliable alternative to funding from the Multilateral Fund. Co-financing could be used to strengthen the ability to reach the climate and ozone benefits targeted under the sector plan but not as a replacement for support from the Fund.

⁵ Raw materials which influence the operating cost of XPS foam production include the blowing agents (i.e., HCFCs, hydrocarbon, CO₂, ethanol and HFCs), fire retardants and polystyrene resin.

Climate impact

99. Introduction of the CO₂ and hydrocarbon technologies in the XPS foam sector, would result in an annual reduction of 20.2 million tonnes CO₂-equivalent that would have been emitted into the atmosphere.

Implementation arrangements

100. The Government of Germany (as the lead agency) in cooperation with UNIDO and the Project Management Office (PMO) are committed to carrying out the phase-out activities within a very limited time frame. The PMO has overall responsibility for the sector plan. The implementing agencies will provide policy, technical and management assistance. The lead agency will supervise and arrange verification of major activities carried out.

101. The Government of China will establish a policy framework to complement funding from the Multilateral Fund to ensure a timely phase-out of HCFCs in the XPS foam sector. A quota system based on the regulation of ODS management will be established to prevent enterprises under this Sector Plan from purchasing HCFCs and ensure that the national level of HCFC consumption in the XPS foam sector is meeting the requirements of the Protocol. Furthermore, the Government will strictly control and supervise HCFC production, distribution, import and export in order to maintain the balance between the production and consumption sectors as well as the balance between the HCFC phase-out efforts and national economic development needs. The objectives of the phase-out policy are to: ensure that HCFC consumption in the XPS foam sector is reduced according to the Montreal Protocol schedule; provide a mechanism which encourages XPS foam enterprises to phase-out HCFCs and encourage the use of environmentally friendly alternatives; and ensure that the development of the XPS foam sector is not affected by the proposed HCFC phase-out targets.

102. Grant funds will be disbursed directly from the HCFC phase-out account to XPS foam enterprises based on the terms and conditions of the HCFC phase-out contract for enterprise activities and the consultant service contracts for TA activities.

XPS demonstration projects

Feininger (Nanjing) Energy Saving Technology Co. Ltd (submitted by UNDP)

103. Feininger, established in 2002, is one of the leaders in the extruded polystyrene (XPS) foam sector in China. Feininger manufactures XPS foam extrusion lines and XPS foam recycling machines. In 2009 the enterprise manufactured 1,500m³ of XPS foam and consumed 630 mt of HCFCs. The demonstration project will convert one of the XPS manufacturing lines from HCFC-22/HCFC-142b to CO₂/methyl formate co-blowing technology. The conversion costs, estimated at US \$2,014,776, would cover plant modifications and new equipment, components and processes, including metering systems for CO₂, methyl formate and a third blowing agent, and a re-design and replacement of extruder screws and barrels. The costs would also include the safety measures, laboratory testing, product trials, and evaluation.

104. The successful implementation of the Feininger demonstration project would enable replication of the CO₂/methyl formate technology in similar enterprises. As both an XPS foam and processing equipment manufacturer, Feininger would be in a position to transfer the technology cost-effectively to a large number of enterprises. Furthermore, the project would result in reductions in HCFC-22 and HCFC-142b consumption of 12.3 ODP tonnes (205 mt) and lead to net annual emission reductions of 422,198 tonnes CO₂-eq.

Shanghai Xinzhao Plastics Co., Ltd. (UNIDO and Japan)

105. Xinzhao, established in 2003, manufactures XPS foam and XPS foam manufacturing equipment. Its two production lines use HCFC-22 as a blowing agent and produce an average of 73,525 m³ of foam annually using 13.9 ODP tonnes (253.3 mt) a year. Xinhzhao will convert one extrusion line from HCFC-22 to a butane and methyl chloride co-blowing agent system. The objective of the demonstration project for Xinzhao is to transfer and adapt butane blowing agent technology from Japan with the assistance of Kaneka, Japan (a leading XPS board manufacturer). The project aims to determine and demonstrate methods to maximize the proportion of recycled polystyrene resin in the raw material, reduce flammability of XPS foam caused by the butane blowing agent, equipment modifications and replacements needed. It will also assist the Government of China in selecting low climate impact, zero ODP alternatives and will serve to raise awareness of the alternative technology and accelerate its uptake at SMEs and other enterprises.

106. The conversion will require modification of extruders, material gravimetric dosing unit, blowing agent metering system, introduction of safety measures, procurement of laboratory testing and other auxiliary equipment, commissioning and production trials, tests, provision of technical assistance, implementation of performance evaluation and dissemination of information. The estimated total cost of the project is US \$1,750,020, and it will phase out 7.0 ODP (126.7 mt) of HCFCs and reduce annual green-house gas emissions by 229,327 MT CO₂ equivalent.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

107. The Secretariat reviewed the XPS Foam Plan in light of the plan for the phase-out of 1,372 ODP tonnes of HCFC-141b used in the polyurethane foam sector (Foam Sector Plan) submitted to the 62nd Meeting; the three projects to demonstrate alternative technologies in the XPS foam sector approved by the Committee; the technologies selected by the XPS foam manufacturers in China; and the polystyrene/polyethylene foam projects that had been approved by the Executive Committee.

Demonstration projects on alternatives to XPS foam applications

108. The Executive Committee approved funding for the preparation of three projects to demonstrate the use of alternative technologies in XPS foam applications, namely:

- (a) Preparation for technology demonstration project for hydrocarbon blowing agent in the extruded polystyrene (XPS) foam sector in China (UNIDO);
- (b) Preparation of a demonstration project for conversion from HCFC-142b and HCFC-22 technology to methyl formate and co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd, China (UNDP);
- (c) Validation of the use of HFO-1234ze as blowing agent in the manufacture of extruded polystyrene foam boardstock (phase I) in Turkey (UNDP);

109. It is the view of the Secretariat that these demonstration projects are critical in order to identify and fine-tune the most appropriate, environmentally sound, economically sustainable and preferred replacement formulations that could be applied successfully. In this regard, the submission of a plan of this magnitude (total cost of US \$145 million) ahead of the results of such strategically funded demonstration projects is not only premature, but could turn out to be against the interest of the country

should its implementation result in any delay. In addressing this issue the Government of Germany stated that “with regard to the 2013 and 2015 targets, China decided that urgent action is needed now in this sector, which has to be built on environmentally and economically proven technologies, which can be transferred to China with minimum adaptation efforts and time. The outcome of currently implemented demonstration projects is as yet uncertain. If action will only commence upon availability of the results, it will be too late to contribute to the freeze and first reduction targets”. Furthermore, “the two technologies selected for China’s XPS foam sector are mature technologies in Europe and Japan and their technical viability is likely in China and a demonstration project for CO₂ is already successfully operating”. In regard to the use of methyl formate, the Government of Germany stated that “if successfully proven, methyl formate could be a suitable technology for SMEs in Phase II. However, during Phase I of the sector plan SMEs will not be targeted for conversion projects”. Since Stage I of the XPS Foam Plan consists of the conversion of 40 XPS enterprises, 43 workshops including Feininger (Nanjing) Energy Saving Technology Co. Ltd. the request for funding for the demonstration project does not appear to be eligible as it would constitute double counting.

Demonstration project at Feininger (Nanjing) Energy Saving Technology Co. Ltd

110. In supporting the demonstration project submitted at the same time as the XPS Foam Plan, UNDP indicated that the rationale of the demonstration project is that CO₂/methyl formate technology has not been tried out commercially and is thus consistent with relevant Executive Committee guidelines for demonstration projects. Furthermore, the Secretariat was advised that the results of the project would be available before the end of 2013 in time to begin preparation for phase II compliance activities and would thus play a crucial role in achieving the target of a 35 per cent reduction from the baseline. Regarding the double-counting issue, UNDP clarified that the enterprises listed in the XPS Foam Sector Plan for phase I are “candidate enterprises”. The total baseline HCFC consumption of these “candidate enterprises” is higher than the target reductions under the XPS Foam Sector Plan. The actual enterprises participating in conversions under the XPS Foam Sector Plan would be selected from the list of candidates, which includes Feininger because it has two production lines. The second production line, not included for conversion in the demonstration project proposal, remains eligible for funding under the XPS foam Sector Plan. The Government of China has confirmed by letter that China is not seeking funding under the XPS Foam Sector Plan for the first production line at Feininger.

Demonstration project for Shanghai Xinzhaio Plastics Co., Ltd.

111. In supporting the demonstration project submitted at the same time as the XPS Foam Sector Plan, UNIDO indicated that the 40 enterprises (including Xinzhaio) listed in the sector plan are candidate enterprises for implementation of phase I. Not every company will participate in the phase-out activities in Phase I, since the overall consumption of these 46 companies is far above the target set forth in the XPS sector plan. Xinzhaio has 2 XPS lines, and as the demonstration will take place on one line only, the other line would still be eligible for funding. Should Xinzhaio participate in phase I of the sector plan, double counting would be avoided, since one line would be funded through the demonstration project and one line through the sector plan.

112. As described in the project document, this demonstration is of utmost importance for a number of reasons, including: the need to test hydrocarbon technology for XPS in Article 5 countries; the need to gain experience in dealing with the flammable and explosive characteristics of hydrocarbons; the fact that the XPS sector is large and diversified; and the fact that Xinzhaio is also an XPS equipment manufacturer and can help to promote the technology on the local market after the demonstration project. Furthermore, the first phase of the XPS sector plan will last up to 2015, which provides ample opportunity not only to finalize the demonstration project, but also to convert additional lines to HC technology within the plan. However, phase II will start right in 2015, with the requirement of implementing more difficult targets in

a very short timeframe, meaning that the demonstration project must start as soon as possible. Finally, such a large sector cannot be left with only one technology option. Based on the priorities set in the XPS sector plan, the only technology which could be adopted in China in the shortest time possible is hydrocarbon technology, with the assistance of Japan.

Technology issues

113. The two replacement technologies selected by the Government are CO₂ (80 per cent) and hydrocarbons (20 per cent). Although the performance of HFC-134a and HFC-152a as blowing agents is similar to HCFCs, they have not been considered as viable technologies. HFC-134a is a strong greenhouse gas and has a softening effect that requires special additives, while HFC-152a is flammable and explosive, does not provide improvement in the insulation properties, and will be emitted easily into the atmosphere (as stated in the XPS Foam Plan). However, there are a number of considerations to take into account, including: the fact that both the replacement technologies chosen by the Government are flammable and explosive; the fact that HFC-152a/dimethylether (DME) mixture technology has been selected in Turkey for the XPS sub-sector, at a cost-effectiveness threshold that is half the threshold for the XPS Foam Sector Plan in China of (US \$5.13/kg as submitted vs. US \$10.27/kg); the lower thermal conductivity of the foam using CO₂ technology, and other process and safety considerations leading to higher capital costs for conversion, and operating costs that are more than double those of hydrocarbon technology (e.g., US \$2.47/kg for CO₂/ethanol as compared to US \$1.11/kg for hydrocarbon); and the potential, when using hydrocarbon technology, for flammable gas build-up during closed transportation of the final product.

114. The Government of Germany indicated that, with CO₂/ethanol, only low quantities of flammable ethanol were added to non-flammable CO₂. The cost-effectiveness of the HFC-152a/DME mixture technology in Turkey was based on a very different technology base. Unlike Turkey, China's equipment is locally manufactured (and in most cases low quality), making it risky to try the untested DME technology in China without testing retrofit possibilities. On the subject of costs, economies of scale and adaptation to local requirements in China (i.e. use of recycled material) were expected, by both the Government and enterprises, to drive down operating costs for CO₂/ethanol technology. Finally, with regard to transportation, any XPS foam product must adhere to the fire protection standard, which includes transportation safety requirements. Other blowing agents like methyl formate and HFO are also flammable and subject to proper precautions

115. Due to the high costs associated with the introduction of the CO₂ and hydrocarbon technologies, over US \$41,770,399 (29 per cent of the costs) will have to be provided by the enterprises. But also of concern is the long term sustainability at the enterprise level of a technology with inherently high operating costs. The Government of Germany stated that the selected technologies are deemed necessary to ensure that China can meet its Phase I targets and avoid non-compliance by the sector and the overall HPMP. Given that funding from the Multilateral Fund will only cover a portion of the costs, the enterprises will have to participate financially in achieving China's commitments. For the conversion projects in Phase I, stable and established enterprises were chosen, which are considered able to bear this additional responsibility. To assist the enterprises in this unusual endeavour, possible support through international co-funding (such as KfW Germany) is under discussion. The Government of China will establish the required framework to allow the companies to operate in a sustainable business environment and supply the insulation products required under China's energy efficiency regulations for buildings.

116. In regard to counterpart funding, it was pointed out that Executive Committee decision 24/49 established, *inter alia*, that in cases where counterpart contributions were needed to ensure implementation, in order to avoid delays in the projects' implementation, those counterpart contributions should be known to the implementing agency to be in place before the projects were submitted. The

Government of Germany indicated that the term “counterpart contribution” might not be applicable. In an effort to match the increasing demand for insulation foam products with the needs to convert a large number of enterprises to achieve Montreal Protocol goals, as well as the funding constraints currently experienced within the Multilateral Fund, China decided to put a large burden of the required costs onto the enterprises selected for phase I. Only financially viable companies with sustained business positions have been selected. Still, not all enterprises will have cash funds readily available to cover the difference, but can be assisted with loans. China and Germany are making efforts to attract credit, but such financing cannot be negotiated without a prior commitment from the Multilateral Fund in the form of the approved sector plan. Decision 24/49 cannot be applied to this unique situation, as the circumstances described under this decision do not exist in China.

Polystyrene/polyethylene foam projects so far approved

117. The project document states from the perspective of processing technology, producing XPS foam panels is almost the same as producing extruded polyethylene (PE)/polystyrene (PS) foam sheets. During the phase-out of CFCs, butane was typically used to replace CFC-12 in extruded PE/PS foam sheets production. The main conversion included fire and explosion proofing upgrades into the production environment, improvement in the transportation of the blowing agent (butane), relevant upgrades to the aging and transportation of products. Experiences in the conversion as well as the production safety have been accumulated with the conversion on PS foam sheets. As hydrocarbons are also one of the most important alternative technologies for the HCFC phase-out in XPS foam sector, and fire and explosion proofing are one of the core technological issues during conversion, the experiences in phase out of CFC-12 in PE/PS foam are very helpful.

118. An analysis of the polystyrene/polyethylene foam projects approved by the Executive Committee concluded that, in the case of the 30 projects in China, the CFC consumption ranged from 30 to 1,146 ODP tonnes, with cost-effectiveness values between US \$1.00/kg to US \$11.23/kg. Only in two enterprises, the cost-effectiveness value was over US \$7.40/kg. The average cost-effectiveness values for enterprises with consumption between 100 and 200 tonnes was about US \$2.40/kg, far below the standard cost-effectiveness threshold of US \$8.22/kg for the sector. The conversion of the plants included installation of hydrocarbon storage facilities, retrofit of the extruders and other equipment to use hydrocarbons, plant modifications, safety-related equipment, training, trials and technical assistance. Notwithstanding the outstanding cost-effectiveness of the conversion of the polystyrene/polyethylene foam sub-sector and its similarities to the XPS sub-sector (as stated in the document), the overall cost-effectiveness of the XPS Foam Sector Plan in China is US \$14.46/kg (i.e., six times that of the polystyrene/polyethylene foam sub-sector). Responding to this issue, the Government of Germany listed the reasons why the cost effectiveness and technical specifications could not reasonably be compared. The reasons included: underestimation of actual costs and funding needed in the polystyrene/polyethylene project; the industry consolidation that had to take place in the polystyrene/polyethylene sector in order to make the approved funds suffice; and the negative incremental operating costs of the polystyrene/polyethylene projects and their impact on cost-effectiveness. Furthermore, there is greater complexity and capacity of extruders for XPS foam, making their conversion much more costly than for polystyrene extruders; the need for higher pressure in the system to make up for lower hydrocarbon and CO₂ solubility, requiring broad extruder redesign and upgrade; the need for specially designed extruders due to the use of recycled polystyrene in XPS board production; the need for much bigger tanks, meters and pumping systems because butane is a co-blowing agent in XPS production, rather than being the sole blowing agent, as in polystyrene production; and differing and incomparable product requirements, uses, properties, standards and equipment add-ons.

Data gathering

119. The Executive Committee approved US \$570,740 for the preparation of the XPS Foam Sector Plan for China (Germany, UNDP and UNIDO). During the project preparation stage, questionnaires were sent to 320 XPS manufacturing enterprises out of the 500 enterprises in operation. However, only 125 responded (i.e., 25 per cent of all enterprises). The XPS Foam Sector Plan has been developed based on the results of this survey. This can lead to inadequate assumptions and extrapolations regarding the needs of the 75 per cent producers who did not respond. The prediction that 80 per cent of producers prefer CO₂ technology and 20 per cent prefer hydrocarbons is based only on 37.5 per cent of the surveys sent, which is not significant and may therefore be erroneous. Addressing this issue, the Government of Germany indicated that the technology choice of 80 per cent CO₂ and 20 per cent hydrocarbon refers to the 125 responding companies that represent 17,786 mt or 43% of sector consumption. The technology choice is further validated by expert opinions both in China and internationally, experiences gained from demonstration projects in China, and reference to the application of the technologies in particular in China and Europe. Investment activities of the phase I XPS Foam Sector Plan are based only on the responding companies. There is no erroneous extrapolation to the entire sector.

Alternative approach to calculating the incremental cost

120. The Secretariat further reviewed the XPS Foam Sector Plan in light of the responses received from the relevant bilateral and implementing agencies with regard to the comments raised on the Plan and the two demonstration projects.

121. The XPS foam enterprises predominately use extruders manufactured in China, normally with two installed extruders in series⁶. The production capacity is usually 300-400 kg/h. The injection pumps of the blowing agent are normally plunger pumps, with blowing agent leakage occurring easily from fluid seals. The average foam density ranges between 30 and 36 kg/m³. The main capital items needed for the conversion from HCFCs to CO₂ or hydrocarbon as blowing agent are: blowing agents storage systems; retrofit of extruder and die, including the replacement of the screws and barrels; installation of safety equipment⁷; technical and safety training; and technology transfer, trials, product testing and safety certification.

122. To meet the 2013 and 2015 phase-out target, 40 XPS enterprises with 43 workshops (production sites) accounting for total HCFC consumption of 11,397 mt of HCFC-22/HCFC-142b will be converted to CO₂/ethanol (80 per cent of the enterprises) and hydrocarbon (20 per cent of the enterprises). The total funding requested for the conversion of these enterprises was estimated at US \$94,800,000, based on estimated costs for retrofitting a “typical” production line to either CO₂/ethanol or hydrocarbon technology. However, the actual requirements for the conversion of each production line will be only known during project implementation.

