United Nations Development Programme

[redacted]

Country: China

Project Document

Project Title	Sector Plan for HCFC Phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China (Stage-I compliance with 2013 and 2015 targets)
UNDAF Outcome(s):	**Outcome:** Government and other stakeholders ensure environmental suitability, address climate change , and promote a green, low carbon economy
Expected CP Outcome(s): *(Those linked to the project and extracted from the CPAP/UNDAF Action Plan)*	Low carbon and other environment sustainable strategies and technologies are adapted widely to meet China's commitments and compliance with Multilateral Environment Agreements
Expected Output(s): *(Those that will result from the project and extracted from the CPAP)*	Achievement of HCFC consumption control targets for 2013 and reduction targets for 2015 through implementation of HCFC Phase-Out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) sector in China
Executing Entity:	Foreign Economic Cooperation Office, China Ministry of Environmental Protection (FECO/MEP)
Implementing Agency:	United Nations Development Programme (UNDP)

Project Summary

The XIXth Meeting of the Parties to the Montreal Protocol in September 2007, through its Decision XIX/6, adopted an accelerated phase-out schedule for HCFCs. The first control is the freeze on production and consumption of HCFCs from 01 January 2013, at the Baseline Level (average of 2009 and 2010 consumption levels). The other control steps are reduction of 10% by 2015, reduction of 35% by 2020, reduction of 67.5% by 2025, reduction of 100% by 2030, allowance of 2.5% of baseline (annual equivalent) for period 2030-2040 and complete phase out by 2040. China is a party to the Montreal Protocol and must comply with the above targets.

During the 64th Meeting of the Executive Committee, Sector Plan for HCFC Phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China (Stage-I), addressing 2013 and 2015 targets, was approved by the Executive Committee with UNDP as the implementing agency. Total approved funding was US $ 61,000,000. The ICR HPMP comprises of a combination of interventions such as technology transfer investments, policies and regulations, technical assistance, training, awareness and communications and management, coordination and monitoring to be implemented over five years from 2011 to 2016. Upon successful completion, the plan will result in sustainable reductions of 465 ODP tonnes of HCFC consumption in the ICR Sector by 2015, contributing to China's compliance with the 2013 and 2015 control targets for Annex-C, Group-I substances (HCFCs) under the Montreal Protocol. In addition, the project will result in direct CO2-equivalent emission reductions of about 7.66 million tones annually. The implementation of the project will follow the rules and procedures of National Execution (NEX). The Performance Based Payment (PBP) Mechanism will be applied for the implementation.

Programme Period:	**2011 – 2016**	Total resources required	61,000,000US$
Key Result Area (Strategic Plan):		Total allocated resources:	
Atlas Award ID:	00063099	• Regular	
		• Other:	
Start date:	1 December 2011	• MLF	61,000,000US$
End Date	31 December 2016		
		In-kind Contributions	-
Management Arrangements	NEX		

Agreed by FECO/MEP: 2011.12.05

Agreed by UNDP: 2011.12.06

LIST OF ABBREVIATIONS

CFC Chlorofluorocarbons
CP Country Programme
CRAA China Refrigeration and Air Conditioning Industry Association
CTC Carbontetrachloride
ExCom Executive Committee of the Multilateral Fund
FECO Foreign Economic Cooperation Office
GWP Global Warming Potential
HCFCs Hydrochlorofluorocarbons
HFCs Hydrofluorocarbons
IA Implementing Agency
MEP Ministry of Environmental Protection
MLF Multilateral Fund for the Implementation of the Montreal Protocol
MOP Meeting of Parties to the Montreal Protocol
MP Montreal Protocol
MT Metric Tonnes
ODP Ozone Depleting Potential
ODS Ozone Depleting Substances
PBP Performance Based Payment
SBAA Standard Basic Assistance Agreement
UNDP United Nations Development Programme

I. SITUATION ANALYSIS

1. OBJECTIVE

The objective of this project is to assist Government of China implement the "Sector Plan for HCFC Phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China (Stage-I compliance with 2013 and 2015 targets)" under UNDP component of HPMP in line with overall strategy and implementation plan outlined in the HPMP document approved by the 64th Meeting of the Executive Committee. The extract of Annex XXVII to the report of the 64th Meeting of the Executive Committee containing the Agreement between the Executive Committee of the Multilateral Fund and Government of China for Stage I of HPMP is attached in Annex-1 to this document.

2. BACKGROUND

2.1 ODS Phase Out in China

China signed Vienna Convention for the Protection of the Ozone Layer in June 1989, Montreal Protocol on Substances that Deplete the Ozone Layer (hereinafter Montreal Protocol) in June 1991. As of May 2010, China has ratified all amendments to the Montreal Protocol. Chinese government compiled and approved "Country Program for Phase-out of Ozone Depleting Substances" (hereafter Country Program) in January 1993 and established phase-out strategies for major sectors of ODS production and consumption in 1995. In November 1999, Chinese Government updated the Country Program. According to Country Program, with the support of Multilateral Fund and international institutions, China has conducted more than 400 projects and 18 sector plans including chemical production sector, Automobile Air-conditioner Sector, Tobacco Sector, Industrial and Commercial Refrigeration and Air Conditioning, Extinguishing Sector, Solvent Sector, Household Appliance, Foam Sector etc. to phase out production and consumption of CFCs, Halons, CTC, TCA and Methyl Bromide subsequently. With two decades of hard work, China had completed the phase-out of the production and consumption of CFCs and Halons on July 1st 2007, two and a half year earlier than the phase-out schedule under Montreal Protocol. Until January 1st 2010, except for essential use, Chinese Government had completely eliminated the production and consumption of CFC, Halons, CTC and TCA (5 year ahead the schedule) to meet the requirement of Montreal Protocol, which is an outstanding contribution to Ozone Layer protection.

2.2 Evolution of HCFC Phase-out Management Plans

HCFCs, which have Ozone Depleting Potential (ODP) up to 15% of that of CFCs, are also classified as controlled substances under Annex-C, Group-I of the Montreal Protocol. HCFCs, therefore, have use restrictions and would eventually have to be phased-out. Initially, for developing countries, the scheduled phase-out date for HCFCs was 1 January 2040 with an interim control measure of freezing HCFC production and consumption at 2015 levels from 1 January 2016.

During the implementation of the CFC phase-out under the Montreal Protocol, HCFCs were approved as interim substitutes for CFCs in many of the projects and activities supported by the Multilateral Fund. Considering the increasing demand for HCFCs, and considering the imminent restrictions on HCFCs, including the 2016 freeze in consumption for Article-5 countries, it was necessary to address the technology and environmental issues arising from HCFC use reductions. Moreover, it was expected that actions to reduce HCFC consumption needed to be initiated sooner rather than later. Recognizing these challenges, the ExCom

approved at its 45th Meeting in 2005, funding for UNDP to carry out HCFC surveys in 12 countries, to assess the HCFC consumption and growth trends in these countries. China was one of the countries which requested to be a part of this survey. The key result of this survey was establishing the HCFC consumption profiles and projected growth rates in HCFC consumption in various sectors in China until 2015. As established in this survey, which was carried out during 2005-2007, China does not produce HCFCs and the domestic demand is entirely met through imports. The total imports of HCFCs in China during 2005 were 2,114 metric tonnes. At a conservative growth rates, this was projected to reach about 8,293 metric tonnes by 2015.

The 19th Meeting of the Parties to the Montreal Protocol in September 2007 adopted an accelerated phase-out schedule for HCFCs. The first control is the freeze on production and consumption of HCFCs from 01 January 2013, at the Baseline Level (average of 2009 and 2010 consumption levels). The second control step is the reduction of 10% from the Baseline Levels on January 1, 2015. Subsequent control steps are 35% reduction by 2020, 67.5% by 2025, 97.5% by 2030 and complete phase out from January 1 2040. The decision also directed the Executive Committee of the Multilateral Fund to assist Article-5 Parties in preparation of HCFC Phase-out Management Plans (HPMP).

2.3 HCFC Phase-out Management Plan of China

Hydrochlorofluorocarbons (HCFCs) are classified as controlled substances under Annex-C Group-I of the Montreal Protocol and are subject to the adjusted control schedule for Article-5 countries; to freeze the HCFC production and consumption at baseline levels from 2013 and reduction of 10% from baseline levels from 2015. There are more than 30 categories of HCFCs controlled in Montreal Protocol. Currently, only six of them are produced in China: HCFC-22, HCFC-123, HCFC-124, HCFC-133a (mainly used as feedstock), HCFC-141b and HCFC-142b. In addition, HCFC-225 from foreign market is also consumed in China. The production and consumption of HCFCs in China involves 7 sectors: HCFC Production Sector, PU Foam Sector, XPS Foam Sector, Room Air Conditioning Sector, Industrial and Commercial Refrigeration and Air Conditioning Sector, Solvents Sector and Servicing Sector.

Sector Plan for HCFC Phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China

China is currently the world's largest producer and consumer of HCFCs. Due to rapid economic development in the past two decades and resulting demand for consumer, commercial and industrial products in the Foams, Refrigeration, Air Conditioning and Solvents sectors, consumption of HCFCs in China has grown significantly. The significant increase in HCFC consumption will lead to additional environmental impacts on ozone depletion as well as on global warming due to the ozone depleting potential and global warming potential of HCFCs. In the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in particular, there has been a sustained growth in HCFC consumption of 12-15% annually in the past few years. The ICR sector consumption was over 40,000 metric tonnes. The sector contributes about US$ 20 billion to the economy and employs over 100,000 persons in over 1,000 enterprises, many of which are small and medium-sized. This sector also has a large variety of products and applications, categorized into nine sub-sectors. The main constraint faced by the sector is the mature and proven availability of cost-effective and efficient alternative refrigerants and related technology and the ability to deploy alternative technologies for meeting the Stage-I targets, without undue burden on the industry and public. Considering the relatively short net available time of only 3-4 years to implement conversions, and considering the volume of HCFC

consumption needed to be reduced, this will be a considerable challenge. Extraordinary efforts will be needed to counter the momentum of growth in this sector.