123. Given the limited information provided on the equipment in the baseline (including the companies using foreign-made as opposed to those using Chinese-made extruder lines) and the uncertainties associated with the methodology proposed in the XPS Foam Sector Plan, an alternative

⁶ The first extruder is a single screw extruder with a screw diameter of 120-135 mm and length-diameter ratio (L/D) of 30-32. Only in a few enterprises, the first extruder has twin screws with a screw diameter of 70-92 mm. The second extruder is, with rare exceptions, a single screw extruder with a screw diameter of 150 mm and L/D of 34-35.

⁷ Including ventilation system, flammable gas detector and warning system, explosion-proof electrical components, fire-proof components and static prevention components; civil works (foundation of storage tanks, warehouse for steel cylinder, fire-fighting pools).

approach to calculate the incremental costs was suggested. This approach was based on the installation of new XPS production lines, with counterpart contributions from the enterprises to compensate for the equipment components which are independent of the blowing agent and for any intentional or non-intentional technology upgrade. Information available to the Secretariat indicates that the new XPS production lines can be manufactured by the seven enterprises⁸ making XPS production lines in China, which had so far made more than 970 lines (the Secretariat is of the opinion that this approach reflects the level of the incremental cost for the sector given the circumstances of the XPS Sector Plan as presented).

124. The technical characteristics of each new production line are: output of 320 to 480 kg/hr, XPS board width of 600 mm, XPS board thickness of 20 mm to 50 mm, foam density between 32 to 42 kg/m³, suitable for CO₂/ethanol or hydrocarbon blowing agents, with a primary extruder (150 mm screw diameter), and secondary extruder (200 mm screw diameter). The production line will also include other components, such as, feeding and mixing units, cooling roller, cutting and recycling systems that are independent of the blowing agents used. A commercial quotation for a new production line with these specifications is US \$250,000. An additional US \$40,000 per extrusion line is proposed to retrofit the workshops (production facilities) when using CO₂ technology and US \$80,000 when using hydrocarbon technology. To compensate for new equipment components, which are independent of the blowing agents used and for any potential technology upgrade, a 20 per cent reduction on the price of the extrusion line is suggested as a counterpart contribution in line with prevailing rules.

125. Based on the suggested methodology, the total capital cost required for the conversion of the 43 XPS production lines in China to either CO₂/ethanol or hydrocarbon is US \$23,518,000 as shown in the Table 4.

Table 4. Total capital cost for the conversion of the XPS enterprises based on new extrusion lines

Description	CO ₂ /ethanol	Hydrocarbon
Cost of extrusion line including the extruder	250,000	250,000
Counterpart contribution for new equipment (20%)	(50,000)	(50,000)
Hydrocarbon storage system		20,000
Installation, commissioning, trials	20,000	20,000
Plant safety	40,000	80,000
Subtotal	260,000	320,000
Contingency (10%)	26,000	32,000
Unitary cost	286,000	352,000
Number of extruders required	65	14
Total cost	18,590,000	4,928,000

126. Of this amount, US \$654,940 is deducted to compensate for the foreign ownership of three enterprises, namely Dalian Binhai with two extrusion lines and 40 per cent foreign ownership; Shanghai Bioxing with two production lines and 50 per cent foreign ownership; and Chengdu Nikeli with one production line and 49 per cent foreign ownership (assuming that these three enterprises will be converted to CO₂ technology). An additional US \$3,527,700 (i.e., 15 per cent of the total capital cost) is suggested for training, monitoring and supervision resulting in a total cost of US \$26,390,760.

127. During the project review process the Secretariat raised the issue of whether the two stand-alone projects for the demonstration of CO₂ technology at Nainjing Feininger and hydrocarbon technology at Shanghai Xinzhaoh are needed, in light of the request for US \$145 million for the XPS Foam Sector Plan in China. Following the explanation provided by the relevant agencies, it is suggested that the two

⁸ The two XPS demonstration projects submitted to the 63rd Meeting will be implemented in two of these enterprises, namely Shanghai Xinzhaoh Plastic Enterprise and Feininger (Nanjing) Energy Saving Technology.

projects could be implemented in advance of the actual conversion of the XPS enterprises covered under the XPS Foam Sector Plan in order to optimize the production parameters, such as: the amount of recycled polystyrene resin in the raw material; the suitability of CO₂ with methyl formate co-blowing technology; and reduction of flammability of XPS foam caused by butane. It is to be noted that the production lines where the two demonstration projects will be implemented have been included in the list of the 65 production lines converting to CO₂ and the 14 lines converting to hydrocarbon technologies as above. In addition to the capital cost, US \$200,000 is proposed for each demonstration project for the optimization of the production parameters.

128. In responding to the above suggestion by the Secretariat, the Government of Germany requested the following comments to be reflected:

- (a) The recommended cost effectiveness of the proposal is about US \$2.34/kg. This has no relation with the real cost for conversions as presented in the XPS Foam Sector Plan. The Government of China had made considerable concessions in its request for funding. After presenting the real costs of the required conversion, the Government only requested funding based on the negotiated conditions reflected in the approved cost guidelines for HPMPs. This will already result in a situation where enterprises will be required to contribute a large part of the investment cost from their own resources, or from other funding. As the approach suggested amounts only to a small fraction of the real cost of conversions, it will be impossible to motivate the enterprises to convert at this cost, especially considering the short period of time available;
- (b) China's submission is based on agreed funding guidelines. The Government of Germany is concerned about the proposed cost-effectiveness as suggested as well as the reference in the document on the overview of issues identified during project review (UNEP/OzL.Pro/ExCom/62/10) which states that the XPS foam sector plans will only be considered in the first stage if the cost-effectiveness value is below US \$4.50/kg. In Germany's view this contradicts the approved funding guidelines and it also seems to be inconsistent with Article 10.1 of the Montreal Protocol which stipulates that all agreed incremental costs of conversions will be covered. It also appears contrary to the spirit of the 2007 adjustment to the Montreal Protocol in which the Parties agreed for "stable and sufficient" funding to assist Article 5 countries to achieve compliance. Lastly, it does not echo the often repeated statement during the Executive Committee discussions of the funding guidelines about incremental capital and operating costs, that Article 5 countries would "get all new equipment";
- (c) Under the conditions of the suggested approach, most of the targeted enterprises will have reason to refuse to phase out HCFC which will immediately put China's compliance in jeopardy;
- (d) Inquiries made by Germany with local equipment manufacturers showed that commercial quotations for CO₂-lines for XPS- production in the local market vary considerably; however, Germany was not aware of any installed and operating extrusion line at a cost of US \$250,000, even of substandard quality. It is unreasonable to suggest such technologies which would most likely conflict with local laws and regulations, and quality standards;
- (e) While there are companies producing extrusion equipment in China, most of these are assemblers only. These factories build extruders for HCFC-142b and/or HCFC-22 technology. However, there are significant with CO₂ based equipment as the pressure

inside the barrel is about 15 times higher than that for HCFC-based equipment. China has still very limited experience in using and producing equipment for CO₂ or hydrocarbon alternatives. Equipment producers themselves need to change their production from manufacturing HCFC equipment to CO₂ or hydrocarbon equipment. This will of course be a very welcome development for China, but will not suffice or come in time to achieve compliance with the 2013 and 2015 HCFC control targets. Considering also the raw material situation, production lines purchased in China according to the suggestion by the Secretariat, may not be able to meet required foam standards to be accepted in the market;

- (f) The suggested approach did not consider other components of the HPMP, such as incremental operating costs, technical assistance and other essential elements.

Impact on the climate

129. The replacement of HCFC-22/HCFC-142b used in the manufacturing of XPS foam products in China by hydrocarbon and CO₂ blowing agents would avoid the emission of 20,769,688 tonnes of CO₂-equivalent into the atmosphere (Table 5).

Table 5. Impact on the climate

Substance	GWP	Tonnes/year	CO ₂ -eq (tonnes/year)
Before conversion			
HCFC-22	2,270	6,018.6	13,662,222
HCFC-142b	1,780	4,012.4	7,142,072
Total		10,031.0	20,804,294
After conversion			
Hydrocarbon	25	1,304.0	32,600
CO ₂	1	2,006.2	2,006
Total		3,310.2	34,606
Net impact			(20,769,688)

RECOMMENDATIONS

130. The Executive Committee might wish to consider the sector plan for phase-out of HCFCs in the extruded polystyrene foam sector in China, and the demonstration projects for conversion from HCFC-22 to butane blowing technology in the manufacture of extruded polystyrene foam at Shanghai Xinzhaio Plastic Enterprises Co. Ltd., and from HCFC-22/HCFC-142b technology to CO₂ with methyl formate co-blowing technology in the manufacture of extruded polystyrene foam at Feininger (Nanjing) in light of the Secretariat's comments contained in document UNEP/OzL.Pro/ExCom/63/26.

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS
China

(I) PROJECT TITLE	AGENCY
Sector plan for phase-out of HCFCs in the industrial and commercial refrigeration and air conditioning sector (stage I)	UNDP

(II) LATEST ARTICLE 7 DATA	Year: 2009	18,602.7 (ODP tonnes)
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(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)								Year: 2009			
Chemical	Aerosol	Foam	Fire fighting	Refrigeration		Solvent	Process agent	Lab Use	Total sector consumption		
				Manufacturing	Servicing						
HCFC123				4.0	2.0					6.0	
HCFC124					6.1					6.1	
HCFC133											
HCFC141b		5,056.8				465.9				5,535.7	
HCFC142											
HCFC142b		1,066.0		2.0	349.8					1,417.7	
HCFC22		1,353.0		6,221.6	3,456.2					11,030.8	
HCFC225ca						1.0				1.0	
HCFC225cb						0.0				0.0	

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	To be determined	Starting point for sustained aggregate reductions:	n/a
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	1.7	Remaining:	

(V) BUSINESS PLAN		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
UNDP	ODS phase-out (ODP tonnes)	98.7	98.7	98.7	98.7	98.7	54.4	0.0	0.0	0.0	0.0	548.0
	Funding (US \$)	24,800,400	24,800,400	24,800,400	24,800,400	24,800,400	13,778,000	0	0	0	0	137,780,000

(VI) PROJECT DATA				2011	2012	2013	2014	2015	Total
Montreal Protocol consumption limits				n/a	n/a	baseline	baseline	baseline - 10%	
Maximum allowable consumption (ODP tonnes)				n/a	n/a	19,100.0	19,100.0	17,190.0	
Project Costs requested in principle(US\$)		Germany	Project costs						
			Support costs						
		UNIDO	Project costs						
			Support costs						
Total project costs requested in principle (US \$)									
Total support costs requested in principle (US \$)									
Total funds requested in principle (US \$)									

(VII) Request for funding for the first tranche (2011)		
Agency	Funds requested (US \$)	Support costs (US \$)
UNDP	To be determined	To be determined
Funding request:		
Secretariat's recommendation:	Pending	

**SECTOR PLAN FOR HCFC PHASE-OUT IN THE INDUSTRIAL AND COMMERCIAL
REFRIGERATION AND AIR CONDITIONING (ICR) SECTORS
(STAGE I FOR 2013 AND 2015 COMPLIANCE)**

PROJECT DESCRIPTION

131. On behalf of the Government of China, UNDP, as the lead implementing agency, has submitted to the 62nd Meeting of the Executive Committee the overarching strategy summary of the HCFC phase-out management plan in China, the sector plan for phase-out of HCFCs in the industrial and commercial refrigeration and air-conditioning sector in China (Stage I for 2013 and 2015 compliance; ICR sector plan), at a total cost of US \$137,780,000 plus agency support US \$10,335,500 for UNDP as well as an HCFC-22 phase-out management plan for room air-conditioning manufacturing sector in China (Stage I for 2013 and 2015 compliance), at a total cost of US \$168,623,023 plus agency support US \$12,646,727 for UNIDO. On behalf of the Government of China sector plans have also been submitted for the rigid polyurethane foam sector and the XPS foam sector, as well as a demonstration project for the solvent sector.

132. The Executive Committee, in decision 62/60, noted with appreciation the submission of the sector plan, and requested UNDP to submit the sector plan to the 63rd Meeting. UNDP accordingly resubmitted an unchanged sector plan for the industrial and commercial refrigeration and air conditioning (ICR) sectors.

Background

133. At its 55th Meeting, the Executive Committee approved UNDP's request for HPMP preparation at the level of funding of US \$1,480,000 plus agency support costs of US \$111,000 to cover the costs of developing the overarching strategy, as well as sector phase-out plans for the XPS foam, solvent, and the industrial and commercial refrigeration (ICR) sectors. At the same meeting, the Executive Committee approved UNIDO's request for HPMP preparation at the level of funding of US \$584,000 plus agency support costs of US \$43,800 to cover the XPS foam and room air conditioning sectors (RAC).

Sector plan for phase-out of HCFCs in the industrial and commercial refrigeration and air conditioning (ICR) sector (Stage I, for 2013 and 2015 compliance)

Description of the ICR sector in China

134. The ICR sector was one of earliest to take actions on ODS phase-out in China. In 1995, China finalised its strategy for the phase-out of the consumption of CFC-12 in the ICR sector. From 1994 to 1999, 24 individual investment projects for CFC conversion and one technical assistance project for the ICR sector were approved and implemented. In 2002, the Executive Committee approved the sector plan for phase-out of CFCs in the ICR sector in China. Reportedly, all of the above conversion projects were completed by October 2004. Due to the advantageous physical and chemical properties, safety in production and affordability, HCFCs, particularly HCFC-22, were used widely as proven refrigerants in the ICR sector.

135. Currently, HCFC-22 is a predominant refrigerant used in manufacturing and servicing of industrial, commercial and air-conditioning equipment. According to the ICR sector plan, the total consumption of HCFC-22 in 2008 in China was 173,811 metric tonnes (mt) (9,560 ODP tonnes), of which 40,630 mt (2,235 ODP tonnes) was used for the industrial and commercial refrigeration applications not accounting for consumption in the servicing sector. The 2008 HCFC consumption in the ICR sector, established through a survey, served as a basis for estimation of HCFC-22 consumption in the

subsequent years. In 2009, given China's macroeconomic development and industrial slowdown resulting from the global financial crisis, HCFC consumption in the ICR sector was estimated to increase by a moderate 3 per cent compared with 2008, reaching 41,850 mt. Based on survey results, the growth in the ICR sector in the next five years is expected to continue at least 5 per cent a year. The continuing growth is driven by the significant increase in domestic demand, which is consistent with the national economic development of China. Under the unconstrained growth scenario (business-as-usual or BAU), the consumption of HCFCs from 2010 to 2015 would have expected to be 43,940 mt, 46,140 mt, 48,450 mt, 50,870 mt, 53,410 mt and 56,080 mt respectively.

136. Since the adjustment on accelerated phase-out of HCFCs was adopted at the 19th Meeting of the Parties, the Government of China issued directives on strict control of HCFC production and new HCFC-based manufacturing facilities. At the sector level, the Ministry of Environment Protection (MEP), through the China Refrigeration and Air-conditioning Industry Association (CRAA), has conveyed strong signals to the industry, that HCFC production and consumption would be restricted. The proposed sector plan is supposed to be a key part of the overall strategy for HCFC phase-out in the ICR sector. Once all the proposed actions are taken, the growth rate in HCFC consumption will be significantly reduced and the sector-equivalent baseline level for HCFC-22 consumption as an average for 2009 and 2010 can be expected at about 42,900 mt.

137. The target of the ICR sector plan is to reduce HCFC consumption in the sector in 2013 to the sector-equivalent baseline level and to 90 per cent of that baseline in 2015. Based on the BAU scenario for 2012, phase-out of 4,160 mt (229 ODP tonnes) of HCFCs from the 2012 consumption level would be required in order to return to the sector-equivalent baseline consumption in 2013. Reduction of 4,290 mt (236 ODP tonnes) of HCFCs is required to meet the 10 per cent reduction in 2015. Thus, the total phase-out required would be 8,450 mt (465 ODP tonnes).

Data collection methodology

138. The ICR sector has a very wide range of products, used in various applications and produced by numerous manufacturers. The different industrial and commercial refrigeration and air-conditioning products are categorized according to applications (cooling, heating or both) and the configuration and size of the equipment. For this sector plan, the following seven categories of products have been selected:

- (a) Unitary air-conditioners;
- (b) Multi-connected air-conditioners/heat pumps;
- (c) Small-sized air chillers/heat pumps;
- (d) Small- sized water chillers/heat pumps;
- (e) Heat pumps/water heaters;
- (f) Condensing units, freezer and cold storages; and
- (g) Compressors.

139. The sector plan provides detailed description of each category, including the typical capacity range in kiloWatts.

140. CRAA conducted a survey to obtain the following information: product categorization of refrigerating and air-conditioning equipment using HCFCs; detailed information regarding manufacturers in the ICR sector; amount of refrigerating and air-conditioning equipment using HCFCs; production capacity and sales revenue; and status of research regarding HCFC substitute technologies. The information obtained during the survey was used to induce the HCFC-22 consumption in the entire sector from 2006 to 2008.

141. The information was collected through questionnaires from 150 manufacturers. In parallel, on-site surveys were carried out at 68 enterprises which have been selected to maintain the balance in terms of geographical regions, sub-sectors and scale of operations. Since most enterprises are multi-production based, with the diversity of types of products, all together 195 product lines were involved.

142. The information obtained was analyzed and summarized for 133 enterprises since the remaining 17 enterprises contacted were engaged in the production of components and did not consume HCFCs. Table 1 summarizes the analysis undertaken in the sector plan using some key parameters such as ownership, capitalization, sales and HCFC consumption for 133 surveyed enterprises.

Table 1 – Classification of enterprises in the ICR sector

Parameters	Range	No. of enterprises	% of total number
Ownership	Nationally owned	81	60.90 %
	Joint ventures	31	23.31 %
	Foreign owned	21	15.79 %
Capitalization	Below 10 Million RMB	30	22.60 %
	Between 10 and 100 Million RMB	72	54.10 %
	More than 100 Million RMB	31	23.30 %
Sales	Below 0.1 Billion	60	45.10 %
	Between 0.1 and 1.0 Billion RMB	53	39.90 %
	More than 1.0 Billion RMB	20	15.00 %
HCFC consumption	Less than 10 mt	48	36.09 %
	Between 10 and 100 mt	52	39.10 %
	More than 100 mt	33	24.81 %

143. The data in Table 1 demonstrates that about 30 enterprises representing about 20 per cent of the total number of enterprises selected for survey dominate the ICR sector in terms of their capitalization, sales and HCFC consumption.