To fulfil the country's compliance and to achieve the HCFC phase-out targets for stage-I, i.e. freezing the HCFC consumption at the average level of 2009-2010 from January 2013 and reduction of 10% of the baseline consumption from January 2015, the ICR HPMP of China was prepared and submitted for the consideration of the 62n^{d} Meeting of the Executive Committee after due review and endorsement by the Government. The Executive Committee approved the ICR HPMP of China in 64th meeting for Stage-I in July 2011 at a funding level of US $ 61,000,000. The agreement between the ExCom and Government of China indicated the ICR HPMP of China aims to phase out 223.72 ODP tons in 2013 and 240.28 ODP tons in 2015.

II. STRATEGY FOR ICR HPMP IMPLEMENTATION

The ICR HPMP for China proposes to address 2013 and 2015 targets through a combination of activities interventions in prioritized sub-sectors industries for phasing-out HCFCs used in the ICR sector. An overview of specific interventions that would be adopted is given below.

- Implementation of projects for converting compressor and sub-sectors using HCFCs in ICR sector that includes Unitary Air-Conditioners, Multi-Connected Air-Conditioners, Industrial and Commercial Water Chiller, Small Sized Water Chiller, Heat Pump Water Chiller, Compressor condensing unit & Freezer and cold-storage etc. to HCFC free alternatives.

- Development and enforcement of policy and regulatory interventions to control HCFC consumption levels to the targeted limits, thus, constraining growth of HCFCs and reduce dependence on HCFCs.

- Development and revision of technical standard and regulations for the industrial & commercial air-conditioner and refrigeration equipment production and compressor production.

- Providing technical support for conversion projects at enterprises and establishment of Industrial Information & Network System.

- Training for sector enterprises on alternatives and/or alternative technologies.

- Awareness and information outreach programs targeting consumers and other identified national stakeholders for achieving HCFC phase-out.

- Project Management and Coordination for sector plan and monitoring and verifying the implementation of ICR HPMP.

III. TIME FRAME/MONITORING MILESTONES

Overall time plan for implementation of the programs is given in the table 1 below:

MILESTONE/TIME FRAME	Half-Years (HY) beginning 1 July 2011										
	2011	2012		2013		2014		2015		2016	
	HY1	HY2	HY3	HY4	HY5	HY6	HY7	HY8	HY9	HY10	HY11
Conversion for compressor production lines											
Finalisation of overall implementation plan											
Signing of agreement between FECO and enterprises											
Project implementation											
Monitoring implementation against agreement milestones											
Conversion for air-conditioner and refrigeration equipment production lines as stipulated in the HPMP											
Finalisation of overall implementation plan											
Signing of conversion contracts between FECO and enterprises											
Project implementation											
Monitoring implementation against agreement milestones											
Policy and regulatory actions											
Development of related policy and regulations											
Implementation and enforcement											
Technical Support Programe											
Providing technical support to participating enterprises											
Technical Standards and Regulations											
Development of technical standards											
Implementation and enforcement											
MIS establishment											
Development of MIS											
Implementation and enforcement											
Awareness and Training											
Promoting awareness and training activities											
Monitoring											
Monitoring project implementation											
Verification											
Verification of 2013 and 2015 targets											
Project Management											
Finalisation of Implementation Plan for Project Management and Monitoring											
Project implementation and coordination											

IV. RESULTS AND RESOURCES FRAMEWORK (Table 2)

Applicable Goal (UNDAF):	**Outcome:** Low carbon and other environment sustainable strategies and technologies are adapted widely to meet China's commitments and compliance with Multilateral Environment Agreements **Indicator:** Regulations, codes, guidelines, standards, and labels for energy efficiency and renewable energy developed and improved
ATLAS Award ID:	00063099
ATLAS Project ID:	00080423

Intended Outputs	Output Targets for 2011 to 2016	Indicative activities	Responsible Parties	Inputs (US $ 000)
Output: China's HCFC compliance targets for 2013 and 2015 achieved through ICR HPMP implementation **Baseline:** Average of 2009 and 2010 HCFC consumption **Indicator:** a freeze at the average of 2009 and 2010 levels from 01 January 2013 and a subsequent 10% reduction from the baseline level from 01 January 2015. Reduction of 224.5 ODP tons in 2013 and 240.3 ODP tons in 2015.	**Targets : 2011** Completion of project implementation plan. **Targets : 2012** - Submission and approval of Implementation Report for 2011 and Plan for 2012 and release of 2012 Tranche. - Detailed Plan for TA activities for 2012 and 2013. - Signed conversion contracts total of 3,000 metric tones (165 ODP tonnes) (of which about 600 metric tones prior to June 2012) **Targets : 2013** - Submission and approval of Implementation Report for 2012 and Plan for 2013 and release of 2013 Tranche. - Meeting the 2013 frozen target * **Targets : 2014** - Submission and approval of Implementation Report for 2013 and Plan for 2014 and Performance Verification Report for 2013. **Targets : 2015** - Submission and approval of Implementation Report for 2014 and Plan for 2015 and Performance Verification Report for 2014.Release of 2015 Tranche. - Meeting the 2015 reduction target ** **Targets : 2016** - Submission and approval of Implementation Report for 2015 and Performance Verification Report for 2015.	**Investment Projects – Conversion of compressor; Conversion for air-conditioner and refrigeration equipment production lines as stipulated in the HPMP** - Completion of project implementation plan - Signature of conversion contracts with Beneficiary enterprises - Completion of conversion to HCFCs free alternatives	FECO/MEP	51,000,000
		Technical Assistance - Completion of plan for technical assistance activities - Technical assistance in implementing project component - Development and enforcement of policy and regulations - Development and implementation of technical standards - Project monitoring and progress reporting on annual basis - Verification on 2013 and 2015 targets achievement - Contingency	FECO/MEP	5,120,000
		Project Management and Monitoring - Monitoring project implementation - Providing Technical, Financial and operational management - Project progress reporting and coordination support	FECO/MEP	4,880,000
		Grand total		**61,000,000**

Note: * To be verified in 2014. ** To be verified in 2016.

V. ANNUAL WORK PLAN

The table 3 below presents the budgets for the **tranche 2011 and tranche 2012** available under the project. The payment schedule and indicators for tranche 2013, 2014 and 2015 will be finalized and agreed upon by UNDP and FECO/MEP during 2012. An Overall budget break-up for ICR HPMP for the period 2011-2016 will be also given in Annex-IV to this ProDoc afterwards.

AWARD ID	00063099							
PROJECT ID	00080423							
Project Title	Sector Plan for HCFC Phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China (Stage-I compliance with 2013 and 2015 targets)							
Executing Agency	Foreign Economic Cooperation Office, China Ministry of Environmental Protection (FECO/MEP)							
ATLAS Activity	**Responsible Party**	**Source of funds**	**ATLAS Code**	**ATLAS Budget Description**	**2011**	**2012**	**2013**	**Total**
Activity 1 : Investment Projects	FECO/MEP	63030	72100	Contractual Services	13,970,000	7,879,600	6,348,000	28,197,600
	Sub-Total				**13,970,000**	**7,879,600**	**6,348,000**	**28,197,600**
Activity 2 : Technical Assistance	FECO/MEP	63030	71300	Local consultants	115,000	115,000	0	230,000
	FECO/MEP	63030	71600	Travel	100,000	100,000	0	200,000
	FECO/MEP	63030	72100	Contractual Services	400,000	400,000	0	800,000
	FECO/MEP	63030	75700	Training, workshop and confer	135,000	135,000	0	270,000
	Sub-Total				**750,000**	**750,000**		**1,500,000**
Activity 3 : Project Management	FECO/MEP	63030	72100	Contractual Services (Project Management for FECO)	1,040,000	609,700	448,500	2,098,200
	FECO/MEP	63030	72100	Contractual Services (Executing for CRAA)	240,000	140,700	103,500	484,200
	Sub-Total				**1,280,000**	**750,400**	**552,000**	**2,582,400**
	Total				**16,000,000**	**9,380,000**	**6,900,000**	**32,280,000**

Note: During the project implementation, the budget as listed above could be adjusted between budget lines under each activity and/or the new budget line could be added while keep the same subtotal for each activity, if deemed necessary; the budget among the activities under each year could be adjusted through the budget revision to be agreed between UNDP and FECO/MEP.

VI. MANAGEMENT ARRANGEMENT

6.1 Implementation Modality

The agreement between the Chinese government and the ExCom will serve as the framework within which the ICR sector plan will be implemented. The project will be managed in accordance with National Execution (NEX) modality. The Government of China through its Foreign Economic Cooperation Office, Ministry of Environmental Protection (FECO/MEP) will be implementing project with support from UNDP. The MoU between UNDP and FECO/MEP which was signed on 8 January 2011 will serve as the guideline for the overall management on the project implementation. The Performance Based Payment (PBP) Mechanism will be applied for the implementation of ICR sector plan project as discussed in this ProDoc. Further details is outlined in the Implementation Plan attached as Annex - VI

6.2 Roles and responsibilities

UNDP is serving as the implementing agency to supervise the implementation of the sector plan, specifically including the following:

- Providing assistance for policy development, planning and management of sector programming as set out in these sectors, when required;
- Ensuring verification of performance and progress of disbursement in accordance with the Agreement between the Chinese government and the ExCom and with its specific internal procedures and requirements as set out in these sectors and assisting FECO in the implementation and assessment of the activities;
- Assisting FECO in the preparation of the ICR sector annual Implementation Plans as per Appendix 4-A in the agreement between Chinese government and the ExCom;
- Ensuring financial verification of the activities implemented;
- Reviewing and clearing the Project Implementation Manual(PIM) and all other TORs for TA activities and provide advice and assistance as needed;
- Monitoring the progress and carrying out supervision missions;
- Ensuring the Fund disbursed in accordance with the guidelines of the ExCom;
- Reporting the progress of implementation plan and submitting requests to the ExCom for future tranches;

FECO/MEP will be responsible for the overall implementation, coordination and management of the ICR Sector Plan, specifically including the following:

- Preparing and implementing the PIM and Annual Implementation plan;
- Implementing, supervising and monitoring the conversion activities;
- Developing policy framework, implementing regulatory actions, and conducting technical assistance activities during the implementation as planned;
- Executing Performance-Based contracts with enterprises participating in Stage I with assistance of CRAA, for technology conversions, and ensuring disbursement to the enterprises based on agreed performance targets;
- Preparing the annual implementation plan and progress reports as per provision of the agreement between the Chinese government and the ExCom; and the reports as required by UNDP.
- Facilitating performance verification and financial audit as required;
- Coordinating between various HCFCs consumption sectors at national level in such a way as to facilitate establishment of sector level HCFC consumption reliably;

- Ensuring coordination between all related stakeholders in the sector with assistance of CRAA;
- Carrying out commissioning procedure for establishing completion of enterprise level conversions with assistance of CRAA;

In connection with above all technical assistance activities will be further clarified through specific TORs to be developed and agreed between UNDP and FECO.

In addition **CRAA** will participate in the overall management and implementation of HCFCs phase-out in ICR industry. Please see Annex VI for areas of responsibility.

6.3 Target for stage I (2011-2015)

Table 4

	2011	2012	2013	2014	2015	Total
Montreal Protocol reduction schedule of Annex C, Group I substances (ODP tonnes)	n/a	n/a	19,269.0	19,269.0	17,342.1	n/a
Maximum allowable total consumption of Annex C, Group I substances (ODP tonnes)	n/a	n/a	18,865.4	18,865.4	16,978.9	n/a
Maximum allowable consumption of Annex C, Group I substances in the ICR sector (ODP tonnes)	n/a	n/a	2402.8	2402. 8	2162.5	n/a
Total Phase-out (ODP tonnes)	n/a	n/a	224.5	n/a	240.3	464.8

Note: the figures above are as per the finalized agreement between the government of China and the Executive Committee of the Multilateral Fund for the reduction in consumption of Hydrochlorofluorocarbons.

6.4 Payment Schedule and Indicators

Fund Allocation for ICR Sector Plan (Stage I)

Table 5

Category	Brief Description	US $
Investment (51,000,000)	Conversion cost for compressor production lines	5,000,000
	Conversion cost for air-conditioner and refrigeration equipment production lines as stipulated in the HPMP	46,000,000
Technical assistance (3,750,000)	Policy and regulatory actions	200,000
	Technical Support Programe	1,000,000
	Technical Standards and Regulations	1,000,000
	MIS establishment	250,000
	Awareness and Training	300,000
	Monitoring	500,000
	Verification	500,000
Project management for FECO		3,965,000

Executing fee for CRAA	915,000
Contingency	1,370,000
Grand total	61,000,000

Tranche 2011 (Table 6)

Payment Date (Indicative)	**Disbursement (US$)**	**Indicators/Milestones**
First disbursement No later than 15 Dec 2011	16,000,000	-Detailed project implementation plan is finalized; -1 stakeholder consultation completed;
Second disbursement No later than 15 July 2012	1,500,000	Detailed Plan for TA activities for 2012 and 2013;
Third disbursement No later than 15 December 2012	7,880,000	Signed conversion contracts total of 3,000 metric tones (of which about 600 metric tones prior to June 2012);
	25,380,000	

Tranche 2012 (Table 7)

Payment Date (Indicative)	**Disbursement (US$)**	**Indicators/Milestones**
First disbursement No later than 30 June 2013	6,900,000	-The annual progress report for tranche 2011 and funding for tranche 2012 have been approved by the ExCom; -Conversion contracts signed totalling 800 metric tonnes;

The payment schedule and indicators for tranche 2013, 2014 and 2015 will be finalized and agreed upon by UNDP and FECO/MEP during 2012.

VII. MONITORING FRAMEWORK AND EVALUATION

7.1 Monitoring & Verification

The reporting with respect to the project shall include the following reports: Implementation Report, Implementation Plan and Verification Report as specified in the Agreement between the MLF Executive Committee and the Government of China.

The activities of Monitoring & Verification include the following:

a) Performance Verification:
UNDP will prepare the TOR of Performance Verification in agreement with FECO/MEP. The Performance Verification will be carried out by a qualified agency/expert team according to the requirements stipulated in the agreement between the Chinese government and the ExCom. The Performance Verification shall establish:

- If the targets of HCFCs consumption and/or phase out which are defined in the agreement between the Chinese government and the ExCom have been achieved.
- If the selected participating enterprises have reduced or have phased out HCFCs consumption as planned.
- If the alternatives and/or alternative technologies have been applied as agreed in the selected participating enterprises.
- If the progress of the conversion at participating enterprises is as planned.
- If the technical assistance activities have been appropriately conducted and obtained achievements which are defined the annual implementation plan.

In accordance with the agreement between the Chinese government and the ExCom, the conversions are to be verified for a random sample of at least 5% of the manufacturing lines which had been completed their conversion in the year to be verified. On the understanding that the total aggregated HCFC consumption of the random sample of the manufacturing companies that completed conversion in the year to be verified, representing at least 10% of the sector consumption phased out in that year.

The Performance Verification is to be carried out for 2013, 2014 and 2015 and will be completed in accordance with the ExCom submission schedule.

b) Financial Audit:

In accordance with the agreement between UNDP and the Chinese government, an annual financial audit on UNDP National Executing (NEX) projects in China will be conducted by an independent contractor. According to the agreement, if the project annual expenditure exceeds the UNDP defined minimum the project will participate in the financial audit. The project will be audited at least one time during its project life cycle. The financial audit aims to verify:

- If the project fund has been appropriately applied which are in line with the agreement between UNDP and the Chinese government.
- If the project fund has been appropriately disbursed in the selected enterprises in accordance with the requirement defined in the contracts between the Chinese government and the enterprises.
- If the project has achieved certain progress which are defined in the project document

and the annual work plan.

The financial audit will be conducted between February and April each year. The invited auditing agency will formulate an auditing report to UNDP China Country Office and share with FECO. If there are any qualified issues which are verified in the financial audit, the related payment will be suspended until the issues to be worked out by the responsible parties and accepted by UNDP.

c) Review Meetings

Two official review meetings between UNDP, FECO/MEP and executing partners will be conducted in the year, one of them to be arranged prior to the submission date of implementation plan and progress report. The objective of the meetings will be to review progress of implementation and finalize the implementation plan. Additional meetings between UNDP and FECO/MEP to monitor the progress, identify any potential risks, work out solutions and to ensure the smooth implementation will be held when UNDP and/or FECO/MEP deem them necessary.

d) Monitoring & Evaluation

UNDP will carry out monitoring & evaluation of enterprises level activities aperiodically. Monitoring will include a continuous review of the various project components and will be intended to (i) measure the progress towards meeting the overall project objectives and (ii) alert implementing partners to potential problems in implementation and propose corrective measures. Monitoring visits can be undertaken jointly between UNDP and FECO/MEP on annual basis. Such visits could be done in connection with the official meetings/project activities involving both parties. An independent expert, if necessary, could be invited to join the visit.

7.2 Quality Management for Project Activity Results

<table>
<tr><td colspan="3">OUTCOME: China's compliance in ICR sector with the 2013 HCFC consumption freeze and reduction of 224.5 ODP tons in 2013 and 240.3 ODP tons in 2015, achieved.</td></tr>
<tr><td colspan="3">Output: The following activities contribute to achieving the outcome above.
• Conversion of HCFCs to alternatives and/or alternative technologies in manufacturing compressor and industrial & commercial refrigeration & air-conditioning sector achieved contributing to phase-out of 464.8 ODP tons.
• Establishment and implementation of policy and regulations on HCFCs control.
• Development and implementation of technical standard and regulations, management information system, and technical support activities etc.
• Development and promotion of awareness and training.
• Planning, monitoring & reporting on project implementation.</td></tr>
<tr><td>Result 1</td><td>Investment Project – Conversion for compressor production lines and air-conditioner and refrigeration equipment production lines as stipulated in the HPMP</td><td>Start Date: Dec 2011
End Date: Dec 2016</td></tr>
<tr><td>Purpose</td><td colspan="2">Convert HCFCs to substitutes and alternatives technologies that are ODS free and minimize other impacts on the environment in manufacturing compressors and industrial & commercial refrigerators.</td></tr>
<tr><td>Description</td><td colspan="2">Signing conversion contracts with participating enterprises.</td></tr>
<tr><td>Quality Criteria</td><td>Quality Method</td><td>Date of Assessment</td></tr>
</table>

Contracts between FECO/MEP and participating enterprises signed	Signed contracts between FECO/MEP and enterprise	June 2015
Result 2	**Technical Assistance** – Providing technical assistance to ensure the achievement of compliance in ICR sector and in particular the implementation of the conversion project.	Start Date: Dec 2011 End Date: Dec 2016
Purpose	Establishment and implementation of policy and regulations on HCFCs control, technical standards, MIS system etc.	
Description	• Establish the related policy and regulations on HCFCs control. • Test and identify new alternatives and/or alternative technologies. • Develop and/or update the technical standard. • Develop the management information system in ICR sector. • Promote training and awareness activities. • Technical inputs, including assistance from technical experts, for project implementation. • Monitoring on project implementation.	
Quality Criteria	**Quality Method**	**Date of Assessment**
Policy and regulations on HCFCs control in ICR sector issued.	Policy and regulations on HCFCs control in ICR sector	December 2013
Technical standard and regulations updated.	Technical standard and regulations	December 2015
Management information system developed.	Management information system	December 2013
Training provided.	Report on project progress	December 2016
Awareness promoted.	Report on project progress	December 2016
Financial audit	Financial audit report	June of each year
Performance verification	Verification report	June of 2014 and 2016
Result 3	**Project Management**	Start Date: Dec 2011 End Date: Dec 2016
Purpose	Ensuring smooth technical and operational management of project, build partnership with project stakeholders and monitor performance.	
Description	• Technical, Financial and Operational management • Coordination and consultation with national stakeholders • Monitoring and reporting	
Quality Criteria	**Quality Method**	**Date of Assessment**
Annual progress on technical and operational aspects achieved	Annual progress report by FECO/MEP and UNDP	31 December of each year
Project implemented as planned	Timely submission of Implementation Report and Plan, and Performance Verification Report (as required) to the Executive Committee.	Due date for submission to the relevant Executive Committee Meeting

VIII. LEGAL CONTEXT

This project document shall be the instrument referred to as such in Article 1 of the Standard Basic Assistance Agreement (SBAA) between the Government of the People's Republic of China and the United Nations Development Programme, signed by the parties on 29 June 1979.