HCFC consumption in surveyed enterprises

144. The survey provided other important information. The total consumption of all types of refrigerants by 133 enterprises was 31,332 mt in 2008 comprising of 18,241 mt of HCFC-22 (58.2 per cent) with the following breakdown: nationally owned enterprises – 9,860 mt; joint ventures – 7,103 mt; foreign owned – 1,278 mt. The remaining portion of the consumption is the combination of other HCFCs, HFCs and ammonia refrigerants.

Production capacity, output and overall HCFC-22 consumption

145. The ICR sector plan provides information on the estimated number of enterprises, and production of ICR products for nine designated sub-sectors. The estimates regarding the overall ICR sector production have been made by CRAA on the basis of the above-mentioned survey mentioned in paragraph 140. The average charge of HCFC-22 refrigerant per unit was calculated for one typical

product in each sub-sector. The HCFC-22 consumption in each sub-sector was calculated by multiplying the estimated production amount by an estimated average of HCFC-22 charge per unit. On this basis, the overall 2008 HCFC-22 consumption was estimated to be 40,280 mt. Table 2 provides data used in estimates of the overall HCFC-22 consumption.

Table 2 – Parameters used in estimates of overall HCFC-22 consumption

ICR sub-sector	Typical capacity range (kW)	2008 Production (unit/year)	Average refrigerant charge (kg/unit)	HCFC-22 consumption (mt)*	HCFC-22 consumption (ODP tonnes)
Compressor condensing unit	0.5 – 2,600	150,000	23.0	3,450	189.75
Small sized chiller/heat pump	7 - 50	90,000	12.0	1,050	57.75
Industrial and commercial chiller	50 – 12,250	150,000	120.0	17,700	973.5
Heat pump water heater	3 - 100	130,000	13.0	1,700	93.5
Unitary air-conditioner	7 - 200	1,700,000	9.0	14,600	803
Multi-connected air-conditioner	5 - 150	60,000	18.0	1,100	60.5
Freezer and cold storage equipment	0.5 – 14,000	n/a	n/a	600	33
Transport air-conditioning	3 - 50	13,000	6.0	80	4.4
Total				40,280	2,215.4

*HCFC-22 consumption in sub-sectors does not represent exactly the product of multiplication of production by average refrigerant charge. Adjustments were made for rounding up and reflecting production specific circumstances in some sectors.

146. Additionally, consumption of 320 mt of HCFC-123 and 30 mt of HCFC-142b was identified in the ICR sector.

Existing policy framework

147. In China, a comprehensive policy framework has been created for overall control and management of ODS production, consumption, import and export. The framework has played an important role in controlling the growth of ODS production and consumption, promoting research, development and replication of alternatives and alternative technologies, and ensuring that China could meet the phase-out targets under the Montreal Protocol. As of April 2010, the Government of China has formulated and issued more than 100 policies and regulations on ozone layer protection. Meanwhile, each sector has also formulated a number of technical standards for HCFC alternatives. The ICR sector plan includes an overview with existing policies and regulations relevant to HCFCs phase-out. The following regulations appear to be the most important ones:

- (a) “Regulation of ODS Management” that became effective on 1 June 2010 after a five-year period of preparation and review. This Regulation will serve as a solid legal basis for sustainable ODS phase-out;
- (b) “Circular on strict control of new, innovation or expansion of HCFC production facilities” that was adopted in 2008; and
- (c) “Notice on control of new production facilities that use HCFCs” that was adopted in 2009.

Alternative technologies

148. The sector plan describes the process used for the selection of zero ODP substitute refrigerants taking into account physical, chemical and thermo-dynamic properties, energy efficiency and potential impact on climate, safety and economy as recommended in decision XIX/6 adopted at the 19th Meeting of the Parties. HFCs and natural refrigerants such as ammonia, CO₂ and hydrocarbons have been analyzed. The substitute routes have been identified for each ICR sub-sector based on HFC-410A and HFC-32 refrigerants selected for all but two applications. Ammonia (NH₃)/CO₂ technology was selected for medium-and large-sized freezing and refrigeration equipment and condensing units with the introduction of HFC-32 at a later stage. HFC-134a was selected to substitute HCFC-22 in heat pump water heaters in the near future with the subsequent promotion of HFC-32 at a later time. Table 3 provides ODP and global warming potential (GWP) values for the selected refrigerants.

Table 3 – ODP and GWP values in selected refrigerants

	HFC-410A	HFC-32	HFC-134a	NH ₃	CO ₂
ODP	0	0	0	0	0
GWP	2100	675	1430	<1	1

149. Depending on the maturity of technology and expected availability of required compressors in specific sub-sectors, it was decided that the conversion should actually be planned as a two-step process. The first step should concern conversions completed in time for the 2013 consumption freeze, and the second step was for conversions meant to contribute towards achieving the 2015 compliance target.

Strategy and prioritization of sub-sectors

150. The strategy for HCFC phase-out in 2011-2015 (Stage I) is built on the following principles:

- (a) Cost and market acceptability are taken into full consideration. The HCFC conversion programmes will be organized according to the rule “easy first, difficult later”;
- (b) The process and steps of production conversion for different product categories should be determined on the basis of the current status of industry development;
- (c) Conversion priority should be decided upon maturity and availability of substitute technology and market acceptance; and
- (d) The priority for carrying out the conversion programme shall be given to key players with large HCFCs consumption, strong capacity and sound operation practice.

151. The conversion plan was developed based on the above principles. HCFC consumption of about 1,585 mt (87.2 ODP tonnes) was identified in companies with 100 per cent foreign ownership. With 2009 and 2010 growth of 3 per cent and 5 per cent, the average of 2009 – 2010 consumption for those companies is calculated to be 1,674 mt (92.1 ODP tonnes). It was assumed that these companies would be responsible for the 10 per cent reduction of their HCFC consumption by 2015. Therefore, 167 mt was deducted from the sectoral HCFC phase-out target of 8,450 mt. The remaining balance of 8,283 mt is to be addressed in the plan and was distributed among six ICR manufacturing sub-sectors by assigning specific HCFC phase-out targets as shown in Table 4. The phase-out in two demonstration projects that were recently approved by the Executive Committee has been deducted from the starting point for sustained aggregate reduction accordingly.

Table 4 – Reduction by sub-sector from 2011 to 2015

Sub-sector	Substitute refrigerant	2011-2013		2014-2015		Aggregated: 2011-2015	
		Reduction mt	No. of projects	Reduction mt	No. of projects	Reduction mt	No. of projects
Refrigeration compressor	HFC-32 R2S*	n/a	0	n/a	1	n/a	1
	HFC-32 S**	n/a	1	n/a	0	n/a	1
Unitary AC	HFC-32	1,000	5	1,700	9	2,700	14
	HFC-410A	1,698	8	635	3	2,333	11
Multi-connected AC	HFC-410A	400	2	400	2	800	4
Industrial and commercial water chiller	HFC-32	200	2	650	7	850	9
	HFC-410A	300	3	500	5	800	8
Small-sized water chiller	HFC-32	130	2	70	1	200	3
Heat pump water heater	HFC-134a	100	1	0	0	100	1
	HFC-32	0	0	100	1	100	1
Condensing unit & freezer, cold storage	NH ₃ /CO ₂	250	1	0	0	250	1
	HFC-32	0	0	150	1	150	1
Total		4,078	25	4,205	30	8,283	55

* Reciprocating two-stage compressors

** Scroll compressors

152. Altogether 55 conversion projects are envisaged between now and 2015 to phase-out 8,283 mt (455.6 ODP tonnes) of HCFCs in order to comply with the 2013 and 2015 Montreal Protocol targets. Two projects in the compressor manufacturing sub-sector are included in the sector plan. One is for conversion of a production line of HCFC-22 scroll compressors to HFC-32 to be implemented as a priority providing annually about 100,000 compressor sets for projects related to the manufacturing of small- and medium-sized air-conditioning equipment. The second one is for the conversion of reciprocating compressors adopting HFC-32 technology for refrigeration and freezer applications. Compressor conversion projects will not yield HCFC phase-out directly, but the availability of compressors is indispensable for HCFC phase-out projects in the respective sub-sectors.

153. Subsequent to approval of the ICR sector plan, MEP/Foreign Economic Cooperation Office (FECO) and CRAA will choose enterprises for conversion projects from the list of candidates taking into account their HCFC consumption, production capability and technological competence. The unitary air-conditioner sub-sector will be the key sub-sector with planned HCFCs phase-out of 2,698 mt, accounting for 65 per cent of the overall sectoral target for 2013 of consumption at or below the sectoral baseline. Condition to the timely availability of MLF funding, all of the planned conversion projects will be finished before 2013, ensuring the achievement of the freeze target. The phase-out of HCFC consumption by enterprises with foreign capital will be undertaken using their own resources.

154. For reaching the sector specific reduction target of a 10 per cent lower consumption by 2015, the unitary air-conditioning sub-sector will be again the central sub-sector, bringing the unitary air-conditioner into the centre of HCFC phase-out and conversion activity followed by the multi-connected air-conditioners/heat pumps sub-sector.

Programme management mechanism

155. The overall management and implementation mechanism will be created to unify the research and development of the substitute technologies, organize conversion programmes in batches, control and supervise the consumption of HCFCs. It will also make full use of the resources of the industry to provide technical guidance to the HCFCs substitutes and conversion.

156. MEP will be working as the liaison with international agencies and other stakeholders of the Montreal Protocol and the Secretariat. MEP will also lead the State Leading Group for Ozone Layer Protection; coordinate the management of HCFCs and key events concerning the implementation of the Protocol; develop the national HCFCs management and control plans and policies; and coordinate with the General Administration of Customs, Ministry of Finance, State Administration of Taxation and regional environmental protection departments. It will cooperate with related organizations to constitute HCFC phase-out policies; comprehensively supervise and manage the events and activities related with the ICR industry; and evaluate and inspect the implementation of the programmes.

157. The Project Management Office (PMO) will be established to have full responsibility to implement the ICR sector plan. To maintain expertise and continuity, staff and experts of the PMO for the CFC phase-out plan will be assigned to this new Office. To support day-to-day operations of the PMO, funding is requested as part of the ICR sector plan. The PMO will be responsible for carrying out the following tasks:

- (a) Coordination with stakeholders in the public and private sectors;
- (b) Preparation or review of the terms of reference for consultancy services and conducting monitoring and supervising works of the consultants to support implementation, and supervision of HCFC phase-out activities;
- (c) Preparation, implementation, and review of the work programme for the ICR sector plan;
- (d) Preparation of relevant reports as required the Executive Committee as well as by the implementing agencies;
- (e) Financial management to ensure effective use of the MLF resources;
- (f) Development and maintenance of project management information system;
- (g) Facilitating project supervision or evaluation as may be required by the implementing agency and/or the Executive Committee, e.g. through its evaluation programme;
- (h) Facilitating performance and financial audit as required by the plan;
- (i) Organizing meetings and workshops for FECO's staff and staff of other relevant agencies to ensure full cooperation of all stakeholders in the HCFC phase-out efforts; and
- (j) Supervision and evaluation of conversion projects with assistance from technical experts to be engaged as part of the technical assistance component.

158. The implementing agency, UNDP, will supervise the general implementation of the sector plan, report on progress and submit requests for future funding tranches to the Executive Committee.

Policy and regulatory framework

159. The Government will establish a policy structure to complement activities funded by the MLF to ensure timely phase-out of HCFC in this sector. The objectives of the phase-out policies are to: ensure that the consumption of HCFCs in the ICR sector is reduced as scheduled; provide incentives for enterprises to phase-out HCFCs and adopt environmental alternative technologies; encourage the propagation of low cost, technically suitable alternatives to replace HCFCs; promote the development and dissemination of substitute technology; and ensure that the growth of the ICR sector is not affected by the proposed phase-out targets. The sector plan identified several factors that are relevant for a policy framework for the ICR sector and listed 13 policies and regulations that are expected to be prepared and issued before 2015.

Technical assistance

160. The sector plan envisaged a series of technical assistance activities to facilitate the promotion of substitute technologies, such as the establishment of a national technical support programme, establishment and revision of technical standards, establishment of an industrial information network system, and public awareness.

161. The proposed national technical support programme comprises the following elements:

- (a) Follow-up the latest progress on substitutes;
- (b) Preliminary research on potential refrigerant;
- (c) Product application design and testing;
- (d) Technical supervision and guidance to conversion project; and
- (e) Technical exchange and seminar.

Investment costs

162. The incremental capital cost (ICC) for the conversion projects at the enterprise level in the ICR sector mainly include: system, component and process redesign, prototype testing, production line conversion, prototype production trials and testing, product quality inspection, finishing and testing, process and safety training and safety facilities modifications. The incremental operating cost (IOC) for the conversion project at the enterprise level in the ICR sector is mainly for compensating the increased cost for the raw material, component and accessories after adopting the new alternative technology.

163. One typical and representative manufacturing application is selected for each sub-sector/alternative technology, to consider the total cost for the conversion of each line. In six ICR equipment manufacturing sub-sectors, altogether ten model production lines have been defined to represent the current situation in manufacturing. The ICC varied from US \$571,000 to US \$1,307,000 per production line. The production output in unit/year and the average HCFC-22 charge in kg/unit have been defined for each line. The HCFC-22 consumption to be phased-out in each line varied from 75 mt to 100 mt per line. The IOC has been estimated using the difference in cost of material and components between baseline and alternative technology for production of one unit of the respective product. IOC for each production line was calculated by multiplying the incremental cost per unit by the annual production (unit/year). The cost effectiveness of both ICC and IOC was calculated separately for each sub-sector. Table 5 provides

these values for the six sub-sectors for three selected technologies (nine calculated cases with values for ICC and IOC each). Cost-effectiveness of CO₂/NH₃ technology was not identified.

Table 5 – Cost-effectiveness by sub-sector and technology (US \$/kg)

Sub-sector	HFC-32		HFC-410A		HFC-134a	
	ICC	IOC	ICC	IOC	ICC	IOC
Unitary AC	14.5	10.7	8.3	8.8		
Multi-connected AC /heat pump			8.9	8.5		
Industrial & commercial chiller/heat pump	1.7	10.6	8.0	9.1		
Small-sized water chiller/heat pump	14	10.9				
Heat pump water heater	14.2	10.8			7.6	9.6
Condensing unit & freezer and cold-storage	13.7	9.7				

164. The overall cost of conversion in the ICR sector was calculated using cost-effectiveness values obtained for nine model cases of production line conversion as depicted in Table 5. These values have been multiplied by reduction of HCFC-22 consumption in the respective six sub-sectors as proposed for Stage I and extended to 53 production lines. Cost of conversion of two compressor manufacturing lines was added resulting in a total of 55 conversion projects. The following table provides the cost of converting 55 proposed production lines.

Table 6 – Overall cost of conversion of 55 production lines

Sub-sector	Stage I: 2011 – 2015			
	Proposed reduction (mt)	ICC (million US \$)	IOC (million US \$)	Sub-total (million US \$)
Compressor	n/a	18.09	n/a	18.09
Unitary AC	5,033	58.51	49.42	107.93
Multi-connected AC /heat pump	800	7.12	6.80	13.92
Industrial and commercial chiller/heat pump	1,650	18.05	16.29	34.34
Small-sized water chiller/heat pump	138	1.93	1.51	3.44
Heat pump water heater	200	2.18	2.04	4.22
Condensing unit, freezers and cold-storage	150	2.06	1.46	3.51
Total	7,971	107.94	77.52	185.45

Eligible incremental cost - requested MLF grant

165. According to decision 60/44 on HCFC phase-out funding guidelines, IOCs will be considered at US \$6.30 and US \$3.80 per metric kg of HCFC to be phased-out for projects in the air-conditioning and the commercial refrigeration sub-sectors respectively. As a result of applying those thresholds, the costs for funding the conversion of 55 production lines are US \$ 157.78 million.

166. The candidates for the 55 conversion projects will be selected from the 133 surveyed enterprises whose production lines were established before 21 September 2007, the same enterprises referred to in paragraph 142. According to data obtained from the survey and provided by CRAA for these 133 enterprises, the HCFC consumption at joint venture companies accounted for 17 per cent on average. For the scroll compressor conversion project, the foreign capital calculated based on the average ratio of three joint venture companies is about 55 per cent. For the reciprocating compressor conversion project, one fully domestically owned company would be selected. The net eligible investment cost is summarized in Table 7.

Table 7 – Net eligible investment cost (million US \$)

Sub-sector	2011 - 2013	2014 – 2015	Total
Compressor conversions	6.57	3.49	10.06
Refrigeration and air-conditioning equipment manufacturer conversions in six sub-sectors	52.06	63.88	115.94
Grand total	58.63	67.37	126.00

167. The summary of investment and non-investment costs requested from MLF is shown in the following Table 8:

Table 8 – Non-investment costs and total MLF funding (US \$)

Funding components	Cost (US \$)
Non-investment components:	
Project implementation supervision, coordination and management	3,500,000
Policy and regulatory framework	480,000
Technical assistance	
National Technical Support Programme	5,450,000
Technical Standards and Regulations	1,050,000
Industrial Information Network System	500,000
Public Awareness and Training	800,000
Sub-total for non-investment components	11,780,000
Investment components	126,000,000
Grand Total	137,780,000
Overall CE (US \$/kg) on a basis of a reduction in consumption of 7,971.1 mt of HCFC-22	17.28

Implementation schedule and monitoring milestones

168. According to the implementation schedule and monitoring milestones, the verification of the phase-out is planned for the 2nd and 3rd quarters in both 2014 and 2016.

Estimation of environmental benefits from HCFC phase-out

169. Because of the zero ODP of adopted substitute, the ozone layer protection benefits equal the quantity of phased-out HCFCs in ODP tonnes. On this basis the ODS phased-out during the first stage will generate an impact of 465 ODP tonnes reduction.

170. The direct GHG emission reductions are calculated as the difference between the greenhouse effect of the substitute and that of the replaced HCFCs. As different refrigerants have different global warming potential (GWP) values, direct GHG emissions of a certain refrigerant equal the amount of the refrigerant multiplied by its GWP. It is estimated that the direct GHG emission reduction after successful implementation of State I would be 7,660,000 tonnes of CO₂ equivalent.

171. The theoretical efficiency of equipment can be potentially optimized and improved, with suitable design changes while using alternative refrigerants. This can potentially result in reduction of electricity consumption through the equipment lifetime and reduce indirect CO₂ emissions. Since activities to achieve energy efficiency improvements are not the objective of this plan, their impact on indirect GHG emissions cannot be accurately estimated at this time.