Consistent with the Article III of the SBAA, the responsibility for the safety and security of the executing agency and its personnel and property, and of UNDP's property in the executing agency's custody, rests with the executing agency.

The executing agency shall:

a) put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried;
b) assume all risks and liabilities related to the executing agency's security, and the full implementation of the security plan.

UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.

The executing agency agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list can be accessed via http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm. This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document.

In addition, the following types of revisions may be made to this Project Document with the signature of the UNDP resident representative only, provided he or she is assured that the other signatories of the Project Document have no objections to the proposed changes:

1. Revision in, or addition of, any of the annexes of the Project Document;
2. Revisions which do not involve significant changes in the immediate objectives, outputs or activities of the project, but are caused by the rearrangement of the inputs already agreed to or by cost increases due to inflation; and
3. Mandatory annual revisions that rephrase the delivery of agreed project inputs, or reflect increased expert or other costs due to inflation, or take into account agency expenditure flexibility.

IX: Annexes

ANNEX-I: RISK ANALYSIS

ANNEX-II: Agreement between the Government of China and Executive Committee of Multilateral Fund to the Montreal Protocol on HPMP (Stage-I) *(To be attached)*

ANNEX-III: Final revised version of ICR HPMP of China for Stage I (approved by 64th Excom) *(To be attached)*

ANNEX-IV: Provisional Budget of ICR HPMP of China for the period 2011 to 2016 *(To be finalized)*

ANNEX-V: Milestones, Indicators and Funding for Project Management

ANNEX-VI: Implementation Plan

ANNEX-I

RISK ANALYSIS

Description	Date identified	Type	Impact and Probability (Low 1 to High 5)	Counter Measures	Owner
Delay in completion of project deliverables	Project initiation date	Operational	Probability - 3 : Impact - 4	Close coordination with FECO/MEP and periodic monitoring of project tasks. Facilitating timely completion of tasks.	FECO/MEP UNDP
Delay in available cost-effective HCFC free options	Project initiation date	Operational	Probability - 3 : Impact - 4	Consultation with specialist technical experts on technical options, closely monitoring technical developments.	FECO/MEP UNDP
Delay in implementation of conversion on HCFCs	Project initiation date	Operational	Probability - 3 : Impact 4	Close coordination with FECO/MEP and periodic monitoring at participating enterprises. Facilitating timely monitoring & verification activities.	FECO/MEP UNDP
Delay in implementation of policies, regulations, technical standards etc	Project initiation date	Operational	Probability -2 : Impact - 4	Close coordination with FECO/MEP and regulatory agencies on expeditious implementation of regulations	FECO/MEP UNDP

ANNEX-II

AGREEMENT BETWEEN THE GOVERNMENT OF CHINA AND THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE REDUCTION IN CONSUMPTION OF HYDROCHLOROFLUOROCARBONS

ANNEX-III

Final revised version of ICR HPMP of China for Stage I (approved by 64th Excom)

ANNEX-IV

Provisional Budget for ICR HPMP of China: 2011 to 2016

The provisional budget for ICR HPMP of China for the period 2011 to 2016 will be finalized in 2012 upon scheduling the payment of the tranches 2013, 2014 and 2015.

ANNEX-V

Milestones, Indicators and Funding for Project Management

The milestones, indicators, timelines and payments for Project Management component in accordance with tranche 2011 and 2012 are presented in the table below in columns B, C, D and E, respectively.

No.	Milestone	Indicator	Time Line	Amount in USD
A	B	C	D	E
1.	Finalisation of Project Document between FECO/MEP and UNDP	(a) ProDoc signing by two parties (b) Preparation for ICR HPMP launch	15 December 2011	1,280,000
2.	Submission of second tranche request to the Executive Committee	(a) Submission of Implementation Report for 2011, Implementation plan for 2012 and request for tranche for 2012 to the Executive Committee (b) At least one stakeholders' consultation meeting for ICR sector.	15 December 2012	750,400
3.	Submission of third annual tranche request to the Executive Committee	(a) Submission of Implementation Report for 2012, Implementation plan for 2013 and request for tranche for 2013 to the Executive Committee (b) Submission of Article-7 data for the year 2011 (c) At least one stakeholders' consultation meeting for ICR sector.	15 December 2013	552,000
	Total			**2,582,400**

Note: The milestones, indicators, timelines and payments for Project Management component in accordance with tranche 2013, 2014 and 2015 will be finalized in 2012.

ANNEX-VI
Implementation Plan

1. Introduction

a) In order to achieve the HCFC phase-out targets for stage-I, i.e. freezing the HCFC consumption at the average level of 2009-2010 from January 2013 and reduction of 10% of the baseline consumption from January 2015, the HCFC Phase-out Management Plan(HPMP) in the Industrial and Commercial Refrigeration and Air-conditioning (ICR) Sector in China has been submitted to 62nd MLF ExCom in November 2010 and got approved in 64th MLF ExCom in July 2011

b) The agreement between Chinese government and the ExCom will serve as the framework within which the ICR sector plan will be implemented. The MoU between UNDP and FECO/MEP which was signed on 8 January 2011 will serve as the guideline for the overall management on the project implementation. The Performance Based Payment (PBP) Mechanism will be applied for the implementation of ICR sector plan project as discussed in this ProDoc.

c) This overall Implementation plan will cover the parts of "Management and Supervision, Implementation Schedule, Payment Management, Verification and Monitoring", representing the agreement between UNDP and FECO on the implementation of this ICR sector plan project.

2. Management and Supervision

a) United Nations Development Programme (UNDP) is serving as the implementing agency to supervise the implementation of the sector plan, specifically including the following:

I. Providing assistance for policy development, planning and management of sector programming as set out in these sectors, when required;

II. Ensuring verification of performance and progress of disbursement in accordance with the Agreement between China and the ExCom and with its specific internal procedures and requirements as set out in these sectors and assisting FECO in the implementation and assessment of the activities;

III. Assisting FECO in the preparation of the ICR sector annual Implementation Plans as per Appendix 4-A in the agreement between Chinese government and the ExCom;

IV. Ensuring financial verification of the activities implemented;

V. Reviewing and clearing the Project Implementation Manual(PIM) and all other TORs for TA activities and provide advice and assistance as needed;

VI. Ensuring technical verification undertaken by appropriate and independent technical experts;

VII. Monitoring the progress and carrying out supervision missions;

VIII. Ensuring the Fund disbursed in accordance with the guidelines of the ExCom;

IX. Reporting the progress of implementation plan and submitting requests to the ExCom for future tranches;

b) MEP/FECO will be responsible for the overall implementation, coordination and management of the ICR Sector Plan, specifically including the following: (TBC, following agreement Appendix 5-A)

I. Preparing and implementing the PIM and Annual Work plan;

II. Implementing, supervising and monitoring the conversion activities;

III. Developing policy framework, implementing regulatory actions, and conducting technical assistance activities during the implementation as planned;

IV. Executing Performance-Based contracts with enterprises participating in Stage I with assistance of CRAA, for technology conversions, and ensuring disbursement to the enterprises based on agreed performance targets;

V. Preparing the annual implementation plan and progress reports as per provision of the agreement between China and the ExCom;

VI. Facilitating technical verification, performance verification and financial audit as required;

VII. Coordinating between various HCFC consumption sectors at national level in such a way as to facilitate establishment of sector level HCFC consumption reliably;

VIII. Ensuring coordination between all related stakeholders in the sector with assistance of CRAA;

IX. Carrying out commissioning procedure for establishing completion of enterprise level conversions with assistance of CRAA;

c) China Refrigeration and Air-conditioning Industry Association (CRAA) will participate in the overall management and implementation of HCFCs phase-out in ICR industry and will be responsible for the following tasks:

I. Providing comprehensive technical support to the overall phase-out and conversion of the industry;

II. Assisting FECO in selecting and finalizing the enterprise that would participate in stage I conversions;

III. Assisting FECO in monitoring and reporting the progress of the conversion at enterprise level;

IV. Carrying out selected technical assistance activities, such as organizing workshops and information disseminations activities, arranging technical experts meeting, and training, etc., as and when requested by FECO;

V. Ensuring selection of the appropriate alternative technology at enterprise level and ensuring their sustainable implementation consistent with the agreed schedule;

VI. Assisting FECO in formulation and implementation of policy and regulatory interventions that would ensure reductions in the HCFC consumption required for compliance with the 2013 and 2015 targests;

VII. Assisting FECO in developing the programme implementation manual (PIM);

VIII. Providing up-to–date data information and statistics related to consumption of HCFC and alternatives, manufacturing, import and export volumes of the products containing HCFCs and alternatives and any other data related to the industry as maybe requested by FECO;

IX. Assisting FECO in ensuring coordinating with related stakeholders during the implementation tasks mentioned above;

Note: all technical assistance activities will be further clarified through specific TORs to be developed and agreed between UNDP and FECO.

3. Target for stage I (2011-2015)

	2011	2012	2013	2014	2015	Total
Montreal Protocol reduction schedule of Annex C, Group I substances (ODP tonnes)	n/a	n/a	19,269.0	19,269.0	17,342.1	n/a
Maximum allowable total consumption of Annex C, Group I substances (ODP tonnes)	n/a	n/a	18,865.4	18,865.4	16,978.9	n/a
Maximum allowable consumption of Annex C, Group I substances in the ICR sector (ODP tonnes)	n/a	n/a	2402.8	2402. 8	2162.5	n/a
Total Phase-out (ODP tonnes)	n/a	n/a	224.5	n/a	240.3	464.8

Note: the figures above are as per the finalized agreement between the government of China and the Executive Committee of the Multilateral Fund for the reduction in consumption of Hydrochlorofluorocarbons.

4. Payment Schedule and Indicators

Tranche 2011

Payment Date (Indicative)	**Disbursement (US$)**	**Indicators/Milestones**
First disbursement No later than 15 Dec 2011	16,000,000	-Detailed project implementation plan is finalized; -1 stakeholder consultation completed;
Second disbursement No later than 15 July 2012	1,500,000	Detailed Plan for TA activities for 2012 and 2013;
Third disbursement No later than 15 December 2012	7,880,000	Signed conversion contracts total of 3,000 metric tones (of which about 600 metric tones prior to June 2012);
	25,380,000	

Tranche 2012

Payment Date (Indicative)	**Disbursement (US$)**	**Indicators/Milestones**
First disbursement No later than 30 June 2013	6,900,000	-The annual progress report for tranche 2011 and funding for tranche 2012 have been approved by the ExCom; -Conversion contracts signed totalling 800 metric tonnes;

Note: The payment schedule and indicators tranche 2013. 2014 and 2015 will be finalized based on the approval from the ExCom and the actual implementation. A further agreement between UNDP and FECO/MEP on the above-mentioned three tranches will serve as the amendment to be attached.

5. Monitoring & Verification

e) Performance Verification:

FECO/MEP will prepare the TOR of Performance Verification for UNDP's review and clearance. FECO/MEP will organize the qualified agency/expert team to conduct the verification according to the requirements stipulated in the agreement between the Chinese government and the ExCom. The Performance Verification aims to verify:

- If the targets of HCFC frozen, reduction and/or phase-out which are defined in the agreement between the Chinese government and the ExCom have been achieved.
- If the selected participating enterprises have stopped consuming HCFCs.
- If the alternatives and/or alternative technologies have been appropriately applied in the selected participating enterprises.
- If the progress of the conversion at selected enterprises have met the requirement as defined in the contracts between FECO/MEP and the enterprises.
- If the technical assistance activities have been appropriately conducted and obtained achievements which are defined the annual implementation plan.

In accordance with the agreement between the Chinese government and the ExCom, the conversions are to be verified for a random sample of at least 5% of the manufacturing lines which had been completed their conversion in the year to be verified. On the understanding that the total aggregated HCFC consumption of the random sample of the manufacturing companies that completed conversion in the year to be verified, representing at least lines representing at least 10% of the sector consumption phased out in that year.

The Performance Verification is to be completed by April and the verification report is to be submitted to FECO/MEP and UNDP no later than end of May in that year.

f) Financial Audit:

In accordance with the agreement between UNDP and the Chinese government, an annual financial audit on UNDP National Executing (NEX) projects in China will be conducted by an independent contractor. According to the agreement, if the project achieved the annual expenditure exceeded the UNDP defined minimum the project will participate in the financial audit. The project will be audited at least one time during its project life cycle. The financial audit aims to verify:

- If the project fund has been appropriately applied which are in line with the agreement between UNDP and the Chinese government.
- If the project fund has been appropriately disbursed in the selected enterprises in accordance with the requirement defined in the contracts between the Chinese government and the enterprises.
- If the project has achieved certain progress which are defined in the project document and the annual work plan.

The financial audit will be conducted between February and April each year. The Audit Report will be submitted to UNDP China Country Office and shared with FECO/MEP. If there are any qualified issues which are verified in the financial audit, the related payment

will be suspended until the issues to be worked out by the responsible parties and accepted by UNDP.

g) Review Meetings

Two official review meetings between UNDP, FECO/MEP and executing partners will be conducted in the year, one of them to be arranged prior to the submission date of implementation plan and progress report. The objective of the meetings will be to review progress of implementation and finalize the implementation plan. In addition, additional meetings between UNDP and FECO/MEP to monitor the progress, identify any potential risks, work out solutions and to ensure the smooth implementation will be held when UNDP and/or FECO/MEP deem them necessary.

h) Monitoring & Evaluation

UNDP will carry out monitoring & evaluation of enterprises level activities aperiodically. Monitoring will include a continuous review of the various project components and will be intended to (i) measure the progress towards meeting the overall project objectives and (ii) alert implementing partners to potential problems in implementation and propose corrective measures. Monitoring visits can be undertaken jointly between UNDP and FECO/MEP on annual basis. Such visits could be done in connection with the official meetings/project activities involving both parties. An independent expert, if necessary, could be invited to join the visit.

MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE
MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

HPMP SUBMISSION CHECKLIST

BASIC INFORMATION	
Country:	China
Project Title:	Sector Plan for HCFC Phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China (Stage-I compliance with 2013 and 2015 targets)
Lead Agency:	UNDP
Cooperating Agencies:	N/A

MONTREAL PROTOCOL AMENDMENT RATIFICATION STATUS		
Amendment	**Ratified (Y/N)**	**Date**
Copenhagen Amendment	Yes	April 2003
Beijing Amendment	Yes	May 2010

HCFC DATA	
Article-7 data reported	☒ Yes ☐ No **Year:** 2009 (will be reported as soon as possible)
CP progress data reported	☒ Yes ☐ No **Year:** 2009 (will be reported no later than 30 September 2010)
Calculated HCFC baseline (ODP tonnes)	2,360 ODP tonnes (Please refer to the proposal)
Starting point (ODP tonnes)	2,360 ODP tonnes (Please refer to the proposal)

HCFC REGULATIONS		
Regulation	**In place (Y/N)**	**Remarks**
HCFC Regulations	Yes	Additional targeted regulations as part of Sector Plan
HCFC Licensing System	Yes	Since June 2004
HCFC Quota System	Yes	Consumption quota as part of the Sector Plan

DOCUMENTATION		
Document	**Submitted (Y/N)**	**Remarks**
Letter of transmittal	Yes	
HPMP document and components	Yes	
Draft agreement	Yes	
MYA online tables	No	Will be filled out as soon as possible
Technical review (where applicable)	NA	

HPMP SCOPE		
Sectors covered	☒ Manufacturing only ☐ Servicing only	☐ Manufacturing and Servicing
Phase-out targets	☒ Freeze and 10% reductions (2015) ☐ Complete phase-out (Year:)	☐ 35% reductions (2020) ☐ Other
Priority given to reductions/phase-out in manufacturing (over servicing)	☒ Yes ☐ No ☐ Not required/applicable	
Justification for not prioritizing HCFC-141b	☐ Yes ☐ No ☒ Not required/applicable	

HPMP COMPONENTS		
Components	**Included (Y/N)**	**Remarks**
Executive Summary	Yes	
Overarching Strategy	Yes	
Strategy and action plan for Stage-I	Yes	
Sector plans/individual projects	Yes	
Annual implementation plan	No	Will be submitted as soon as possible for first tranche
Implementation arrangements	Yes	
Environmental Impact	Yes	

HPMP FUNDING		
Components	**Included (Y/N)**	**Remarks**
Consistency with guidelines (for servicing sector, cut-off date, second conversions, HCFCs in preblended polyols, technology upgrade, non-A5 ownership, non-A5 exports)	Yes	
Funding for first tranche requested	Yes	
Funding for last tranche in last year	Yes	

中 华 人 民 共 和 国 环 境 保 护 部
Ministry of Environmental Protection of the People's Republic of China
115 Nanxiaojie, Xizhimen, Beijing 100035, the People's Republic of China

FACSIMILE COVER SHEET AND MESSAGE

Date: August 23, 2010
To: Dr. Suely Carvalho
Chief
Montreal Protocol/Chemicals Unit
UNDP

No. of Pages: 1
From: Mr. Wen Wurui
Director General
FECO/MEP

Subject: Sector Plan for HCFC phase-out in the Industrial and Commercial Refrigeration and Air conditioning (ICR) Sector in China (Stage-I)

Dear Dr. Suely Carvalho,

We request the kind assistance of UNDP, as the implementing agency for HCFC phase-out in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China, to submit the above-mentioned sector plan for consideration of the 62nd Meeting of the Executive Committee of the Multilateral Fund, to be held in November 2010.

We also request UNDP to kindly keep us informed of the review process of the ICR Sector Plan by the MLF Secretariat.

Thanking you,

Sincerely,

Wen Wurui

Director General

Foreign Economic Cooperation Office
Ministry of Environmental Protection

Cc: Nandan Chirmulay, Regional Coordinator - Asia Pacific
UNDP Montreal Protocol/Chemicals, Bangkok

MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE
MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

PROJECT COVER SHEET

COUNTRY: CHINA

PROJECT TITLE:

Sector plan for phase-out of HCFCs in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in China (Stage-I, for 2013 and 2015 compliance)

IMPLEMENTING/BILATERAL AGENCIES:

UNDP

NATIONAL COORDINATING AGENCY: Foreign Economic Cooperation Office (FECO) Ministry of Environment Protection (MEP)

LATEST REPORTED CONSUMPTON DATA FOR ODS ADDRESSED IN THE PROJECT:

A. Article-7 Data (ODP tonnes for 2008):

Annex-C, Group-I substances (HCFCs)	15,079.0

B. Country Programme Sectoral Data for ICR Sector (ODP tonnes for 2008):

Substance	Total
HCFC-22	2,215.4
HCFC-141b	0
HCFC-142b	1.95
HCFC-123	7.04
HCFC-225ca	0
HCFC-225cb	0

ODS CONSUMPTION REMAINING ELIGIBLE FOR FUNDING (ODP tonnes) :	**2,124**
CURRENT YEAR BUSINESS PLAN:	**Included**

PROJECT DATA		2011	2012	2013	2014	2015	2016	Total
Annex-C Group-I (HCFCs)	Montreal Protocol Limits (ODP tonnes) [1]	N/A	N/A	Note 1	Note 1	Note 1	N/A	N/A
	Annual Consumption Limit (ODP tonnes) [2]	N/A	N/A	2,360	2,360	2,124	N/A	N/A
	Annual Phase-out in Plan (ODP tonnes) [3]	N/A	N/A	207.3	N/A	231.3	N/A	438.6
	Phase-out from approved projects (ODP t)	N/A	N/A	17.2	N/A	N/A	N/A	17.2
	Annual Unfunded Phase-out (ODP tonnes)	N/A	N/A	4.5	N/A	4.7	N/A	9.2
	Total Phase-out (ODP tonnes)	**N/A**	**N/A**	**229**	**N/A**	**236**	**N/A**	**465**

1. To be established in 2011, in accordance with ExCom Decision 60/44 Para (e). 2. Based on a projected baseline for the ICR Sector. 3. All amounts rounded off to nearest 1.0

FUNDING (US$)							
Funding through Lead Agency (UNDP)	25,000	25,000	25,000	25,000	25,000	12,780	137,780
Total Funding (US$)	**25,000**	**25,000**	**25,000**	**25,000**	**25,000**	**12,780**	**137,780**

AGENCY FEES (US$)							
Agency fees for Lead Agency (UNDP)	1,875	1,875	1,875	1,875	1,875	958.5	10,333.5
Total Agency Fees (US$)	**1,875**	**1,875**	**1,875**	**1,875**	**1,875**	**958.5**	**10,333.5**

Note: All funding figures in US$ '000s. Funding for the year presumes approval in the last ExCom meeting of the previous year except 2016.