Estimation of other environmental benefits from the HCFC phase-out

172. The sector plan used the Total Equivalent Warming Impact (TEWI) methodology for the calculation of the reduction of the greenhouse emissions. It was calculated that the direct GHG emission

reduction after the successful implementation of Stage I would be 7,660,000 tonnes of CO₂ equivalent; this is based on a simplified calculation by the Government of China. Due to the lack of information about the framework conditions, the Secretariat is unable to assess the validity of that data. Industrial and commercial refrigeration and air-conditioning equipment typically has a long life cycle of ten to twenty years. The theoretical efficiency of equipment can be potentially optimized and improved, with suitable design changes while using alternative refrigerants. This can potentially result in the reduction of electricity consumption through the equipment's lifetime and reduce indirect CO₂ emissions. Since energy efficiency improvements are not the primary objective of this plan, the impact of indirect GHG emissions cannot be accurately estimated at this time.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

173. The Secretariat reviewed the proposal in line with the recommendations of the Executive Committee on preparation of HPMPs and taking into account existing guidelines and policies pertinent to the determination of the incremental costs. A number of clarifications and additional information was requested from UNDP. The Secretariat identified several issues related to the determination of eligible incremental costs that remain to be unresolved.

Implications of the 2002 CFC phase-out plan in the ICR sector in China

174. In 1995, China developed its strategy for the phase-out of the consumption of CFC-12 in the ICR sector. According to this strategy, the ICR CFC sector plan had adopted a two-stage approach to ODS phase-out, with the first stage being a conversion to HCFC-22. HCFC-22 was shown at that time to be the most cost-effective option available to China, considering the availability of materials, the technical status of the service industry, and the overall cost considerations. The strategy stated that the subsequent change to non-ODS would be undertaken when appropriate technology is available and will be at China's own expense.

175. In 2001, China with the assistance from the World Bank updated the strategy and developed the CFC phase-out plan in the ICR sector. The sector plan incorporated the most updated information on the structure of the sector provided by the China Air-Conditioning and Refrigeration Industrial Association (CACRIA). The total number of enterprises engaged in the production of different commercial and industrial refrigeration and air-conditioning equipment amounted to about 1,000, many of them being small and medium enterprises (SMEs). CACRIA listed 543 companies, among which 347 were registered members of CACRIA. The sector plan confirmed the major principles formulated in the 1995 strategy as follows:

- (a) The Multilateral Fund would assist in:
 - (i) Converting compressor production at 24 companies out of a total of 73 production lines at 68 companies;
 - (ii) Transferring to modern non-CFC compressor technology from industrial countries; and
 - (iii) Replacing existing old dedicated machines and tools with modern, highly flexible production equipment, allowing China's manufacturers to meet the more stringent requirements of non-CFC compressors produced by industrial countries.

These activities would allow a complete phase-out of ODS use in the sector through a two-step conversion, both steps being included in the funding request. The first step would be a conversion to HCFC-22, HFC-134a and NH₃ refrigerants. The next step would be a conversion to non-ODS substances, once suitable replacements for CFC-12 would be available in the country for those applications where HCFC-22 was chosen as an alternative.

- (b) In return China would (among others):
 - (i) Finance from its own resources the technical upgrade associated with more production equipment necessary to allow the two-step approach;
 - (ii) Develop and introduce the necessary supporting policies to support and ensure a sustainable conversion to non-CFC production for new refrigeration equipment in the refrigeration sector from 2002 onwards;
 - (iii) Ban the production of CFC-based refrigeration equipment from 2000;
 - (iv) Establish a taxation system for CFCs in order to support the use of substitutes; and
 - (v) Develop the necessary standards and a licensing system to support and control the production of non-CFC based compressors.
- (c) China also agreed not to request MLF funding for otherwise eligible incremental costs related to:
 - (i) Conversion costs of the commercial and industrial refrigeration equipment manufacturing companies;
 - (ii) Conversion costs of end users; and
 - (iii) Incremental operating costs related to the conversion of compressors, commercial refrigeration equipment producers and incremental operating costs associated with non-CFC substitutes.

176. The MLF fulfilled its commitments allocating US \$49,800,275 for the implementation of several compressor conversion projects in 24 enterprises. This included a technical assistance project for establishing the testing and standardisation centre, and providing the required technology and the state of the art manufacturing equipment including numerically-controlled machining centres and computerized coordinated measuring systems. All of the conversion projects were completed by 2006. In project completion reports the compressor and refrigeration manufacturing enterprises recognized that the HCFC-22 based technology is a transitional one and the ultimate target is the adoption of zero ODP technology. According to these reports the companies were planning to invest their own capital to substitute HCFC-22 technology by non-ODS technology.

177. China prepared for the 35th Executive Committee Meeting the CFC phase-out Plan in the ICR Sector which stated that the support provided by the Multilateral Fund would allow conversion of the entire sector to a manufacturing technology that can be used for HCFC and non-HCFC-technology alike. This CFC phase-out Plan in the ICR Sector was noted by the Executive Committee in decision 35/50, and formed the basis for the approval of the last project for 5 enterprises. This suggests that the HCFC

phase-out plan in the ICR sector prepared by UNDP needs substantial adjustments including an extensive reassessment of the basis on which funding could be provided by the Multilateral Fund.

178. The above information has been communicated to UNDP. In a related response, UNDP suggested that the baseline outlined in the submitted ICR sector plan is completely different from projects approved by the Executive Committee under the 2002 ICR sector plan, and therefore funding provided by the Multilateral Fund under the 2002 sector plan has no relationship with the current submission.

179. The Secretariat is seeking clarification from the Executive Committee concerning the interpretation of the agreement with the Government of China in respect of the transition from HCFCs to non-ODS technology in the ICR sector.

Determination of the baseline HCFC consumption

180. HCFC consumption in 2008 served as a source to forecast a sector-specific HCFC baseline consumption. It is estimated that the overall number of enterprises in the ICR sector would be around 1,000, with a sizable number of them being SMEs combining manufacturing and servicing activities. The 2008 consumption was estimated on the basis of data obtained through questionnaires (mentioned in paragraph 141) from 133 manufacturers and from on-site surveys at 68 enterprises. On the basis of this data, average values of the HCFC charge per unit of different products were estimated in each sub-sector. The HCFC consumption was determined by multiplying the average charge by the number of HCFC-22-based units produced in each sub-sector, using statistics collected by CRAA. The resulting 2008 consumption of 40,630 mt is characterized by UNDP as “reliable figure with acceptable accuracy for the intended purpose.” A “revenue comparison” methodology was used to validate the obtained HCFC consumption values, working on the basis of an assumed linear correlation between turnover and HCFC-22 consumption of a company.

181. The Secretariat requested detailed information on both methodologies used for the determination of the sector specific 2008 HCFC consumption. In particular, the Secretariat was interested in the calculation of the average charge in the ICR sub-sectors; an average value is typically applied in cases where the deviation from the average has a sound statistical significance, however, in the case of the ICR sector, in some sub-sectors the charge varies within a very considerable range between the different products. The Secretariat also noted that two different values for the refrigerant charge were used in case of two sub-sectors. For the calculation of the consumption in the industrial and commercial chiller sub-sectors, 120 kg/unit was used, and for the same parameter for condensing units, 23 kg/unit. However, for determining the cost-effectiveness in the calculation of incremental costs, 24.3 – 35.4 kg/unit and 11.9 kg/unit, respectively, was assumed for the two sub-sectors. The Secretariat also requested an explanation on how data on the shipments of various products was obtained and how variances in the production of the different types of product were taken into account in determining the averages for charge and quantity produced for the particular sub-sector. The requested information, however, has not been made available by UNDP.

182. The Secretariat attempted an alternative approach to estimate the sectoral HCFC consumption, using available data included in the proposal, originating from the survey of 133 enterprises and extrapolating these data to the remaining enterprises. The results would suggest a much lower value of HCFC consumption in the sector, even prior to applying a reduction for use of refrigerant for servicing carried out by the manufacturers. The Secretariat has also tried to assess the “revenue comparison” methodology with no satisfactory results. Thus, it is not in a position to ascertain the validity and accuracy of the estimated value of HCFC consumption in the sector.

Attribution of HCFC phase-out to enterprises with foreign-owned capital

183. The share of HCFC phase-out by enterprises with foreign-owned capital was established at 167 mt (or about 2 per cent) out of 8,450 mt total HCFC reduction target by 2015. According to the survey, the enterprises with foreign-owned capital consumed 8,688 mt of HCFCs in 2008 representing about 47 per cent of the total HCFC consumption in the 133 surveyed enterprises. The Secretariat proposed to UNDP to consider the allocation of a higher portion of the HCFC consumption of foreign-owned enterprises in the efforts to achieve the reduction targets. UNDP explained that “the control of HCFC consumption in non-A5 owned enterprises can be ensured only through regulations or through their voluntary actions. Regulations need to be introduced in such a way that the market is not distorted and maintains a level playing field for all players. It would be difficult to obtain a phase-out commitment from both Chinese-owned as well as non-A5-owned enterprises, if the market conditions are not fair.”

184. The Secretariat still believes that regulations can be adjusted in a way to encourage enterprises with foreign-owned capital to more actively participate in Stage I of the HCFC phase-out in China. Such an undertaking would result in a substantial reduction of requested incremental costs, and might even provide overall a more balanced approach to the different industry stakeholders in China.

Determination of the number of converted production lines

185. At this point, the Secretariat would like to discuss in more detail the approach taken in the proposal to determine the project cost. A number of steps were undertaken by China to determine the total number of conversion activities, i.e. the number of production lines to be converted:

- (a) In a first step, the total HCFC consumption to be phased-out was distributed among the different sub-sectors;
- (b) In a second step, “one typical and representative manufacturing application”, i.e. a model case was created or selected for each sub-sector, and for this model case the typical consumption, incremental costs and the cost-effectiveness were defined; and
- (c) The cost-effectiveness obtained from the model case conversion was extrapolated to determine the incremental cost in the entire respective sub-sector.

186. Using such an approach, the incremental costs in the sub-sector are very sensitive to the parameters used in the model case conversion. Most of the six selected sub-sectors demonstrate a significant variance in the existing set-up, the production mode of the enterprises and the size and capacity of the product. As an example, the cooling capacity range varies from 50.5 kW to 12,250 kW in the industrial and commercial chiller sub-sector. In the condensing unit sub-sector, the average charge of 11.9 kg/unit was selected in the model case conversion, but despite this a number twice as high was used in the proposal. Furthermore, in the industrial and commercial chiller sub-sector, this discrepancy was in the order of a factor of four (see also paragraph 181 above). Under these circumstances, the Secretariat could not accept this approach as an accurate or sufficiently accurate representation of the respective sub-sector. Moreover, the Secretariat has no means to assess to what degree any of the other sub-sectors has selected an average charge which would be sufficient to allow the determination of the incremental cost.

187. The sector plan contains the statement that, according to the priority of the sub-sectors and the phase-out targets in 2013 and 2015, investment activities will aim at converting two compressor manufacturing lines and 53 product manufacturing lines using HCFC-22 in the selected sub-sectors.

These lines are initially discussed in paragraph 164. However, later UNDP clarified that the 55 lines meant 55 conversions and “each conversion project may entail one or more production lines. The model case chosen to demonstrate the calculation of the expected cost of conversion and the cost-effectiveness represent production lines of relatively large capacity in their respective sub-sectors. But they do not represent the maximum output achievable by production lines in the same sub-sector, which can be significantly more than the model case. At this point of time it is not clear how many production lines will be converted in each manufacturing sub-sector.” The Secretariat has at this point in time no clear understanding of how the different parameters for the model case were selected; however, this is not the only issue the Secretariat is concerned about. For example, an average over all production lines would result in different characteristics from the average of those production lines considered for conversion in the first step, with a presumed strong representation of large companies with often high-capacity, and well utilized production lines. Average values for parameters based on such a sub-set representing the larger companies would likely result in higher capacities than a sector average, and thus in fewer lines to be converted with a proportional impact on the eligible funding level.

188. Altogether, 54 enterprises have been selected as potential candidates for the implementation of HCFC conversion projects. The sector plan establishes that a sub-set of 33 enterprises out of the 133 enterprises covered by the survey reach a share of 85 per cent of the HCFC consumption. Only 20 of them have revenues over US \$150 million (RMB 1 billion). The remaining enterprises do not match this group of larger enterprises on two important factors that were identified as key to the selection. Many enterprises included in the group of 54 manufacture products in multiple sub-sectors. It appears that the number of selected enterprises for conversions can be further reduced.

189. The percentage of HCFC consumption by joint ventures (17 per cent) was calculated as an average of the 133 enterprises that participated in the survey mentioned earlier in this document. Accordingly, the total eligible incremental costs have been reduced by 17 per cent. UNDP informed that “the adjustment in the share of companies with foreign ownership can be done accurately when the final selection of enterprises participating in the Stage-I sector plan is established. At this point, it can only be mentioned with certainty that the proportion of HCFC consumption originating from non-A5 ownership will not exceed 17 per cent.” However, the transnational ownership is an average value for the whole set of enterprises but not of the sub-set, which will receive support from the Multilateral Fund for their conversion. The methodology as proposed in the HPMP with the final selection of the enterprises taking place only after approval of the plan, with the funding attached does not allow the decision of the Executive Committee on transnational corporations to be applied,⁹ and determine accurately eligible incremental costs prior to the approval of the project by the Executive Committee.

190. The Secretariat requested detailed information about the HCFC consumption, production and foreign ownership of the selected 54 enterprises. UNDP noted that the proposal represents a strategic plan for compliance with the ICR sector, rather than a collection of individual projects that describe conversions in a higher level of detail. Consequently, the delineation had to be done in the context of the strategic nature of the document, by providing model cases for categories of enterprises, which best represent the ground reality. UNDP pointed out that the prevailing time and resource constraints did not allow for describing over 50 individual enterprise-level conversions, as is expected for individual projects.

191. UNDP received US \$1,480,000 plus agency support costs of US \$111,000 to cover the costs of developing the overarching strategy and the proposal for the industrial and commercial refrigeration

⁹ The decision adopted by the Executive Committee at its 7th Meeting reads as follows: “Partial funding should be considered on a case-by-case basis to finance the local share ownership of any given enterprise partly owned by a transnational corporation. In such a case, funding could be provided as a percentage of project incremental costs proportionate to the local share ownership of the enterprise with the transnational corporation responsible for the rest.”

sectors, as well as the sector phase-out plans for the XPS foam and solvent sectors. From the Secretariat's perspective the resources provided seem to be sufficient to submit the information that is necessary for the appropriate assessment and review of the proposal amounting to US \$137.8 million.

192. The lack of information on the existing and selected production lines for conversion does not allow the Secretariat to assess and review the eligible incremental costs. It is specific for the methodology selected, i.e. the final selection of beneficiaries post approval, to show a large variation of enterprise and product characteristics as well as a flexible share of foreign ownership. Under these circumstances, the uncertainty in the determination of the incremental eligible cost makes it impossible for the Secretariat to provide a reliable estimation of these costs.

Incremental capital costs

193. The Secretariat raised a number of questions on the eligibility of the costs related to the modification of heat exchangers, replacement of vacuum pumps, and purchases of helium leak detection systems. The Secretariat has also questioned the very significant costs requested for system, component and process redesign, prototype testing, prototype production trials and testing, and process and safety training. It referred to policies and guidelines established by the Executive Committee in the CFC conversion projects and the practices applied by the Secretariat and the implementing agencies. UNDP insisted, however, on keeping the funding level of all of these costs as submitted. The discussion between the Secretariat and UNDP on these issues has not been completed due to lack of time.

194. In the compressor manufacturing sub-sector, the Secretariat pointed to the high level of eligible incremental cost of US \$14.6 million requested for the conversion of a production line to HFC-32 at the scroll compressor manufacturer with an annual production capacity of 100,000 units. Notwithstanding the more sophisticated design of scroll compressors, the requested amount is uncommonly high in comparison with previous funding levels granted for a compressor conversion. For instance, the demonstration project for conversion of a production line with an annual capacity of 1,830,000 units to R-290 flammable refrigerant at Guangdong Meizhi Co. was approved at the 61st Meeting at the amount of US \$1,875,000, yielding a cost-effectiveness of about US \$1.02/unit capacity versus US \$146/unit as requested by UNDP in this proposal. In the past, the Executive Committee dealt with many compressor conversion projects in the refrigeration and AC sector but the approved incremental costs had in no case exceeded US \$2 million per production line conversion. The Secretariat called for detailed information substantiating the requested cost. UNDP responded that in a context of a sector plan, the constraints in time and resources simply do not allow the collection and presentation of information with the requested level of detail. However, subsequently, and after finalization of this document, the Secretariat received further information, which could not be sufficiently assessed due to the set deadline for document dispatch. The Secretariat will work with UNDP to clarify issues related to compressor conversion and will inform the Executive Committee accordingly.

Incremental operating costs

195. Incremental operating costs (IOC) in the proposed projects are strongly dependent on the specific product, production volume and refrigerant charge, which were not established in a process that met the Secretariat's expectations in terms of being sufficiently justifiable and convincing. The nature and magnitude of the proposed incremental cost for the individual IOC items have not been explained at the required level of detail. The Secretariat is unable therefore to ascertain the eligibility of the requested IOC.

196. The requested IOC included incremental costs related to additional labour. Labour costs were never recognized as eligible IOC in the past and had never been funded by the Multilateral Fund. UNDP,

however, maintains that the incremental nature of this category of IOC should be funded by the Multilateral Fund.

197. All of the requested IOCs include costs associated with a compressor and a lubricant. The ICR sector plan incorporates conversion of compressor manufacturers in China. The IOC associated with compressor and compressor oil should not however be part of IOC for manufacturer conversion projects in compliance with past Executive Committee decisions. UNDP recognized that the principle suggested by the Secretariat is well understood. To implement this principle, a formula reflecting the real situation would need to be worked out, so that eligible costs are properly and fairly assigned. The Secretariat is working with UNDP on that issue and will report to the Executive Committee at a future meeting accordingly.

Non-investment components

198. A total of US \$11,780,000 is requested for the non-investment components with a break down presented in Table 8 in the description of the ICR sector plan above. The Secretariat informed UNDP that costs associated with project implementation and management, policy and regulatory framework, and technical assistance need to be considered in the context of financial assistance provided to China from other sources related to the implementation of the ICR sector plan. Those are:

- (a) Preparation of the overall HPMP (US \$4.1 million);
- (b) Funding under the continuing institutional strengthening project in China (US\$ 390,000);
- (c) UNDP agency fee for the general management support and the supervision of the project (US \$10.33 million);
- (d) The intended non-investment project in the refrigeration service sector which was announced by UNDP; a related demonstration project for UNEP for the same sector, covering one city in China, was submitted to this meeting at a requested level of US\$ 3.1 million, but subsequently withdrawn. Synergies with the non-investment component in the ICR sector plan would have to be taken into account;
- (e) The UNDP-GEF project on Promoting Energy Efficient Room Air-Conditioners (PEERAC) with the total cost of US\$ 27.6 million that provided incremental costs of US \$616,300 for the FECO MEP management unit;
- (f) The UNDP-GEF Project on Barrier Removal to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling Project (BRESL) with a funding amount of US \$35.9 million approved in November 2008. This project provided support to China on capacity building and the policy and regulatory aspects of energy standards and labelling, as well as technical assistance in the development of standards for refrigeration and AC equipment. The BRESL project also provided support for the national training programme on the planning, implementation and evaluation of a national programme for standards and labels development.

199. The Secretariat exchanged communications with UNDP on detailed aspects of each of the requested components suggesting that synergies with the above indicated sources of assistance be identified, which could be potentially beneficial to the ICR sector plan implementation. The discussion on eligibility of the requested costs between the Secretariat and UNDP could not be finalized. The Secretariat

is unable to report to the Executive Committee on the agreed eligible incremental costs of the requested components.

200. The Secretariat continues to work with UNDP on the outstanding issues. At this point in time, the Secretariat is not in a position to advise the Executive Committee on the level of funding that could be recommended for approval. In order to facilitate a discussion with UNDP on the remaining issues, the Secretariat is seeking the Executive Committee's recommendation urging UNDP to provide, in cooperation with the Government of China, the additional information requested by the Secretariat on several aspects of the ICR sector plan.

201. The Secretariat is also seeking the Executive Committee's views on the interpretation of the agreement with the Government of China about commitments in regard to the implementation of the 2002 ICR sector plan as outlined in paragraph 175(b) and (c), and implications of these commitments for the submitted proposal.

202. Between the issuance of document UNEP/OzL.Pro/ExCom/62/26 and the 62nd Meeting of the Executive Committee, no further developments had taken place in regard to the sector plan for the industrial and commercial refrigeration and air conditioning manufacturing sector that would have enabled the Secretariat to develop a recommendation on funding levels. Although there has been a significant exchange of correspondence between UNDP and the Secretariat and each question of the Secretariat was replied to, the replies were not in all cases either substantive enough or provided the needed information that would enable the Secretariat to assess the eligibility and incrementality of the requested funding.

Developments since the 62nd Meeting

203. After resubmission for presentation at the 63rd Meeting of the project proposal for HCFC phase-out in the industrial and commercial refrigeration and air-conditioning sectors, the Secretariat posed a number of additional questions to UNDP. The Secretariat provided in its set of questions more specifics regarding the exact data needed for further review of the proposal. In this communication, the Secretariat requested information related to the specific companies manufacturing ICR equipment as well as the associated compressors. The Secretariat also has raised questions related to the prioritization of the unitary air conditioner sub-sector over the industrial and commercial water chiller sub-sector.

204. UNDP provided, for a subset of the companies in the sector consisting of 48 enterprises, more detailed information. These enterprises included two compressor manufacturers and eight manufacturers of both refrigeration equipment and compressors. The information provided included the date of establishment, the share of foreign ownership, the number of employees, the main products manufactured, the number of production lines based on HCFCs, the total refrigerant consumption in 2008 as well as the approximate production volume for HCFC products in that year, overall turnover, the capacity increases since 21 September 2007 and whether the company was engaged in a compressor production line conversion project during CFC phase-out, which is the case for five of the enterprises. The information also indicated that none of the enterprises using refrigeration equipment had any export to non-Article 5 countries and, that of the 48 enterprises, 38 had been visited during the preparation of the sector plan.

205. UNDP informed that in the chiller sub-sector, about 70 per cent of the chillers are using air cooled condensers and 30 per cent liquid cooled ones, typically in conjunction with a cooling tower. UNDP also informs that most companies in the chiller sub-sector manufacture a variety of products, and therefore have equipment to manufacture air-cooled condensers. UNDP maintains substantially higher IOCs for HFC-410A and HFC-134a based chillers, and commented at the cost of HFC-32 chillers. On HFC-32, UNDP cannot provide any insights before the demonstration project in one of the enterprises has

progressed significantly to allow using the experience for determining the actual cost, on the basis that HFC-32 is a relatively new technology for mass production. In response to questions of the Secretariat regarding the use of HC-290, propane, UNDP advised about building codes in China which might be more restrictive than elsewhere due to the high building density in urban areas; at the same time, UNDP forecasted an easier safety-regulatory future for the flammable HFC-32 than for propane, since the requirements on equipment containing the HFC-32 are likely to be less stringent than requirements on HC-290 (propane) refrigeration equipment. UNDP has this understanding since the two flammable substances had recently been put into different hazard classifications in an internationally important classification standard, with a less stringent classification for HFC-32; however, there are currently no standards as to what differences in product design and use might follow from the differences in classification.

206. The Secretariat has commenced with the analysis of the data provided by UNDP but this analysis had not been completed at the time of writing of this document.

RECOMMENDATION

207. Pending.

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS

China

(I) PROJECT TITLE	AGENCY
HCFC-22 phase-out management plan for room air-conditioner manufacturing sector	UNIDO

(II) LATEST ARTICLE 7 DATA	Year: 2009	18,602.7 (ODP tonnes)
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(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP)						Year: 2009			
Chemical	Aerosol	Foam	Fire	Refrigeration		Solvent	Process	Lab Use	Total sector consumption
				Manufacturing	Servicing				
HCFC123				4.0	2.0				6.0
HCFC124					6.1				6.1
HCFC133									
HCFC141b		5,056.8				465.9			5,535.7
HCFC142									
HCFC142b		1,066.0		2.0	349.8				1,417.7
HCFC22		1,353.0		6,221.6	3,456.2				11,030.8
HCFC225ca						1.0			1.0
HCFC225cb						0.0			0.0

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	To be determined	Starting point for sustained aggregate reductions:	n/a
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	1.7	Remaining:	

(V) BUSINESS PLAN		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
UNIDO	ODS phase-out (ODP tonnes)	104.4	104.4	69.6	69.6	174.0	64.8					586.8
	Funding (US \$)	32,250,000	32,250,000	21,500,000	21,500,000	53,750,000	20,019,750					181,269,750

(VI) PROJECT DATA				2011	2012	2013	2014	2015	Total
Montreal Protocol consumption limits				n/a	n/a	baseline	baseline	baseline - 10%	
Maximum allowable consumption (ODP tonnes)				n/a	n/a	19,100.0	19,100.0	17,190.0	
Project Costs requested in principle(US\$)		UNIDO	Project costs						
			Support costs						
Total project costs requested in principle (US \$)									
Total support costs requested in principle (US \$)									
Total funds requested in principle (US \$)									

(VII) Request for funding for the first tranche (2011)		
Agency	Funds requested (US \$)	Support costs (US \$)
UNIDO	To be determined	To be determined

Funding request:	
Secretariat's recommendation:	Pending

HCFC-22 PHASE-OUT MANAGEMENT PLAN FOR ROOM AIR-CONDITIONER MANUFACTURING SECTOR

PROJECT DESCRIPTION

208. On behalf of the Government of China, UNIDO has submitted to the 62nd Meeting of the Executive Committee an HCFC-22 phase-out management plan for the room air-conditioning manufacturing sector (RAC), at a total cost of US \$168,513,023 plus agency support costs of US \$12,638,477. Stage I, covering the years 2013-2015, is expected to phase-out 10,670 mt (586.9 ODP tonnes).

Production and refrigerant consumption in the RAC sector

209. The RAC sector is the major manufacturing sector consuming HCFC-22 in China. To ensure the accuracy and reliability of the data collected, the China Household Electric Appliances Association (CHEAA) carried out a survey using three different approaches: Questionnaires to 31 RAC manufacturing enterprises through which most of the data were collected; on-site visits and communications with enterprises; and a seminar for major enterprises. The data collected was crosschecked and verified with the database of the CHEAA, the data of the National Bureau of Statistic and the General Administration of Customs. According to the survey, in 2008, the production volume of RAC in China was 75.6 million units, of which 65.3 million were charged with HCFC-22 and the HCFC-22 consumption amounted to 66,100 metric tonnes (mt) based on an average charge of 1.01 kg of refrigerant per unit. In addition, a second round of data collection was undertaken at the end of 2009. This second survey focused on the assessment of RAC appliance production and HCFC-22 consumption in 2009, and forecast for 2010. The 2009 production in the RAC sector was 60 million units. The 2009 HCFC-22 consumption is calculated to be 71,500 mt with an average charge of 1.2 kg/unit. The increase of about 19 per cent in the charge per unit is explained by requirements for better energy efficiency of RAC equipment, a higher share of split units and the increasing importance of multi-split systems. Data was gathered in 2009 through two comprehensive surveys of the RAC and RAC compressor sectors.

210. The RAC manufacturing industry developed particularly fast from 2005 to 2008. The production of RAC peaked in 2007, when it reached 76.8 million units, with an increase of 28 per cent compared to 2006. The reason for this sharp increase in the year 2007 was the fast domestic economic development and the high domestic demand for RAC units. However, RAC producers overestimated the market demand in 2007 leading to an increase in RAC equipment stocks. This had a further impact on the volume of RAC production in 2008 because, during the same year, the demand was partly covered from stocks built in 2007. Furthermore, starting from the second quarter of 2008 the global financial crisis affected the RAC industry; as a result in 2008 the production volume decreased slightly. In 2008, the total production capacity of RAC in China was approximately 100 million units. The 2005-2008 production, domestic sales and exports is shown in Table 1.

Table 1: RAC production, domestic sales and exports

Year	Total production (thousand units)	Domestic sales (thousand units)	Export to A-5 countries (thousand units)	Export to non-A5 countries (thousand units)
2005	57,000	30,600	10,000	16,400
2006	60,000	31,600	9,900	18,500
2007	76,800	41,000	14,600	21,200
2008	75,600	39,800	15,300	20,500

211. In 2008, around 7.8 million window type units were exported to North America charged with HCFC-22, and another 3.2 million units charged with HCFC-22 were exported to other non-Article 5 countries. The rest of the export products to non-Article 5 countries were charged with HFC-410A. The refrigerant charge in the window units is half of that in the split units. Thus, the charge contained in exported HCFC-22 RAC units to non-Article 5 countries amounted to about 6 per cent of the overall consumption of HCFC-22 in RAC production. As of the end of 2009 exports of HCFC-22 products to North America were ceased.

212. The compressor is the key component in any refrigeration and air-conditioning system, including any RAC system; it is also built specifically for a certain refrigerant, and can often not be easily used with another. RAC compressors are designed and manufactured specifically for RAC applications. The design and manufacturing process in the compressor production should be modified according to the characteristics of the new refrigerants.

213. The RAC compressor sector has been growing rapidly, and in line with the growth of the RAC manufacturing sector. In 2007, the production volume of compressors was 85 million units, with a growth rate of 35 per cent compared to 2006. In 2008, the production volume of compressors decreased slightly, to 79 million units. The RAC compressors are primarily produced to cover the demand for compressors by RAC manufacturers in China, where more than 82 per cent of the total production is being sold. The export volume also grew and reached 14.1 million units in 2008, which is nearly unchanged as compared to the year before. The largest part of exports was to other Article-5 countries, such as India, the Republic of Korea and Thailand. About 1.68 million units were exported to non-Article 5 countries, such as Japan and the United States of America. Table 2 provides a summary of the development in recent years.

Table 2: RAC compressor production and exports

Year	Production (thousand units)	Export (thousand units)
2005	59,600	9,390
2006	63,000	9,990
2007	85,000	14,250
2008	79,000	14,100

214. The competition within the RAC sector is very strong. As a result, several leading enterprises are taking a constantly growing share of the market, while most of the second-tier and third-tier brands disappeared. Around the year 2000, there were about 400 RAC brands in the domestic market. This number shrank to about 150 brands in 2003 and further to about 30 in 2009. In 2009, the three leading manufacturers Gree, Midea, and Haier accounted for 65.1 per cent of the sales volume, a 4.7 per cent increase compared with 2008. A similar trend has been observed in the RAC compressor manufacturing sub-sector.

215. The scope of this RAC sector plan is limited to RACs with a cooling capacity lower than 14,000W, in accordance with the Room Air-conditioner national standard GB/T7725. Consequently, RACs with a cooling capacity larger than 14,000W are not included in this RAC sector plan. There are three main types of RACs in China:

- (a) Package air-conditioners, such as window and portable RAC;
- (b) Split type air-conditioners, such as wall-mounted split RAC and cabinet RAC; and
- (c) Multi-split RAC.

216. In the period from 2004 to 2008, split units were the predominant type of RAC in China, with approximately 70 per cent of the share of the total RAC production, followed by window RAC, with about 14 per cent of the share of the total production. Window RACs are mainly produced for exports. The share of portable RAC was steady during this period, it represents about 2 per cent and it is mainly for export. An overview is provided in Table 3.

Table 3: Production of various RAC types from 2005 to 2008

Year	Split RAC (thousand units)	Portable RAC (thousand units)	Window RAC (thousand units)	Other RAC (thousand units)
2005	43,700	970	9,100	3,200
2006	44,200	1,200	11,000	3,600
2007	58,700	1,500	12,400	4,200
2008	59,900	1,100	10,200	4,400

217. Due to its excellent refrigeration performance and chemical stability, HCFC-22 was the refrigerant of choice. HCFC-22 continues to be the most important refrigerant in the RAC sector globally. In recent years, some countries banned imports of RAC equipment containing HCFC-22. Consequently, the RAC sector in China developed a number of products using alternative refrigerants, mostly for exports. These alternatives are HFC-410A and HFC-407C. Only small quantities of RACs using HFC-410A are sold on the domestic market. Predominantly, these units are equipped with inverters that significantly improve energy efficiency of the RAC units. In addition, some RAC enterprises in China started to cooperate with foreign companies to produce and export portable RACs using HC-290.

218. In 2008, the production volume of some types of RAC (portable and window) was lower than in the year 2007. However, the average charge of the units was higher due to the larger share of energy efficient products, which was related to a subsidy programme of the Government; in addition, the product mix changed, with more split RAC, which have a higher charge. This led to an overall increase in the HCFC-22 consumption in 2008 as compared to the previous year. The consumption and production of RAC systems using HFC-410A grew rapidly during the same period. The share of non-HCFC RAC was about 14 per cent of the total production in 2008. North America banned the import of equipment using HCFC-22 as of 2010, which will inevitably have an impact on HCFC-22 consumption in China.

Table 4: RAC consumption and manufacturing by technology

Year	HCFC-22 (mt)	RAC using HCFC-22 (thousand units)	HFC-407C (mt)	HFC-410A (mt)	RAC using other refrigerants (thousand units)	Total (thousand units)	RAC using other refrigerants (% of total)
2005	45,700	51,200	554	767	5,800	57,000	10.18
2006	52,000	54,300	303	1,285	5,700	60,000	9.50
2007	63,700	69,200	503	3,188	7,600	76,800	9.90
2008	66,100	65,300	357	4,623	10,300	75,600	13.62

Alternative technologies

219. The RAC sector plan describes the process of the selection of alternative refrigerants taking into account physical, chemical and thermo-dynamic properties, energy efficiency and potential impact on climate, safety and economy. HFC-410A, HC-290 (propane) and HFC-161 have been selected as substitutes to HCFC-22.

220. HFC-410A is a well known and widely used technology for manufacturing RAC equipment in Europe, Japan and North America; it is also known to many enterprises in China. These enterprises may

adopt this alternative in accordance with their market and development strategies. Due to its high global warming potential (GWP) its use may be restricted sometime in the future. Therefore, HFC-410A is considered as a transitional replacement of HCFC-22 and will not be considered as a priority refrigerant beyond the first step (2013) of the HCFC-22 phase-out.

221. HC-290 is a natural hydrocarbon refrigerant with zero ODP, and its GWP is three. HC-290 has a good thermo-dynamic performance. It is an ideal environmentally-friendly refrigerant. However, HC-290 is a highly flammable gas, therefore safety measures should be implemented during RAC manufacturing and servicing. There is commercial production of HC-290-based RACs in Italy and Australia.

222. HFC-161 is non-toxic, and has good physical and chemical properties and is an environmentally-friendly refrigerant with zero ODP and a GWP of 12. However, HFC-161 is a flammable gas requiring additional safety measures in manufacturing and servicing. Several chemical companies and research laboratories in China and abroad studied this refrigerant. Some RAC enterprises have also started to study the application of HFC-161. With the same cooling capacity, the charge amount of HFC-161 is less than in the equivalent HCFC-22 system. There are no compatibility problems with the materials used in the existing systems; therefore, there is no need to change the compressor and the lubricant. Regarding the system performance, HFC-161 may improve the energy efficiency of products between 9 and 12 per cent compared to HCFC-22 after a redesign is carried out and structural changes have been introduced.

RAC sector development trend and HCFC-22 baseline consumption

223. In 2008 and the first half of 2009, the production of RAC decreased slightly as compared to 2007, due to the impact of the financial crisis. Since the second half of 2009, there are evidences that the RAC sector has started to recover. Forecasts show that the Chinese RAC sector will grow again in 2010 for the following reasons:

- (a) The positive effects of incentive policies that have been promoted by the Government of China to compensate the effect of the financial crisis and to burst the demand of the domestic market;
- (b) The rapid development of the real estate industry in China and the growing demand for RAC appliances in the domestic market covering both urban and rural areas; and
- (c) The recovery of the global economy and expectations that the demand for home appliances will grow in the international market in 2010.

224. It is expected that the production of RAC using HCFC-22 as well as the HCFC-22 consumption after 2010 will be more or less stable because of the introduction of the regulatory “Ban on construction of new production lines using HCFCs” in China. In addition, the growth rate will be curbed by the reluctance of several markets to accept HCFC-based equipment and by the reductions stemming from conversion efforts to replace HCFC-22 with alternative refrigerants.

225. The levels of HCFC-22 RAC production and HCFC-22 consumption for the years 2009 and 2010 were obtained based on the data collected during a second survey carried out at the end of 2009. These levels are shown in Table 5:

Table 5: HCFC-22 RAC production and HCFC-22 consumption in the baseline years

Year	HCFC consumption (mt)	RAC using HCFC-22 (units)
2009	71,500	59,994,000
2010	77,900	65,181,000

226. The HCFC baseline consumption for Article-5 countries is defined as the average consumption of 2009 and 2010. The RAC sector plan aimed to define a sector baseline consumption based on the estimated sector consumption during the same years. The figures of the related calculation are shown in Table 6.