TOTAL COST MULTILATERAL FUND (US$)	26,875	26,875	26,875	26,875	26,875	13,738.5	148,113.5

STATUS OF COUNTERPART FUNDING: **Yes**
PROJECT MONITORING MILESTONES: **Included**

PROJECT SUMMARY

China's Sector plan for phase-out of HCFCs in the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector, comprises of a combination of interventions such as technology transfer investments, policies and regulations, technical assistance, training, awareness and communications and management, coordination and monitoring to be implemented over five years from 2011 to 2016.

Impact: Upon successful completion, the plan will result in sustainable reductions of 465 ODP tonnes of HCFC consumption in the ICR Sector by 2015, contributing to China's compliance with the 2013 and 2015 control targets for Annex-C, Group-I substances (HCFCs) under the Montreal Protocol. In addition, the project will result in direct CO_2-equivalent emission reductions of about 7.66 million tonnes annually.

Prepared by: FECO and UNDP in consultation with national stakeholders **Version:** Final **Date:** 23 August 2010

SECTOR PLAN FOR PHASE-OUT OF HCFCS IN THE INDUSTRIAL AND COMMERCIAL REFRIGERATION AND AIR CONDITIONING (ICR) SECTOR IN CHINA
(Stage-I for 2013 and 2015 compliance)

EXECUTIVE SUMMARY

China acceded to the Vienna Convention in 1989 and ratified the Montreal Protocol on Substances that deplete the Ozone Layer in June 1991. China has ratified all the amendments to the Montreal Protocol. As a party designated as operating under Article-5 of the Montreal Protocol, China is committed to phasing out Ozone Depleting Substances in accordance with the control schedule of the Montreal Protocol.

Since becoming a party to the Montreal Protocol, China has taken progressive measures to phase out designated controlled substances and is in compliance with the Montreal Protocol control schedule for CFCs, CTC and Halons. This has been successfully accomplished through assistance from the Multilateral Fund including technology transfer investments, technical assistance, training and capacity building, information dissemination and awareness-raising, management and coordination. China has established an effective policy and regulatory framework for designated controlled substances.

Hydrochlorofluorocarbons (HCFCs) are classified as controlled substances under Annex-C Group-I of the Montreal Protocol and therefore they have to be controlled and eventually phased out. In accordance with the adjusted control schedule of the Montreal Protocol for Article-5 countries, production and consumption of HCFCs will be subject to a freeze at the average of 2009 and 2010 levels from 01 January 2013 and a subsequent 10% reduction from the baseline level from 01 January 2015.

China is currently the world's largest producer and consumer of HCFCs. Due to rapid economic development in the past two decades and resulting demand for consumer, commercial and industrial products in the Foams, Refrigeration, Air Conditioning and Solvents sectors, consumption of HCFCs in China has grown significantly. The significant increase in HCFC consumption will lead to additional environmental impacts on ozone depletion as well as on global warming due to the ozone depleting potential and global warming potential of HCFCs.

In the Industrial and Commercial Refrigeration and Air Conditioning (ICR) Sector in particular, there has been a sustained growth in HCFC consumption of 12-15% annually in the past few years. The ICR sector consumption was over 40,000 metric tonnes. The sector contributes about US$ 20 billion to the economy and employs over 100,000 persons in over 1,000 enterprises, many of which are small and medium-sized. This sector also has a large variety of products and applications, categorized into nine sub-sectors. The main constraint faced by the sector is the mature and proven availability of cost-effective and efficient alternative refrigerants and related technology and the ability to deploy alternative technologies for meeting the Stage-I targets, without undue burden on the industry and public.

Considering the relatively short net available time of only 3-4 years to implement conversions, and considering the volume of HCFC consumption needed to be reduced, this will be a considerable challenge. Extraordinary efforts will be needed to counter the momentum of growth in this sector.

Phase-out Targets

The ICR sector in China proposes to return its HCFC consumption to the baseline level (average of 2009 and 2010) by 2013 and reduce a further 10% to meet the 2015 target. The ICR sector will need to phase-out a total about 8,450 metric tonnes of HCFC consumption for meeting the 2015 target, of which 167 metric tonnes are expected to be phased out by non-A5 owned enterprises through their own resources. Thus, the net eligible HCFC consumption in the ICR Sector is 8,283 metric tonnes. Of this, about 312 metric tonnes will be phased out by the two previously approved demonstration projects (Yantai Moon and Tsinghua Tongfang). The remaining eligible HCFC consumption of 7,971 metric tonnes will be addressed in this Sector Plan, through technology conversions in about 55 enterprises, which will be carefully selected based on their financial soundness and sustainability, technical and managerial capacity, reputation and criticality for sustainable reductions. In order to ensure that the phase-out actions are carried out on time and remain sustainable, targeted policy and regulatory actions, management and coordination, technical assistance and awareness programmes will also need to be introduced. The summary of the phase-out targets is tabulated below:

Target year/ Phase-out	HCFC Phase-out for Stage-I Compliance (2013 and 2015 targets)			
	Through the ICR Sector Plan	Through non-A5 owned enterprises	Through approved projects	Total
By 2013	207.3	4.5	17.2	**229**
By 2015	231.3	4.7	0	**236**
Total	**438.6**	**9.2**	**17.2**	**465**

Note: All figures in ODP tonnes

Costs

The overall costs of achieving reductions in the ICR sector to meet the Stage-I targets for 2013 and 2015 are estimated at over US$ 200 million. The funding request for the ICR Sector Plan is for US$ 137.78 million, of which US$ 126 million are for the investment components to carry out the enterprise-level conversions and US$ 11.78 million are requested for the non-investment components. The balance of the costs will be borne by the industry. The summary of the costs is tabulated below:

Cost Head	Total Costs	Financing	
		MLF Funding	Counterpart Funding
Approved Ongoing Projects	6,572,786	5,193,794	1,378,992
ICR Sector Plan			
Investment Components	185,450,000	126,000,000	59,450,000
Non-investment Components	15,000,000	11,780,000	3,220,000
Total	**207,022,786**	**142,973,794**	**64,048,992**
Net funding request (Stage-I)	**N/A**	**137,780,000**	**N/A**

Note: All figures in US dollars and do not include implementing agency support costs.

Impact

Upon successful completion, the plan will result in sustainable reductions of 465 ODP tonnes of HCFC consumption in the ICR Sector by 2015, contributing to China's compliance with the 2013 and 2015 control targets for Annex-C, Group-I substances (HCFCs) under the Montreal Protocol. In addition, the project will result in direct CO_2-equivalent emission reductions of about 7.66 million tonnes annually.

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LIST OF ABBREVIATIONS

CFC	Chloro Fluoro Carbons
CP	Country Programme
CRAA	China Refrigeration and Air Conditioning Association
CTC	Carbon Tetra Chloride
ExCom	Executive Committee of the Multilateral Fund
FECO	Foreign Economic Cooperation Office
GWP	Global Warming Potential
HCFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
IA	Implementing Agency
MAC	Mobile Air Conditioning
MLF	Multilateral Fund for the Implementation of the Montreal Protocol
MOP	Meeting of Parties to the Montreal Protocol
MP	Montreal Protocol
MT	Metric Tonnes
ODP	Ozone Depleting Potential
ODS	Ozone Depleting Substances
TEAP	Technology and Economic Assessment Panel of the Montreal Protocol
TR	Tons of Refrigeration
UNDP	United Nations Development Programme

SECTOR PLAN FOR PHASE-OUT OF HCFCS IN THE INDUSTRIAL AND COMMERCIAL REFRIGERATION AND AIR CONDITIONING (ICR) SECTOR IN CHINA

STAGE-I (FOR 2013 AND 2015 COMPLIANCE)

AUGUST 2010

I. INTRODUCTION

I.1 RATIFICATION STATUS

1.1 In an effort to protect the depleted stratospheric ozone layer, the international community signed the Vienna Convention for the Protection of the Ozone Layer (hereafter referred to as the Vienna Convention) and the Montreal Protocol on Substances that Deplete the Ozone Layer (hereafter referred to as the Montreal Protocol or MP) in 1985 and 1987, respectively. The Montreal Protocol and its subsequent adjustments and amendments called for joint actions from both developed and developing countries to gradually phase out production and consumption of Ozone Depleting Substances (ODS). The London Amendment to the Montreal Protocol agreed in 1990 to set up the funding mechanism to ensure technology transfer among countries under the principle of the most favorable conditions.

1.2 The Government of China signed the Vienna Convention in 1989. In June 1991, China ratified the Montreal Protocol and its London Amendment. As a Party to the Montreal Protocol, China has committed to phase out Ozone Depleting Substances (ODS) in accordance with its designation as an Article 5 country. Subsequently, China proceeded with its ratification of the Copenhagen Amendment, Montreal Amendment, and Beijing Amendment. The dates of ratification by China of the Montreal Protocol and its amendments are:

Agreement	Ratification
Montreal Protocol	June 1991
London Amendment	June 1991
Copenhagen Amendment	April 2003
Montreal Amendment	May 2010
Beijing Amendment	May 2010

I.2 CFC PHASE-OUT EXPERIENCE

1.3 In 1991, State Council approved establishment of the Leading Group for Ozone Layer Protection which is composed by 18 ministries and departments and led by State Environmental Protection Administration (upgraded as the Ministry of Environmental Protection, MEP), to manage the implementation of the Vienna Convention and the Montreal Protocol as well as to enforce the Country Program. In the meantime, the Multilateral Fund Project Management Office (PMO) for the protection of the ozone layer was established at the former State Environmental Protection Administration (SEPA) to take charge of MLF project application and approval. The PMO is also responsible for coordination, organization and supervision throughout the project implementation.