Table 6: Baseline of HCFC-22 consumption in Chinese RAC sector

Category	HCFC amount (mt)
HCFC-22 consumption in 2009	71,500
HCFC-22 consumption in 2010	77,900
Baseline	74,700
Difference between 2010 and baseline consumption	3,200

227. Based on the estimate from Table 6, the amount of HCFC-22 to be phased out in the Chinese RAC sector during the first stage is calculated as shown in Table 7. Based on an average charge, the Table also shows the approximate manufacturing volume to be converted to reach this objective.

Table 7: HCFC-22 Phase-out targets in the RAC sector in China (Stage I)

Step	Category	HCFC-22 amount
A	Baseline (mt)	74,700
B	HCFC-22 to be phased out in 2013 (mt) (Step 1)	3,200
C	HCFC-22 to be phased out in 2015 (mt) (Step 2)	7,470
D	HCFC-22 to be phased out in Stage I (B+C) (mt)	10,670
E	RAC equipment manufacturing to be converted until 2015 (units)	8,892,000

228. As shown in Table 7, the Chinese RAC sector should phase-out 10,670 mt of HCFC-22 in the first stage, before 2015, and convert from HCFC-22 to various alternatives a corresponding production capacity equivalent to 8,892,000 units of RAC appliances. This latter figure was calculated based on the average charge volume of 1.2kg/unit.

229. Some RAC manufacturing enterprises are either owned by enterprises from non-Article 5 countries or jointly owned by enterprises from non-Article 5 countries. A number of others however, are under full Chinese ownership. In accordance with the policies of the Executive Committee, the HCFC-22 consumption of enterprises owned by non-Article 5 countries or the proportion corresponding to the share of non-Article 5 ownership is not eligible for funding by the Multilateral Fund. According to the data collected for the RAC sector plan, the part of HCFC-22 consumption corresponding to such enterprises is about 9.6 per cent of the total HCFC-22 consumption. Enterprises with a share of ownership originating from the Republic of Korea were included in these numbers. In this sector plan, the HCFC-22 consumption quota corresponding to non-Article 5 countries is deducted from the total HCFC-22 consumption.

230. The RAC sector plan envisaged the introduction of alternative technologies in the period from 2011 to 2015. The plan differentiates between step 1 until 2013 and step 2 until 2015, each being designed to reach the respective compliance target in the last year.

- (a) In step 1, eligible capacity corresponding to 85 per cent of the reduction target for that step, i.e. 2,459 mt, will be converted to HFC-410A and the remaining 15 per cent (434 mt) to HC-290 or HFC-161; and

- (b) In step 2, eligible capacity corresponding to 10 per cent of the target for that step, i.e. 675 mt, will be converted to HFC-410A and the remaining 6,723 mt to HC-290 or HFC-161.

231. Apart from HFC-410A, HFC-161 and HC-290 technologies, enterprises may adopt additional environmentally-friendly alternatives according to their development plan and market demand. The application of alternative technologies is presented in Table 8 as production capacity to be converted (in number of units).

Table 8: Selection of alternative conversion technology for Stage I

Production capacity	Eligible amount (units)
Overall production capacity to be converted in Stage I	7,878,000
Production capacity to be converted to HC-290 and HFC-161	5,402,000
Production capacity to be converted to HFC-410A	2,476,000

Calculation of environmental benefit of the HCFC-22 phase-out

232. The ODP phase-out to be achieved through the reduction of HCFC-22 consumption in the RAC sector during Stage I equals to 586.9 ODP tonnes.

233. Total Equivalent Warming Impact (TEWI) was used as a methodology to assess the reduction of the greenhouse gas emissions due to HCFC-22 phase-out in the RAC sector in Stage I. TEWI allows assessing the direct reduction of the greenhouse impact of refrigerant emissions and the reduction of indirect contribution of the greenhouse gas emissions produced by energy consumption in the lifetime of RAC products.

Table 9: GHG reduction

Emission reductions	CO₂ equivalent tonnes
Emission reduction due to leakage during operation	12,740,000
Emission reduction at disposal of RAC at the end of life time	11,948,000
Emission reduction due to energy saving achieved with the given alternative technologies	8,101,000
Total GHG reduction	32,789,000

Government policies

234. Since the current HCFC-22 technology is technically and economically effective and enterprises wish to maintain their market share, keep their quality standard and increase their profits, most RAC enterprises have little incentives to phase-out HCFC-22. To provide incentives for enterprises in addition to the financial support from the Multilateral Fund, the Government will establish and enforce policies to force enterprises to convert their HCFC-22-based production facilities and, for those that refuse to convert, eventually close the production facility. In addition to the existing policies, the introduction of the following policies is foreseen to achieve the HCFC-22 phase-out targets set in the first stage of the RAC sector plan:

- (a) Enforcement of ban on the installation of new HCFC production lines;
- (b) Establishment of a quota system controlling the supply of HCFC-22;
- (c) Introduction of a ban on the import of RACs containing HCFC-22 and equipment for production of RAC using HCFC-22 refrigerant;

- (d) Establishment of a financial incentive mechanism to encourage the application of environmentally-friendly alternatives. In line with the MLF rules, part of the IOC will be allocated to establish financial incentive mechanisms to encourage the application of environmentally-friendly alternatives;
- (e) Incorporation of RACs using environmentally-friendly refrigerant into the Government's procurement list;
- (f) Adoption of a refrigerant recycling and destruction protocol for the RAC sector in synergy with existing waste management regulations;
- (g) Revision of existing standards to meet the requirement for application of new flammable alternative technologies and development of new standards regulating installation, handling, storage, transportation and maintenance of RAC products using new alternative refrigerants including flammable ones;
- (h) Establishment of a standard for HCFC-22 recycling and reduction of HCFC-22 emissions during the RAC production, service and disposal; and
- (i) Assessment of the feasibility of establishing a certification system for the installers of split RAC appliances.

Action plan for Stage I

235. The action plan has been developed with the following seven components to ensure the effective implementation of HCFC-22 phase-out activities while not affecting negatively the development of the RAC sector:

- (a) Creation of the "National Ozone-layer Protection Leading Group" for coordination of HCFC phase-out activities with government bodies and establishment of a mechanism for communication with international organizations, industrial and consumers associations and other institutions;
- (b) Assessment of existing alternatives, and research and development of new alternative refrigerants, technologies and applications;
- (c) Technical cooperation and information exchange through international and national seminars;
- (d) Conversion of 36 RAC equipment and the related six compressor production lines;
- (e) Training programmes for government officials, enterprise's staff, and servicing and RAC installation personnel in relation to new regulations and requirements associated with new technology and alternative refrigerants;
- (f) Raising awareness at the government, enterprise and consumer levels using relevant information distribution channels and media;
- (g) Establishment of an information system to collect and exchange data provided by the industry; and

- (h) Establishment and operation of a quota system.

Conversion cost estimates

236. The RAC sector plan assessed the 2009 installed production capacity for RAC equipment to be about 100 million units, with the same level for compressor production as well. In 2009, about 89 per cent of this capacity used HCFC-22 as a refrigerant, therefore, the production capacity for about 89 million RAC appliances and compressors will have to be converted from HCFC-22 to zero ODP alternatives with the following timeline:

- (a) Before 2013, a production capacity of three million units;
- (b) Before 2015, a production capacity of nine million units (including the target for 2013); and
- (c) Before 2030, a production capacity of 89 million units (including the target for 2015).

237. In order to convert the RAC equipment from HCFC-22 to any alternatives, the design changes need to be made because of different thermo-physical and thermo-dynamic properties of the refrigerant, the new type of lubricant required and, in the case of HC-290 and HFC-161, refrigerant flammability. These changes in the design of the systems will also require conversion of some of the related production and performance-testing equipment, storage facilities, etc. Although the actual incremental cost associated with the different technologies may be different, the cost items are to some degree similar and will, according to the proposal, include:

- (a) Incremental capital cost (ICC) both for the RAC equipment manufacture and compressor manufacture will include conversion and/or purchase of production equipment for the assembly line, possibly the heat-exchanger line, refrigerant supply system, and the product-testing equipment; for conversion to flammable refrigerants (HC-290 and HFC-161), the installation of safety ventilation systems, hydrocarbon sensors, safety monitoring equipment, emergency power supply, as well as anti-static and explosion-proof measures will be required;
- (b) Incremental operating cost (IOC) associated with extra cost due to increased material cost and cost related to the new design, including lubricant and electrical components in the new compressor, to the degree eligible; and
- (c) Technical assistance cost for training for the workers, sellers, installation workers, and for raising awareness.

238. The following assumptions are made to estimate the incremental costs:

- (a) The price of the refrigerants and the cost of equipment, are calculated based on 2009 prices (HCFC-22: US \$1.6/kg; HFC-410A: US \$7.3/kg; HC-290 and HFC-161: US \$3.6/kg).
- (b) The conversion cost is based on the existing production capacities; the conversion will not result in a technical upgrade nor increase production capacity;
- (c) The cost estimates include only the conversion cost from HCFC-22 to alternatives with zero ODP. Any eventual second conversion cost from HFCs to other more

environmentally friendly refrigerant is not included; and

- (d) All cost calculations are based on a production capacity of 250,000 units per year per production line for RAC appliances, and 1,700,000 units per year per production line for RAC compressors.

239. The ICC and IOC items and their valuation are based on demonstration projects approved for conversion of manufacturing RAC appliances and compressors. The capital and operating incremental costs of conversion of one production line are summarized as follows:

Table 10: Incremental capital and operating cost for the conversion of one production line

Production line	Production capacity (unit/year)	Number of manufacturing lines to be converted	Alternative refrigerant	Incremental capital cost (US \$)	Incremental operating cost (US \$/unit)
RAC production line	250,000	22	HC-290 or HFC-161	3,199,959	14.00
RAC production line	250,000	10	HFC-410A	1,532,000	9.50
Compressor production line	1,700,000	3	HC-290 or HFC-161	2,980,275	n/a.
Compressor production line	1,700,000	2	HFC-410A	2,050,000	n/a.

240. The number of production lines required to be converted in the RAC and compressor manufacturing sub-sectors was determined by dividing the total number of units by the model case production capacity of 250,000 and 1,700,000 units respectively. The result total number of production lines in the RAC manufacturing sector is 32, sub-divided between conversion to HC-290/HFC-161 (22 lines) and HFC-410A (10 lines). In the compressor sub-sector, the total number of production lines is five with three and two lines to be converted to HC-290/HFC-161 and HFC-410A, respectively.

241. The charge of HCFC-22 refrigerant is 1.2kg/unit in the model case conversions. Therefore, the IOC per unit exceeded the threshold of US \$6.3/kg established in decision 60/44 and was pegged to the threshold value in the final calculation of the total ICC and IOC as follows:

Table 11: Calculation of total ICC and IOC

Step	Category of cost	Amount (US \$)
A	Total ICC for RAC production sub-sector in Stage I (US \$)	85,719,098
B	Total ICC for RAC compressor sub-sector in Stage I (US \$)	13,041,725
C	Total ICC for conversion in Stage I (A+B) (US \$)	98,760,823
D	HCFC-22 phased out funded by Multilateral Fund in Stage I (mt)	9,454
E	IOC threshold (US \$/kg)	6.30
F	Total IOC (D*1,000*E) (US \$)	59,560,200
G	Total ICC and IOC (C+F) (US \$)	158,321,023

Technical assistance cost

242. HCFC-22 substitution in the RAC sector requires coordinated efforts involving a number of stakeholders such as the Government, industrial associations, research institutes, enterprise employees, service enterprises, installation enterprises, retailers and consumers in order to meet and sustain the phase-out targets. Several activities with associated costs are included in the technical assistance category and shown in Table 12.

Table 12: Cost for technical assistance

Activities	Cost (US \$)
Project implementation and management	4,150,000
Establishment of the technical standards and regulations	770,000
Quota and information system	755,000
Training programme	500,000
Public awareness	550,000
Research and assessment of HC-290/HFC-161 alternative technologies	3,062,000
Technical communication	405,000
Total	10,192,000

Calculation of the overall cost and cost-effectiveness

243. The total cost of the RAC sector plan investment and non-investment activities is US \$168,513,023. The overall cost-effectiveness of the RAC sector plan is calculated dividing the total cost without the cost of conversion of the compressor sub-sector (US \$155,581,298) over the total ODS phase-out (9,454 mt) resulting in US \$16.46/kg.

Co-financing possibilities

244. The RAC sector plan indicates that additional contributions and cost sharing might be required from recipient enterprises to ensure the safe operation of production lines to be converted to flammable refrigerants. The RAC sector plan refers to the UNDP-GEF project “Promoting Energy Efficient Room Air-Conditioners” (PEERAC) that might provide some benefits in the implementation of the technical assistance component. The project on introduction of hydrocarbon technology in the RAC sector is at the final stage of implementation in bilateral cooperation with Germany. This project will provide the necessary experience and facilitate the promotion of a new technology to the RAC manufacturing industry. The contribution of these two projects, however, is not reflected in the proposed budget. Presently it is not known whether there are other reliable bilateral or multilateral sources of co-financing for the RAC sector conversion.

Implementation of the RAC sector plan

245. The implementation of the RAC sector plan is under the responsibilities of UNIDO as the implementing agency, and MEP/FECO and CHEAA as the national implementing institutions. Their responsibilities are summarized as follows:

- (a) MEP/FECO will be responsible for the overall management and coordination of the RAC sector plan implementation with the relevant Government agencies. This will include adopting and enforcing the policies and the quota system, as well as ensuring the implementation of the investment and technical assistance components of the RAC sector plan at the selected enterprises as planned. The responsibilities of MEP/FECO also include enforcement and monitoring of financial and technical performance indicators, the verification of HCFC-22 phase-out targets by organizing verification auditing as well as presenting progress, verification and completion reports to UNIDO. MEP/FECO will be closely working with CHEAA that will be providing assistance related to the technical and financial aspects of the RAC sector plan implementation and will liaise with selected enterprises. CHEAA will be responsible for the implementation of several elements included in the technical assistance component. The funding of MEP/FECO and CHEAA activities will be covered from this technical assistance component, requested at a funding level of US \$10.3 million.

- (b) UNIDO will sign a performance-based contract with MEP/FECO. UNIDO will be monitoring the implementation of the RAC sector plan through the review of annual progress and verification reports prepared by MEP/FECO. Further, UNIDO will present annual reports to the Executive Committee, including requests for replenishment of funding of the RAC sector plan according to the Agreement. As necessary, UNIDO will be providing technical and managerial support and policy advice. UNIDO's activities will be funded from the agency support cost requested at the amount of US \$12.65 million.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

246. The Secretariat reviewed the RAC sector plan in line with the recommendations of the Executive Committee on the preparation of HPMPs and taking into account existing guidelines and policies pertinent to determination of incremental costs. A number of clarifications and additional information was requested from UNIDO. The Secretariat also used additional information on the RAC sector in China obtained from international sources, and identified a number of issues that remain unresolved related to the determination of the HCFC baseline consumption in the sector and the eligible incremental costs.

Determination of the HCFC-22 baseline consumption

247. The Secretariat is for a number of reasons concerned regarding the determination of the sector-specific baseline of HCFC-22 consumption. The RAC sector plan provides data for 2005-2008 RAC domestic sales, export, production of units with HCFC-22 and alternatives, HCFC-22, HFC-407C and HFC-410A consumption. However, 2009 and 2010 data are limited only to the production of HCFC-22 units and HCFC-22 consumption. The availability of data regarding the total 2009 and 2010 output and production of units charged with R410A refrigerant is very important for more accurate assessment of the HCFC-22 consumption.

248. It is clear in the RAC sector plan that the 2008 exports to non-Article 5 countries amounted to 20.5 million units. No information, however, was provided regarding exports to non-Article 5 countries in both the 2009 and 2010 sets of data. In response to the Secretariat's query, UNIDO provided data on 2009 exports to non-Article 5 countries which comprised HCFC-22 products with the total consumption of 1,572 mt. This amount should be deducted from the sector-specific 2009 -2010 baseline. Data on exports of HCFC-22-based products to non-Article 5 countries in 2010 are not available yet. These should be identified, and the related HCFC-22 consumption should be deducted from the baseline consumption in the RAC sector.

249. The HCFC-22 consumption for 2009 and 2010 is calculated using on average 1.2 kg refrigerant charge versus 1.0 kg charge used in calculation of the 2008 HCFC-22 consumption. UNIDO explained that the increase of the average charge is related to higher energy efficiency requirements for AC units. As a result 2009 HCFC-22 consumption was increased by 8.2 per cent in comparison with 2008 in spite of the fact that the 2009 production measured in the number of units was lower than the 2008 figure. Window type, movable and other categories of RAC products are manufactured with an average charge of about 0.5 kg representing about 20 per cent of the total RAC production. The weighted average charge for determining the baseline production would be about 1.06 kg/unit.

250. The 2008 and 2009 accumulated inventory of AC units has not been taken into consideration in the calculation of the 2009 and 2010 consumption. It is recognized in the RAC sector plan that RAC manufacturers originally had overestimated the likely 2007 sales and consequently accumulated stock

because of higher production than sales. The related stock should have affected the 2008 production, but this impact is not reflected in 2008 production figure. A similar situation was observed in 2008 and 2009. In 2008, the financial crisis caused a strong negative impact on the global real estate market which directly caused a slowdown in the overall air conditioning market. The residential air conditioning inventory was increased sharply in the fourth quarter, to reach 15 million units by the end of 2008 which should influence the production in 2009 and 2010. However, the RAC sector plan does not reflect this situation.

251. Several leading RAC manufacturers significantly increased their production capacity in the last three years after the September 2007 cut-off date by installing new production facilities. The Secretariat indicated to UNIDO that production from newly installed plants should be deducted from the eligible HCFC-22 consumption. The Secretariat has requested, but not received additional information on all newly-installed production facilities. Instead, UNIDO clarified that all newly-established capacity is for non-HCFC technology that is not related to the RAC sector plan and the requested data are not available. The Secretariat believes that the establishment of additional non-HCFC-22 production capacity resulted in further shrinkage of HCFC-22 market in 2009 and 2010 and should be reflected in the RAC sector plan accordingly.

252. The Secretariat tried to verify information provided in the RAC sector plan and obtained data on China's RAC production, domestic sales and export from two international sources: The Japanese Air-Conditioning, Heating and Refrigeration News (JARN), and a study from the Building Services Research and Information Association (BSRIA) on the air-conditioning sector in China. Both sources indicate that in 2008 and 2009, exports of single split and window/movable RAC units were close to the data provided in the RAC sector plan. However, the RAC sector plan data on the 2008 and 2009 production and domestic sales are shown to be higher by more than 15 million units.

253. UNIDO assured the Secretariat about the reliability of the data provided in the RAC sector plan, which is based on a second round of data collection in 2009, and in this case on two newly-conducted comprehensive surveys in the RAC sector and RAC compressor sector in China. The data collected in the RAC sector plan were crosschecked and verified with the database of the CHEAA, the data of the National Bureau of Statistic, as well as with that of the General Administration of Customs (GAC). Additionally, UNIDO provided references to the 2008 and 2009 data from the China Statistical Year Book (CSYB) prepared by the National Bureau of Statistics on output of production of household air conditioners. Data from the GAC relate to exports and imports. There is a consistency of export data provided by the GAC with the RAC sector plan, JARN and BSRIA.

254. According to CSYB, the 2008 and 2009 output is about 15 per cent higher than the data reported in the RAC sector plan and about 58 per cent higher than JARN and BSRIA production data. As indicated by BSRIA, according to the definition used in the Statistical Year Book, residential air conditioners refer to equipment (cooling capacity below 14kw) which can control indoor temperature, humidity, air velocity and air cleanliness. It might include dehumidifiers, fan coils, etc. and, therefore, the CSYB data cannot be considered as representative. BSRIA clarified that there were about 15 million RAC units in stock by January 2009 (10.1 million in factories and 4.8 million in distribution channels). The 2009 production should be calculated as home market plus exports minus imports minus utilized stock. The RAC sector plan does not provide a transparent calculation of the 2009 production from which the HCFC-22 consumption could be discerned.

255. It is noted that 2010 was a good year for the sales of RAC globally. However, the RAC sector plan and subsequent UNIDO comments do not provide the necessary information justifying the claimed increase in HCFC-22 consumption of 6,400 mt in 2010 in addition to 71,500 mt in 2009. It is not clear how inventories accumulated in 2007 to 2009 have been utilized in 2010 sales. According to BSRIA,

8.5 million RAC units were in stock by 1 January 2010 with 6.4 million units in factories and 2.1 million units in distribution channels.

Enterprises with foreign ownership and eligible incremental costs

256. According to the RAC sector plan, the share of the HCFC-22 consumption related to ownership of non-Article 5 countries represents 9.6 per cent of the total of the HCFC-22 consumption. In order to account for this ownership, the sector baseline consumption was reduced by this percentage resulting in a “revised sector starting point” of 67,529 mt. However, this methodology of accounting for the foreign ownership is not consistent with the decision of the Executive Committee adopted at its 7th Meeting, which reads as follows: “Partial funding should be considered on a case-by-case basis to finance the local share ownership of any given enterprise partly owned by a transnational corporation. In such a case, funding could be provided as a percentage of project incremental costs proportionate to the local share ownership of the enterprise with the transnational corporation responsible for the rest.”

257. From the total of the 31 RAC manufacturers identified in China, there are 12 RAC manufacturing enterprises fully owned by enterprises from non-Article 5 countries or jointly owned by enterprises from non Article 5 countries and those from China. The share of foreign ownership of these 12 enterprises varies from 11 per cent to 100 per cent. The cumulative consumption of these enterprises is 17,604 mt or 27 per cent of the total consumption of 66,109 mt, with local share of consumption corresponding to 11,257 mt and foreign ownership equivalent to 6,347 mt. In accordance with the policies of the Executive Committee, the eligible HCFC-22 consumption to be phased out in Stage I should be determined according to the exact contribution of specific enterprises with foreign ownership included in Stage I of the conversion plan. The impact of the different approaches is illustrated in the following example: One specific manufacturer has 27 per cent non-Article 5 ownership and a consumption of 13,000 mt of HCFC-22 annually, and might be selected for Stage I conversion. This single manufacturer could achieve the total Stage I phase-out target for the sector, i.e. about 10,000 mt, without even converting all of its manufacturing. In this case, the Multilateral Fund would provide funding for the nationally owned part of the enterprise, i.e. for 73 per cent of the agreed incremental cost, which is equivalent to about 7,300 mt phase-out. However, the calculation methodology used by UNIDO and China in the RAC sector plan would lead to funding based on 90.4 per cent of the sector baseline which is equivalent to about 9,040 mt phase-out.

258. It is not possible to calculate the eligible tonnage of HCFC-22 to be phased out under Stage I of the RAC sector plan without knowledge of the ownership of and phase-out associated with each individual enterprise with foreign ownership that will be included in the Stage I conversion. As a result, it is not possible to calculate accurately the eligible incremental costs.

Selection of enterprises for Stage I conversion

259. The lack of information on the selection of potential beneficiaries included in Stage I and their position in the industry creates a further increase to the perceived risk of allocation of funds to enterprises with limited commercial viability. The RAC sector is experiencing a permanent transformation and consolidation. The market share of a dozen major manufacturers is steadily growing and the aggregated share of other smaller manufacturers is accordingly shrinking. The potential inclusion of smaller manufacturers in the Stage I conversion plan might be detrimental to the objective of HCFC phase-out given their unknown economic viability and sustainability in the very competitive and rapidly consolidating market.

260. The RAC sector plan proposed conversion of ten production lines to HFC-410A not indicating what specific enterprises might be selected for conversion to this technology. The analysis of the current

status of the RAC manufacturing sector indicates that major players in the sector installed significant production capacity based on HFC-410A technology. Their participation during the Stage I conversion would be beneficial given the short time available before control measures are applied, and would contribute to a reduction of the incremental costs.

261. The proposed conversion of five compressor production lines in Stage I needs further justification. Conversion of two production lines is proposed for HFC-410A technology. There is virtually no information provided on the RAC compressor manufacturing sector in the proposal. The compressor manufacturer list included in the RAC sector plan is not complete. It is lacking several important compressor manufacturing facilities, especially those installed in recent years (since 2007). In order to be able to provide an assessment whether and to which degree conversions of compressor manufacturers to HFC-410A technology are necessary, the description of the status of the compressor manufacturing sector needs to be expanded substantially. It needs to include the complete list of manufacturers, showing installed capacity, number of production lines, date of their establishment and technical capability and flexibility of manufacture different type of products for different technologies. At this point in time, and based on third-party market information, it appears that the compressor manufacturing industry built up sufficient capacity for HFC-410A-based product to satisfy the demand of RAC manufacturers in the following several years so there is no need for the MLF funding of additional production capacity.

Incremental costs of conversion in Stage I

262. The calculation of the incremental costs was done on the basis of the definition of two model cases, namely, the conversion of a 250,000 unit capacity production line of RACs and of a 1.7 million unit capacity production line of compressors, by replicating the costs from approved demonstration projects. Notwithstanding the demonstration projects approved recently by the Executive Committee, the Secretariat analyzed the eligibility of the requested capital and the operating incremental costs based on technical specifications of production equipment, existing experience in reviewing investment projects and understanding between the Secretariat and the implementing agencies of the eligible incremental costs. The Secretariat discussed with UNIDO the proposed incremental costs for the RAC conversion to HFC-410A and HC-290/HFC-161 technology, such as vacuum pumps, refrigerant supply equipment, heat exchanger process equipment, ventilation and safety systems, and ultrasonic sealing machines for the case of conversion to HC-290/HFC-161 technology, performance-test equipment, recovery stations, installation tools, and charges for delivery, insurance and installation. The incremental costs of conversion of compressor production lines to HFC-410A and HC-290/HFC-161 have also been discussed, going into details such as manufacturing equipment, performance testing equipment and other costs. There are still considerable differences between the opinions of UNIDO and the Secretariat in regard to the level of the incremental costs for different cost items.

263. Regarding the incremental operating costs, UNIDO had requested costs of lubricant for the RAC equipment manufacturing. However, the Secretariat determined that the cost of lubricant and compressor electrical components for conversion to HC-290 technology belongs to the IOC of the compressor manufacturer and is therefore not eligible since funding of IOC for component conversion is not eligible under the Multilateral Fund. With these adjustments, the IOC for HC-290 conversion is US \$8.5/unit, to be capped at the threshold of US \$6.30. The Secretariat proposed the IOC for HFC-410A conversion to be US \$6.00, which could be further reduced to US \$3.92 if the conversion of heat exchanger manufacturing would be funded.

Synergy with UNDP-GEF project “Promoting Energy Efficient Room Air-Conditioners” (PEERAC) and the incremental costs for technical assistance

264. UNIDO calculated the indirect green house gases (GHG) emission reductions due to energy efficiency improvement at 8.1 mega tonnes (CO₂ equivalent) using better energy efficiency parameters of HC-290 and HFC-410A based products replacing less efficient HCFC-22 units. GHG reduction in the RAC sector in China is also claimed as the major outcome of the UNDP-GEF project “Promoting Energy Efficient Room Air-Conditioners” (PEERAC). That project amounts to US \$27.6 million and is financed by GEF (US \$6.2 million), RAC and compressor manufacturers (US \$20 million) and by the Government and others (US \$1.35 million).

265. The PEERAC project contributes to the reduction of GHG emissions through the transformation of the Chinese air-conditioning market towards more energy efficient room air-conditioners used in residential and commercial buildings, including promotion of new and existing energy efficient technologies among manufacturers of RAC equipment in China. The UNDP-GEF estimates of CO₂ emission reductions do not include the reduction in direct emissions related to differences in GWP of HCFC-22 and alternatives.

266. The Secretariat indicated to UNIDO that the reduction in CO₂ emissions calculated by UNIDO duplicate reductions in CO₂ emissions contained in the UNDP-GEF project. UNIDO agreed to withdraw its claim for GHG emission reductions due to the introduction of HC-290 and HFC-410A-based products.

267. The PEERAC project incorporates many features that are closely related with activities proposed in the RAC sector plan, such as technical assistance components requested in the RAC sector plan at the total of US \$10.3 million components which are closely related, have the same target group and a similar technical content are e.g.: project implementation and management; establishment of the technical standards and regulations; quota and information system; training programme; public awareness; research and assessment of alternative technologies; technical communication. The Secretariat discussed with UNIDO the noticeable synergies of the PEERAC project and technical assistance components proposed in the RAC sector plan. UNIDO perceives the objectives of the PEERAC project as to assist in upgrading the energy efficiency of the conventional products without replacing the ODS refrigerant. This project would complement and underpin the success of the RAC sector plan but UNIDO does not see how funds requested for technical assistance from the Multilateral Fund could be reduced. The discussion on this issue is still ongoing.

Overall cost-effectiveness

268. The Secretariat noted that an overall cost-effectiveness of the RAC sector plan was calculated by UNIDO without accounting for the costs of conversion of the compressor production lines; not taking these into account resulted in a cost-effectiveness of US \$16.46/kg. In Article 5 countries receiving MLF funds for conversion of compressor production, the cost-effectiveness has in the past been calculated discounting the IOC for compressors and including funds allocated for conversion of compressor manufacturers. Accounting for the cost of compressor conversion, the cost-effectiveness value of the RAC sector plan is US \$17.83/kg.

Estimation of other environmental benefits from HCFC phase-out

269. The sector plan calculated that the direct GHG emission reduction after successful implementation of Stage I would be 24,688,000 tonnes of CO₂ equivalent. The indirect climate impact is related to the potential for enhancement of the energy efficiency of newly designed RAC units and has a calculated potential of 8,101,000 tonnes of CO₂ equivalent; however, these improvements seem to

duplicate the impact of PEERAC project and the related claim was withdrawn. Both direct and indirect climate impact is based on a simplified calculation by the Government of China. Due to lack of information about the framework conditions used by China, the Secretariat is unable to assess the validity of that data.

270. Due to the limitations in information referred to in this paragraph, the Secretariat was before the 62nd Meeting not in a position to advise the Executive Committee on the level of funding that could be recommended for approval. The unresolved issues before the 62nd Meeting were as follows:

- (a) UNIDO had provided between the issuance of document UNEP/OzL.Pro/ExCom/62/26 and the 62nd Meeting some additional data that facilitated the understanding of some remaining issues. Based on the information provided, the Secretariat had been able to calculate the share of HCFC-22 based RAC units exported to non-Article 5 countries in 2009. Altogether, 2,667,049 HCFC-22 RAC units have been exported to non-Article 5 countries with 93 per cent exports to the United States of America. HCFC-22 consumption of 1,572 mt was associated with exports to non-Article 5 countries, which would be ineligible for funding and could be deducted from the total 2009 HCFC-22 consumption in the sector, and so impact the 2009-2010 sector-plan baseline accordingly. No data is yet available regarding potential 2010 exports to non-Article 5 countries and associated HCFC-22 consumption. In this regard, the Secretariat would like to point out that increasing amounts of air conditioners appear to be exported from China to, in particular, eastern European and central Asian non-Article 5 countries;
- (b) UNIDO pointed out that the Government of China conducted a survey to obtain 2009 production and consumption data. The complete set of data had not been made available to the Secretariat. The methodology for determination of the 2009 and 2010 HCFC-22 baseline consumption in the RAC sector had remained unclear and, therefore, could not serve as a reliable basis for determining the eligible incremental cost;
- (c) The ownership of non-Article 5 countries in RAC manufacturing capacity has a significant impact on the level of eligible incremental costs. Currently, the share of enterprises with non-Article 5 ownership represents 9.3 per cent of the total consumption of HCFC-22 in the production of room air conditioners. This value was also used in the proposed plan to calculate the target of HCFC-22 phase out for Stage I. The Secretariat had pointed to the fact that the transfer of the share of enterprises with non-Article 5 ownership in the sector consumption to the sub-set addressed in the first stage did not correspond to the respective decisions of the Executive Committee, which requested enterprise specific information, necessitating a re-calculation on the basis of the enterprises to be converted.
- (d) When issuing the documentation for the 62nd Meeting, the Secretariat was not aware of which enterprises are being selected for Stage I conversions and, therefore, could neither advise the Executive Committee on the eligible MLF share of required costs for conversions, nor of the actual incremental cost needed for each particular enterprise;
- (e) The basis for selected average annual production capacity of 250,000 units for the model case production line was not clear. Little supporting information had been provided to corroborate why this size of line had been chosen, or how to determine an alternative number which might better reflect the situation of conversions during Stage I. The selection of a model production line with higher output would have resulted in a lower level of eligible incremental costs, since to reach the calculated reduction in consumption

desired, starting from the assumed sector baseline, fewer production lines would need to be converted;

- (f) A number of incremental capital and operating cost items had not been agreed. For example, the costs of plant engineering, product redesign, trials, testing and training had been assumed to arise for the conversion of each of the production lines to be converted but this did not account for any savings arising where one selected enterprise has several production lines to be converted and might even be manufacturing the same product or similar products on them;
- (g) UNIDO had informed the Secretariat that it could not recognise any synergy between the project proposed and the UNDP-GEF project “Promoting Energy Efficient Room Air-Conditioners” (PEERAC). The Secretariat had demonstrated that the PEERAC project incorporates many features that are closely related with activities proposed in the RAC sector plan, such as the technical assistance components requested in the RAC sector plan and, therefore, has an impact on the requested incremental costs for technical assistance; and
- (h) The Secretariat had informed the Executive Committee that prior to the 62nd Meeting it was not possible to assess the eligible incremental cost for the RAC sector on a technical level with reasonable accuracy, given the gaps in data as explained above.

Developments since 62nd Meeting

271. After resubmission for presentation at the 63rd Meeting of the project proposal for HCFC-phase-out in the room air-conditioning sector, the Secretariat posed a number of questions to UNIDO, several of which had already been raised previously. The Secretariat provided in its set of questions more specifics regarding the exact data needed for further review of the proposal. In this communication, the Secretariat requested information related to the specific companies for manufacturers of room air-conditioners as well as the associated compressors. The Secretariat also has raised questions related to the typical layout of manufacturing facilities and their operation and actual production capacities, contingency and shipping cost, monitoring issues and the calculation of incremental operating costs. Finally a number of questions were also raised related to the proposed technical assistance activities.

272. UNIDO provided to most of the different questions comprehensive information, most importantly regarding the ownership structure, HCFC-22 consumption, production and the manufacturing capacity of 31 manufacturers of room air conditioners and six manufacturers of related compressors; the information on room air-conditioning compressing manufacturers contained also information on the amount of compressors manufactured using alternative technologies. When asked about the manufacturers’ specific export to non-Article 5 countries and the capacity of the largest five lines of each manufacturer, UNIDO informed the Secretariat that this information is not available to the agency. The information provided advised that 19 of the 31 manufacturers have exclusively Article 5 country ownership, while the remaining are partly owned by non-Article 5 countries at levels between 10.64 per cent and 95 per cent. Since the information was provided by enterprise, it was possible to correlate the ownership information with HCFC-22 consumption, production and production capacity. All the information provided was based on 2008 data. UNIDO also agreed in the communications to some cost reductions to reflect concerns of the Secretariat regarding eligibility and incrementality of those costs raised in the communications.

273. The Secretariat has commenced with the analysis of the data provided by UNIDO but this analysis had not been completed at the time of writing of this document.

RECOMMENDATION

274. Pending.

DEMONSTRATION PROJECT ON HCFC MANAGEMENT AND PHASE-OUT IN THE REFRIGERATION SERVICING SECTOR

PROJECT DESCRIPTION

275. On behalf of the Government of China, UNEP and the Government of Japan has submitted to the 62nd Meeting of the Executive Committee a demonstration project on HCFC management and phase-out in the refrigeration servicing sector, at a total cost of US \$900,000 plus agency support costs of US \$90,480 for UNEP and US \$26,520 for the Government of Japan. The Executive Committee, in its decision 62/60, had requested the relevant bilateral and implementing agencies to re-submit the demonstration project to the 63rd meeting. Following the request, UNEP has resubmitted the demonstration project as a pilot project the 63rd Meeting without substantial changes.

276. The estimated consumption of HCFC to maintain and service the HCFC-based refrigeration and air-conditioning equipment is about 3,800 ODP tonnes (69,000 mt) of HCFC-22 per year, representing 21 per cent of total HCFC consumption in China. It is expected that the HCFC consumption for servicing refrigeration systems will continue to grow.

277. In order to strengthen the management of the ODS, the Government of China issued the ODS management regulation in April 2010 which has become effective from 1 June 2010. Among the provisions regarding the servicing sector, are the following:

- (a) ODS dealers should be registered as per the requirement of Ministry for Environmental Protection (MEP);
- (b) Service workshops are required to register with the county level Environmental Protection Bureau (EPB). Service workshop must carry out ODS recovery and recycling, or invite a professional company engaged in ODS refrigerant recovery/recycling, reclamation, and/or disposal, to carry out the safe disposal of ODS;
- (c) A company engaged in ODS refrigerant recovery/recycling, reclamation, and/or disposal must register with the provincial level EPB; and such companies must dispose of ODS properly without any harmful impact;
- (d) Servicing workshop and recovery/recycling companies must keep their business records for at least three years and must report data as per the MEP's provision. Furthermore, they must be equipped with proper tools and/or equipment and, professional staff as stipulated by MEP.