1.4 In January 1993, the Chinese Government approved the Country Program for Phasing out for Ozone Depleting Substances (hereafter referred to as the Country Program or CP) and started implementing ODS phase out activities in China. The Country Program laid down the framework for China to proceed with development and implementation of ODS phase-out activities with the financial support from the Multilateral Fund.

1.5 In October 1999, the Country Program was revised by the formal SEPA, with assistance of United Nations Development Program (UNDP) and United Nations Environment Program (UNEP) and 17 relevant government departments of China. The revision was based on the overall framework of the original version and general requirements by the Executive Committee for implementation of the Multilateral Fund. The Country Program was also intended to be a dynamic document and was intended to be reviewed and updated at an appropriate time to reflect the status of its implementation. In the same year, National ODS Import and Export Office was set up jointly by former SEPA, General Custom Office and Ministry of Commerce to control ODS import and export by adopting licensing system management.

1.6 A large number of individual projects in all sectors consuming and producing CFCs, Halons, carbon tetrachloride, and methyl chloroform, were funded by the Multilateral Fund. As experience in implementing ODS phase-out activities accumulated, China launched the first sector plan for phasing out production and consumption of Halons. The Halon sector plan was the first sector plan funded by the Multilateral Fund for which the implementation of the project is based on well-coordinated supporting policy and regulatory framework and technical assistance interventions in addition to the needed investment activities. Funding from the Multilateral Fund was also agreed up front. Disbursement of grant funds from the Multilateral Fund was made on the basis of China's ODS phase-out achievement in the previous year.

1.7 With a high degree of certainty of funding from the Multilateral Fund, a long-term phase-out policy and implementation plan were carried out by China. This led to an effective and timely phase-out of Halons in both the production and consumption sectors. Because of the effectiveness and early success of the Halon sector plan, a number of sector plans for phasing out CFCs in both production and consumption sectors in China and other countries followed. Currently, the sector plan approach, which ensures permanent aggregate phase-out, has become a norm of the Multilateral Fund operations.

1.8 Through multi-year active action and hard efforts, China has eliminated its production and consumption of CFCs and Halon on July 1st, 2007, two years and a half ahead of the target set in the Montreal Protocol. By 1st January 2010, China has successfully accomplished 15 sector plans and established its management framework and policy framework for compliance of the Montreal Protocol. More than 100 regulations and policies were issued and newly the ODS management regulation has been approved by the State Council and become effectiveness in 1st June 2010.

A series of public awareness and training programs have been launched, and through the implementation of phase-out conversion projects, relevant government bodies, research and science institutes, industry associations, universities, enterprises, media, and international and bilateral agencies have actively participated in the Ozone Action in China. A coalition of Ozone Layer Protection has been formed.

I.3 ACCELERATED HCFC PHASE-OUT SCHEDULE

1.9 To meet China's obligations under the Copenhagen Amendment, China organized surveys and assessment of the feasibility of HCFC phase-out in 2004. Since 2005, MEP has begun the discussions with international communities on opportunities and challenges faced in an accelerated phase-out of HCFCs as well as conditions and targets to carry out the phase-out. This initiative was highly recognized by the international community.

1.10 At the 19th Meeting of the Parties in September 2007, the Parties agreed to accelerate the HCFCs phase-out schedule. As an Article 5 Party, China is required to freeze the production and consumption of HCFCs at the average level of 2009 - 2010 (baseline) by 2013, realize 10%, 35%, and 67.5% reduction in 2015, 2020 and 2025, respectively, and completely phase out HCFCs in 2030 (Fig 1-1) with a limited production and consumption to meet residual demand in the service sector during the period 2030 – 2040.

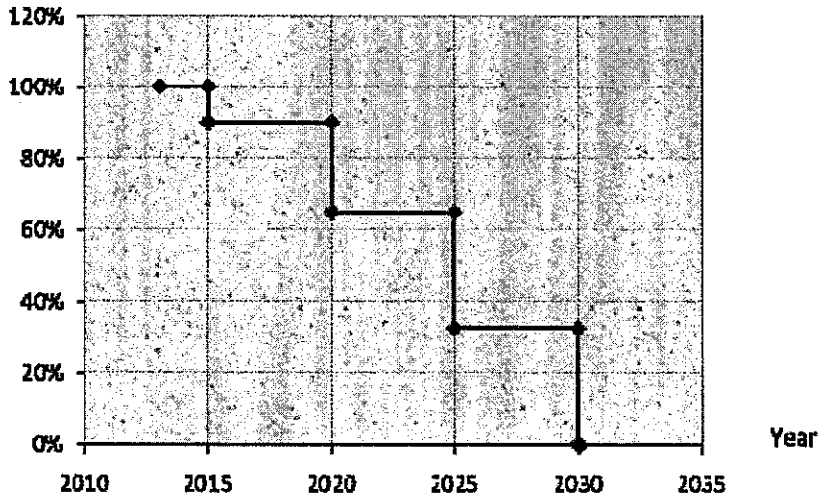


Fig 1-1: Montreal Protocol HCFC Reduction Schedule for A5 Countries

I.4 CURRENT HCFC PRODUCTION AND CONSUMPTION

1.11 According to the statistics from the PMO in the Foreign Economic Cooperation Office (FECO) of the Ministry of Environment Protection (MEP), HCFCs produced and consumed in China include HCFC-22, HCFC-123, HCFC-124, HCFC-141b, and HCFC-142b. In addition, China also imported a limited quantity of HCFC-225 for solvent applications. Annual production and consumption of these chemicals in 2006 – 2009 are shown in Table 1-1.

Table 1-1 HCFC Production and Consumption in China from 2006 – 2009

Substance	2006		2007		2008		2009	
	Production	Consumption	Production	Consumption	Production	Consumption	Production	Consumption
HCFC-22	263,805	173,742	297,677	192,227	287,159	173,811	312,045	200,559
HCFC-123	2,135	815	2,072	152	2558	367	2,238	298
HCFC-124	-	-	398	93	365	0	474	279
HCFC-141b	74,385	46,312	86,837	47,668	81,298	40,139	91,880	50,323
HCFC-142b	21,844	19,464	22,994	18,512	22,724	16,862	29,125	21,811
HCFC-225	-	-	-	-	-	-	-	42
Total	**362,169**	**240,333**	**409,978**	**258,652**	**394,104**	**231,179**	**435,762**	**273,312**
ODP tonnes		**15,933**		**17,024**		**15,079**		**17,997**

Notes:

1. Production for feedstock use is not included.
2. ODP: HCFC-22, 0.055; HCFC-123, 0.022; HCFC-124, 0.022; HCFC-141b, 0.11; HCFC-142b: 0.065

I.5 HCFC CONSUMPTION IN THE ICR SECTOR

1.12 Industrial and Commercial Refrigeration (ICR) sector was one of earliest to take actions on ODS phase-out. From 1995 to 1999, 19 individual projects for CFC conversion and one technical assistance (TA) project for ICR sector were approved and implemented. In 2002, the Executive Committee of the Multilateral Fund (hereafter referred to as the ExCom) approved the ***Sector Plan for Phase out of CFCs in ICR sector in China***. All of the above conversion projects were completed by June 2006. Due to the advantages of physical and chemical properties, safety in production and low price, HCFCs, particularly HCFC-22, were used widely as mature refrigerants in the industrial and commercial refrigeration and air conditioning sector.

1.13 It was reported that the total consumption of HCFC-22 in 2008 was 173,811 MT, of which 40,630 MT was used for the industrial and commercial refrigeration applications. According to ***Survey Report of Basic Information for the Phase-out of HCFCs in China's ICR Sector***, annual growth rate of HCFCs consumption during 2004-2008 was over 12%.

In 2009, given China's macroeconomic development and industrial slow-down resulted from the global financial crisis, HCFCs consumption in ICR sector was estimated to increase by 3% compared with 2008, reaching 41,850 tons.

1.14 Based on survey results, the growth in the ICR sector in the next five years is expected to continue at 5% at least a year. The continuing growth is driven by the significant increase in the domestic demand, which is consistent with the national economic development of China. Based on that, the consumption of HCFCs from 2010 to 2015 will be 43,940 tons, 46,140 tons, 48,450 tons, 50,870 tons, 53,410 tons and 56,080 tons respectively.

Table 1-2 Estimated HCFCs consumption in ICR Sector (BAU Scenario)

Year	2008	2009	2010	2011	2012	2013	2014	2015
Growth rate		3%	5%	5%	5%	5%	5%	5%
HCFC Consumption	40,630	41,850	43,940	46,140	48,450	50,870	53,410	56,080

1.15 However, since the adjustment on accelerated phase-out of HCFCs was adopted in the 19th MOP, MEP issued the Circular on strict control of new, modification and expansion of HCFC production facilities and Circular on strict control of new HCFC-based manufacturing facilities. At the sector level, Foreign Economic Cooperation Office (FECO) of MEP and China Refrigeration and Air-conditioning Industry Association (CRAA) has conveyed signals to the industry, that the HCFCs would be restricted in production and consumption, at various occasions related to the industry interactions, such as industry survey, publicizing workshops and expert seminars, which has been given high attentions by the research institutes, enterprise representatives and experts from the industry.

1.16 In order to achieve the frozen and 10% reduction target, China will take appropriate measures for controlling HCFC production, consumption, import and export. The HCFC Phase-out Management Plan for the ICR sector would also be a key part of overall strategy. Under the sector plan, the demonstration projects, conversion programs, establishment and modification of industrial standard, public awareness, training and marketing campaign etc. will on the place. Under this situation, the growth rate of HCFCs consumption in 2012 will be significantly lower compared with uncontrolled scenario, probably at 2%. Therefore, the baseline level for the ICR sector is estimated to be about 42,900 MT. Projected HCFC consumption is shown in Table 1-3.