278. In considering of the small servicing workshops dispersed over the country and the urgency of the HCFC phase-out schedule, it is very difficult for MEP to manage and monitor the servicing market directly. Therefore, it would need to rely on local government's departments as the most effective measure for improving the management and monitoring of the servicing sector. Accordingly, it is proposed to launch a demonstration project to test the feasibility and validity of policy measures, technical approaches, and management modality, and identify the cost effectiveness of related activities. It is proposed to implement the project in Shenzhen as a demonstration city to establish and carry out the management mechanism of the ODS servicing sector. The experiences and lessons obtained from the demonstration project are expected to be a basis and reference for China to formulate the detailed rules corresponding to the ODS management regulation. If the demonstration project is successful, Shenzhen would also play a role of leadership in encouraging other cities to take similar actions as soon as possible.

279. The overall costs of achieving reductions of 11 ODP tonnes (200 mt) of HCFC-22 in the servicing sector in Shenzhen are estimated at US \$3,000,000, of which US \$900,000 are requested from the Multilateral Fund (i.e., based on the cost-effectiveness threshold of US \$4.50/kg). The balance of the costs will be borne by the local Government and the industry (Table 1).

Table 1. Estimated cost of the demonstration project on HCFC management and phase-out in the refrigeration servicing sector in China

Description	Cost (US \$)	
	Fund	Counterpart
Local regulatory framework and technical standard		
Development of regulations, codes and standards of servicing sector data management and best practices	45,000	
Evaluation meeting/stakeholder meeting	36,000	
Printing and distribution of regulations and standards	20,000	
Survey and assessment on HCFC refrigerant circulation, distribution and use		
Organize the local exporters/TSI to collect details information for at least 50 equipment dealers, 400 chiller servicing workshops, 400 informal servicing workshops, 100 cold storages, 2,000 chillers end- users and 500 small end-users	80,000	
Transportation		35,000
Data input, analysis and prepare report	15,000	
Establishment of Database, dynamic update of HCFC usage in refrigeration servicing		
Hardware and software facilities for information management system	15,000	
Develop Shenzhen refrigeration servicing management system	18,000	
Data input; dynamic update; and maintenance	45,000	
Pilot project at large/medium/small scale of refrigeration/AC equipment		
Equip refrigerant recovery machines for pilot project workshops	204,000	1,396,000
Expert consultancy for development of technical solution and programme for HCFC reduction in operation, servicing, maintenance, of large chiller and train the technicians who operate the chiller	15,000	
Follow-up the daily operation, maintenance, servicing and disposal and summarize the related experience	13,500	
Establishment of R/AC equipment recycling network		
Setting up collection point		51,000
Door-to-door collection		100,000
Equip R/R equipment		40,000
Law enforcement and technical monitoring and inspection		
Enforcement inspection to servicing workshops and interview with end-users	20,000	
Conduct technical inspection regularly for the servicing workshops and end-users	60,000	
Transportation		30,000
Training programme		
Training workshops for government officers and law enforcement officers	25,000	
Training workshops for technician (two days)	125,000	
Recorder, video camera and other facilities	6,000	
Neighborhood-level training		500,000
Public awareness		
Publicity workshops/events/programmes on world environment day, international ozone day (venue rent, programme designing, material publishing)	48,000	
Non-profit advertisements in television, newspaper	60,000	
Promotion of HCFC phase-out and management regulations in annual conference of architecture, refrigeration and property management industries	12,000	
Competition of "excellent refrigeration equipment servicing technician"	10,000	
Pamphlet printing of "knowledge on refrigerant use in household air-conditioner "		50,000
Project assessment		
Project assessment (consultancy fee)	7,500	

Description	Cost (US \$)	
	Fund	Counterpart
Project output dissemination at national level	20,000	
Support personnel (6 persons, 2 years)	80,000	40,000
Office daily operating cost	10,000	
Total cost	990,000	2,242,000

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

280. The Secretariat did not include the demonstration project on HCFC management and phase-out in the refrigeration servicing sector in the document UNEP/OzL.Pro/ExCom/62/26 submitted to the 62nd Meeting, considering that only HCFC investment projects could be submitted outside an HPMP (decision 54/39). As explained in the document on the overview of issues identified during project review (UNEP/OzL.Pro/ExCom/62/10), the Secretariat informed UNEP that decision 54/39 established the general requirements for an HPMP, as well as the exception to allow countries to choose to implement investment projects in advance of completion of the HPMP. Decision 55/43 invited the submission of project proposals to the Secretariat for aerosols, fire extinguishers and solvents sectors as well as projects related to the HCFC phase-out in the foam, refrigeration and air conditioning sectors. This was further specified in the same decision to refer to demonstration projects for the conversion of HCFCs to low-GWP technologies in the refrigeration and air conditioning sub-sectors. Project submissions outside of an HPMP for uses other than those defined in these decisions have not been foreseen.

281. Based on decision 62/60, the Secretariat has included information about the submission of the pilot project on HCFC management and phase-out in the refrigeration servicing sector in this document. However, in the absence of guidance from the Executive Committee related to the eligibility and determination of incremental cost for stand-alone projects and demonstration projects in the HCFC service sector, the Secretariat was unable to provide a more detailed assessment of the project proposal.

RECOMMENDATION

282. In light of the requirements of decision 54/39 the Secretariat is unable to recommend approval of the demonstration project on HCFC management and phase-out in the refrigeration servicing sector in China.

**PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECTS
CHINA**

PROJECT TITLE**BILATERAL/IMPLEMENTING
AGENCY**

(a)	Demonstration project for conversion from HCFC-141b-based technology to iso-paraffin and siloxane (KC-6) technology for cleaning in the manufacture of medical devices at Zhejiang Kindly Medical Devices Co. Ltd.	UNDP and Japan
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NATIONAL CO-ORDINATING AGENCY	Foreign Economic Cooperation Office, Ministry of Environment Protection
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LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT**A: ARTICLE-7 DATA (ODP TONNES, 2009, AS OF MARCH 2011)**

Annex C, Group I	18,584.6
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B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, 2009, AS OF MARCH 2011)

Substance	Consumption by sector (ODP tonnes)						Total
	Aerosol	Foam	Ref. manu.	Ref. serv.	Solvent	Other	
HCFC-22		1,353	6,221.6	3,456.2			11,030.80
HCFC-141b		5,056.8			465.9	12.76	5,535.48
HCFC-142b		1,066	2	349.8			1,417.80
Other			4	8.1	1		13.10

HCFC consumption remaining eligible for funding (ODP tonnes)	n/a
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CURRENT YEAR BUSINESS PLAN ALLOCATIONS		Funding US \$	Phase-out (ODP tonnes)
	(a)	500,000	7.6

PROJECT TITLE:	(a)
ODS use at enterprise (ODP tonnes):	18.48
ODS to be phased out (ODP tonnes):	3.06
Project duration (months):	18
Project costs (US \$):	
Incremental Capital Cost:	320,046
Contingency (10 %):	32,005
Incremental Operating Cost:	205,616
Total Project Cost:	557,667
Local ownership (%):	100
Export component (%):	0
Requested grant (US \$):	557,667
Cost-effectiveness (US \$/kg):	20.05
Implementing agency support cost (US \$):	53,134
Total cost of project to Multilateral Fund (US \$):	610,801
Status of counterpart funding (Y/N):	Y
Project monitoring milestones included (Y/N):	Y

SECRETARIAT'S RECOMMENDATION:	For individual consideration
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PROJECT DESCRIPTION

283. UNDP, on behalf of the Government of China, re-submitted to the 63rd Meeting a “Demonstration project for conversion from HCFC-141b-based technology to iso-paraffin and siloxane (KC-6) technology for cleaning in the manufacture of medical devices at Zhejiang Kindly Medical Devices Co. Limited”. The project proposal had been submitted to the 62nd Meeting but discussions on issues related to the HCFC-phase-out in China could not be finalized at that time, and thus the agency resubmitted an unchanged proposal.

284. Project preparation funding for this project had been approved at the 60th Meeting. The demonstration project is intended to phase out the use of HCFC-141b as a solvent in the production of specific medical devices, to be replaced by a non-ODS, non-HFC solvent with potentially wider application in the medical devices sub-sector. The funding requested for the implementation of the project is US \$557,667 plus support costs of US \$26,404 for UNDP and US \$26,730 for the co-implementing bilateral agency, the Government of Japan.

Background

285. According to information submitted with the project document, China is consuming about 1,700 metric tonnes (mt) of HCFC-141b in medical cleaning applications. The project document proposes to convert one production line for disposable medical devices, particularly medical needles. The experience gained in this project can be used to prepare conversion activities for other companies in the same sub-sector in the future.

Medical devices sub-sector profile

286. The solvent sector in general is characterized by emissive use of HCFCs. The main solvent sub-sectors in China are the medical sub-sector as well as the sub-sectors for metal, electronic, precision electronics, and formulated solvents. The HCFC consumption in the solvent sector in China is estimated to be 4,394 mt in 2009. The medical cleaning applications sub-sector consumed about 1,700 mt (187 ODP tonnes) of HCFC-141b in 2009, representing in the order 39 per cent of the overall sector consumption. The main products manufactured include syringes, infusion sets, blood transfusion sets, various puncture instruments, catheters, and other sanitary materials. It is a common characteristic that the devices manufactured are so-called siliconized, i.e. covered with a thin layer of silicone oil, to reduce friction and reduce the patient’s pain. The tools used for this process need regular cleaning, for which HCFC-141b-containing solvents are being used. The sub-sector consists of a large number of small and medium enterprises (SMEs) with a limited access to alternative technologies. The importance of the sub-sector for human health, the known structure of the sub-sector and the need of the sector participants for support were reasons for China to prioritize this sub-sector in the phase-out of HCFC solvents in China.

Enterprise background

287. Zhejiang Kindly Medical Devices Co. Limited (Zhejiang Kindly) was established in 1987 and has no ownership outside China. It is a subsidiary of the Shanghai Kindly Enterprise Development Group Limited. Zhejiang Kindly is specialized in the manufacturing of disposable medical devices, particularly disposable needles. The enterprise has a completely mechanized production line from jointing capillaries, extruding, grinding, and needle assembly with an annual capacity of 10.5 billion needles for different purposes. In 2009, the enterprise accounted for about 45 per cent of the national production of these products.

288. The project proposal points out that this enterprise is one of the best organized enterprises in the sub-sector with sound technical and financial standing. It has experience in implementing ODS phase-out and was actually the first enterprise in the sub-sector to phase-out CFC-113. The good reputation as well as the close contact with the industry association will subsequently support the dissemination of the know-how in the sub-sector.

289. Technology selection

290. Puncture instruments, such as medical needles, must be coated with a layer of silicone oil on the blade and the tube. The tooling for the application of the oil needs to be cleaned regularly. For this purpose, a solvent is being used; originally, CFC-113 was the solvent of choice. Upon the replacement of CFC-113, first the solvent KC-3000 was introduced, shortly replaced by the solvent KC-3000C, both developed in China and the latter containing 65 per cent of HCFC-141b. This solvent is currently the most widely used one in the medical device industry in China. The company looked at a number of alternatives, among them HFC-365mfc, a solvent containing HFC-365mfc, HFC-4310 and KC-6. The latter is not only the solvent with the lowest global warming potential (GWP) with a value of below 20, but also the most cost-effective replacement for KC-3000C. KC-6 is a medical silicone oil thinner developed by Beijing Aerospace Technology Innovation Co. Limited. Its shortcomings are that it has a certain degree of flammability and, a high boiling point, making it less volatile as compared to the current technology. The cost is favourable at about US \$6.20/kg; the next affordable alternative is KC-3000 at a level of US \$12/kg, the most expensive one at US \$70/kg. The project proposal informed that KC-6 is a mixture, the components for which are easily available on the market at favourable costs. It has a higher boiling point than HCFC-141b, which is both advantageous in terms of consumption of the solvent, but has disadvantages in terms of the energy needed to dry the needles. The solvent properties and chemical stability are good. China has selected KC-6 as the most suitable alternative solvent for the medical solvent sub-sector.

291. Zhejiang Kindly consumes solvent in 29 production lines, such as lines for needle assembly, scalp vein sets, a variety of other needle productions as well as the ultrasonic cleaning of the tooling to apply the silicone oil. While the consumption of HCFC-141b is comparatively small, within the order of 38 to 66 kg per million needles, the total very large production volume as well as the HCFC-141b needed for the cleaning of the tooling leads to a total consumption of 167.97 mt. The consumption of the actual solvent KC-3000C containing HCFC-141b is, accordingly, 50 per cent higher due to other, additional components of the solvent. Only one needle assembly line as well as one line for cleaning of the tooling has been selected for the demonstration project. These two lines are consuming in total 27.82 mt (3.06 ODP tonnes).

292. As KC-6 has a higher boiling point and is flammable, the production lines need to be modified and certain process adjustments need to be carried out. Additional activities concern the management of the silicone oil, the evaluation of the effect of applying it and the evaluation of the quality of the cleaning of the tools. Finally, confirmation of bio-compatibility and drug-compatibility as well as training and technical assistance are needed. The changes will include the installation of an explosion proof fan, the addition of a hot air dryer to evaporate the solvent as well as certain other changes in the production process itself.

293. KC-6 has presently a higher operating cost than HCFC-141b, with the cost of the fluid increasing by US \$3.55/kg. In addition, during the introduction period, a higher needle wastage is assumed when calculating operating cost. Finally, some further costs are related to an increase in electrical load due to the additional equipment, in particular the hot air heater needed to evaporate the new solvent with a lower boiling point.

294. An overview over the incremental capital and the incremental operating costs of the project can be found in Table 1.

Table 1 - Cost overview for the demonstration project

Incremental capital cost (ICC)	
Item	Cost (US \$)
Needle assembly line modifications	60,946
Process adjustments	8,875
Silicification fluid management (mixer, safety, viscometer)	20,488
Silicification tooling line modifications (solvent recovery, modification ultrasonic equipment etc.)	106,805
Performance evaluation (Puncture testing, biocompatibility, drug compatibility, evaluation)	38,923
Other (experts, technical assistance, documentation etc.)	84,009
Sub-total ICC	320,046
Contingencies (10%)	32,004
Total ICC	352,050
Incremental operating cost (IOC)	
Item	Difference [US\$ / a]
Solvent (needle production)	32,660
Needles wastage during introduction period	29,926
Solvent (tool cleaning)	119,280
Increased electrical load due to additional equipment	23,750
Total IOC	205,616
Incremental cost	
Total incremental cost	557,666

295. The project will be implemented by UNDP with the assistance of the Ministry of Environment Protection, FECO. The Government of Japan is the bilateral cooperating agency and will execute the incremental operating cost component. The implementation will take in total 18 months, with the commercial production starting up after 15 months.

SECRETARIAT COMMENTS AND RECOMMENDATION

COMMENTS

296. The Secretariat requested further information regarding the size of the solvent sector and the intended steps to reduce the consumption in the sector. In its response, UNDP pointed to the submission of the overarching HPMP strategy summary. According to the information from UNDP, the solvent sector is supposed to contribute 8 per cent to the overall phase-out target for stage I of the HPMP, amounting to about 39 ODP tonnes. This demonstration project proposes to phase-out about 3.1 ODP tonnes. UNDP advised that the remaining phase-out will be addressed through the solvent sector plan, which is planned for submission to the 64th Meeting of the Executive Committee.

297. Further information on the solvent sector and the sub-sector targeted here was also requested. UNDP informed that the sub-sector for medical equipment experiences a very high growth rate and is critical from the human health perspective. Therefore, the Government of China decided to prioritize the sector for early action. An additional advantage is that enterprises in this sub-sector are oriented towards compliance-based operations due to their exposure to standards for medical devices. This sub-sector also experiences significant similarities in the technology process across the enterprises in the sub-sector, although the scale of the operations may vary considerably. Consequently, once a particular alternative technology is used by one enterprise, the barriers for application are lower for all. Finally, the approval and certification of this technology at one enterprise for the proposed applications will reduce the time and cost of approvals and certification of this technology in other enterprises.

298. In a reply to a Secretariat's question regarding the applicability of the technology across the sector, UNDP advised that all enterprises consuming HCFC-141b in this sub-sector in China produced the same type of puncture instruments with the same kind of silicone oil and the same process of oil-coating, using quite similar applications. Consequently, the outcome can be applied to all types of puncture instruments; in fact, the alternative technology has been developed based on its potential for universal applicability.

299. The project proposal mentioned an alternative solvent KC-3000, containing HFC-365mfc. The Secretariat requested clarification on how long the solvent has been used by the company, whether the solvent KC-3000C has been introduced later and when the introduction took place. The agency informed that although KC-3000 was introduced as a technology, it was not accepted by the sub-sector because the price was significantly higher than CFC-113. Therefore, enterprises started using KC-3000C. The company carried out trials with KC-3000 in August 2005, and started using KC-3000C from October 2005 onwards. The reason cited was that KC-3000 led to significantly higher costs.

300. The Secretariat requested a number of cost details regarding the costs of the hot air dryer and whether certain modifications to a conveyer were necessary, as well as a number of other items. It also questioned the need for undertaking drug compatibility testing and the related cost and whether the information could be spread in the sub-sector sufficiently with the cost provided in the project proposal. The agency provided satisfactory replies for all the issues raised.

301. The Secretariat had so far only had experience of two projects in this sub-sector about 15 years ago, both of which did not address the same issues as this project proposal. Consequently, it identified and contracted an external expert to provide additional insight into the cost structure. The expert assessed the project proposal, the cost items, and the operating costs. In the expert's opinion, the solution provided was cost-effective in particular in terms of the operating costs, and the steps of the conversion appeared to be meaningful. Due to time limitations and limited knowledge beyond the project proposal regarding the exact set-up of the process, the Secretariat accepted the incremental costs as proposed.

RECOMMENDATION

302. The Executive Committee may wish to consider approving the project at the cost level indicated below on the understanding that the eligibility and costs presented in this document do not establish a precedent for the sector:

	Project Title	Project Funding (US \$)	Support Cost (US \$)	Implementing Agency
(a)	Demonstration project for conversion from HCFC-141b-based technology to iso-paraffin and siloxane (KC-6) technology for cleaning in the manufacture of medical devices at Zhejiang Kindly Medical Devices Co. Ltd.	352,051	26,404	UNDP
(b)	Demonstration project for conversion from HCFC-141b-based technology to iso-paraffin and siloxane (KC-6) technology for cleaning in the manufacture of medical devices at Zhejiang Kindly Medical Devices Co. Ltd.	205,616	26,730	Japan