Table 1-3: HCFCs consumption in controlled scenario

Year	2008	2009	2010	2011	2012	2013	2014	2015
Growth rate		3%	5%	5%	2%	-9%	-4%	-6%
Consumption	40,630	41,850	43,940	46,140	47,060	42,900	41,180	38,610
Target		Baseline: 42,900				42,900		38,610

Note: Figures above in metric tonnes

1.17 The ICR sector, which is one of the largest HCFC consumption sectors in China, comprises of more than 1,000 manufacturing enterprises of which the majority are small-and-medium scale enterprises. The main characteristic of small-and-medium scale enterprises is their limited technical and management capacity. They also have limited access to new technologies. Furthermore, the manufacturing in the ICR sector mostly are custom built which lead to the diversity of product series and models at each enterprise. Accordingly, the roadmap for production line conversion would be variable for different sub-sectors, enterprise size, production capacity, and product category. Therefore, the delivery of financial and technical assistance to this large number of enterprises would have to be carried out through an innovative approach. At the meantime, a national-level sector approach with a flexible operating mechanism has to be employed so as to ensure the technical and financial assistance could be delivered to the enterprise in a timely and effective manner.

I.6 HCFC Phase-out Target and Contribution of the ICR Sector Plan to the Overall Compliance

1.18 The ICR Sector Plan is part of the overall HCFC Phase-out Management Plan (HPMP) of China. The overall target of the HPMP is to reduce HCFC consumption in 2013 to the baseline level (average consumption in 2009 and 2010) and to 90% of the baseline level in 2015. To achieve this target, China decided that all HCFC consuming sectors, except the service sector, will have to equally contribute to these targets. Therefore, all sector plans will aim at returning HCFC consumption in respective sectors (except in the service sector), to the sectoral baselines in 2013 and 10% lower than the sectoral baseline in 2015.

1.19 Based on the estimated HCFCs consumption in 2012, phase-out of 4,160 MT of HCFCs from the 2012 consumption level is required in order to return to the sectoral consumption baseline in 2013. Reduction of 4,290 MT of HCFCs is required to meet the 10% reduction in 2015. Thus, the total phase-out required would be 8,450 MT.

Table 1-4: HCFCs Phase-out Schedule for the ICR Sector

Year	2008	2009	2010	2011	2012	2013	2014	2015
Estimated consumption	40,630	41,850	43,940	46,140	47,060	42,900	41,180	38,610
Estimated phase-out	0	0	0	0	0	4,160	1,720	2,570

Note: Figures above in metric tonnes

1.20 Implementation of the ICR Sector Plan will take into account experience gained from prior CFC phase-out in the ICR with MLF assistance. The proposed ICR Sector Plan will also take into account lessons learned and experiences from HCFC phase-out investment and demonstration projects in the ICR sector, which were approved recently by the Multilateral Fund.

I.7 OBJECTIVES OF THE ICR SECTOR PLAN (STAGE-I)

1.21 This proposed ICR sector plan represents part of the Government of China's efforts to meet its overall HCFC freeze and 10% consumption reduction targets in 2013 and 2015, respectively. This proposed plan is the Stage-I of the overall ICR Plan of China. The phase-out targets beyond 2015 will be addressed by subsequent sector plans to be submitted at a later stage.

1.22 The objectives of the proposed ICR sector plan for first phase are to:

a) Contribute to the overall efforts of China to meet the HCFC consumption freeze target in 2013 and 10% consumption reduction by 2015;

b) Ensure compliance with the interim consumption reduction steps at the sector level;

c) Establish an effective implementation mechanism to support long-term phase-out of HCFC in the ICR sector (beyond 2015);

d) Establish an HCFC-22 consumption reduction schedule in order to facilitate future development of the HCFC-22 production phase-out sector plan;

e) Establish an HCFC-22 consumption reduction schedule in order to facilitate future development of the HCFC phase-out in servicing sector plan;

f) Decrease the growth of population of HCFC-based industrial and commercial refrigeration and air-conditioning products and applications, which will beneficial for to the mitigation of the burden of servicing sector plan;

g) Create private-public partnership to foster and promote the overall HCFC phase-out program particularly in small-and-medium scale enterprises.

II. SECTOR BACKGROUND

II.1 Overview

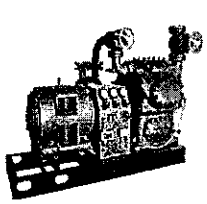
2.1 The industrial and commercial refrigeration and air-conditioning sector has a very wide range of products, widely used in various applications, produced by numerous manufacturers. From earlier 1990s, along with the sustained and healthy development of China's economy, the industrial and commercial refrigeration industry in China has made tremendous progress, maintaining a more than 15% average annual growth rate. China has become a global producer of refrigeration and air conditioning equipment. According to the statistics, the 2008 sales revenue for ICR sector is over 135 billion RMB Yuan and increased by 12.5% compared with the same period in 2007. There are more than 1,000 enterprises in ICR industry, with total asset of over 180 billion RMB Yuan, with over 100,000 employees.

II.2 Product Categories and Applications

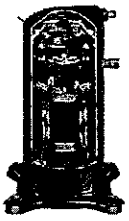
2.2 The different industrial and commercial refrigeration and air-conditioning products are categorized according to applications.. They are generally classified in the following sub-sectors:

a) Refrigerating compressors

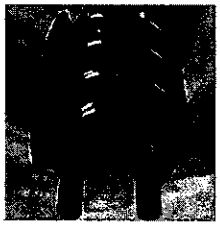
Refrigerating compressor is the core part of refrigerating and air-conditioning equipment, which plays a key role in operation performance, application life and noise libration. Different types of refrigerating compressor are used in industrial and commercial refrigeration and air-conditioning equipments, including reciprocating refrigeration compressor, scroll refrigeration compressor, screw refrigeration compressor, and centrifugal refrigeration compressor, etc .

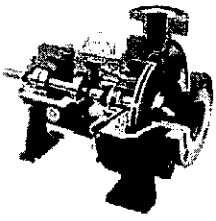


Reciprocating compressor



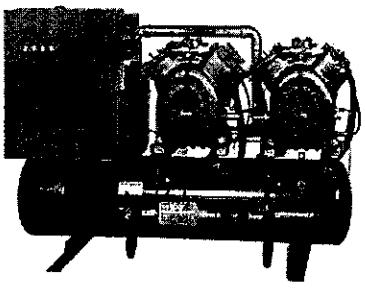
Scroll Compressor





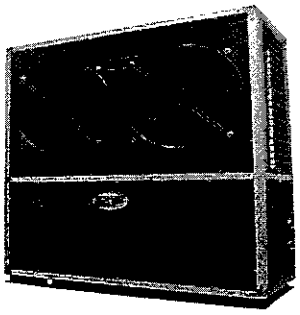
b) Compressor condensing units

Compressor condensing units for refrigeration are composed of one or several refrigerating compressors, condenser, tank and accessories, using for compressing and fluidifying refrigerant. Compressor condensing unit is widely used in direct evaporating refrigeration system composed on spot, has good flexibility, and could satisfy the requirements of custom-built by the customers.



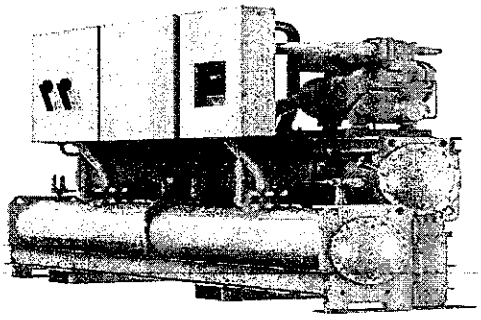
c) Small-sized water chillers (heat pump)

Small-sized water chillers (heat pump) refer to the chiller (heat pump) unit with refrigerating capacity below 50kW. Chiller (heat pump) refers to use water as carrying refrigerant to realize energy exchange by evaporator and cooler and make it cooler or heater and then carry the water to recycling refrigerant system. Small-sized water chiller (heat pump) is applied to small scale business, such as hotel, office building, restaurant and hospital.



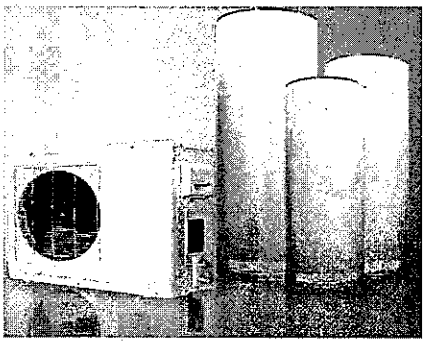
d) Industrial& commercial chillers (heat pump)

With refrigerating capacity over 50kW, industrial & commercial chiller (heat pump) can be divided into reciprocal, scroll, screw and centrifugal type based on different types of compressor applied. Industrial & commercial chiller (heat pump) has a big family in ICR and air-conditioning sector, with refrigerating capacity from 50KW to thousands of KW for centrifugal type chiller. It is widely used in large-scaled industrial and commercial site, including office building, stadium, shopping mall, hotel, plant and restaurant.



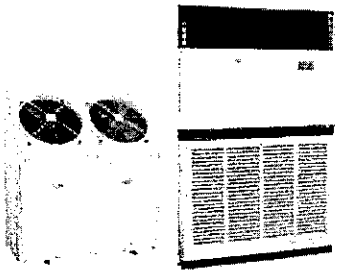
e) Heat pump water heaters

Heat pump water heater is an equipment to adopt refrigeration circulation and transfer the energy from low heat power (air or water) to heated water to make hot water. Compared with traditional mode of hot water making directly from energy like electricity, gas, coal and oil, heat pump water heater has the advantage of energy conservation and environmental protection, expands rapidly and applies widely to hot water making sites, including hotel, restaurant, dormitory, swimming pool and beauty parlor.



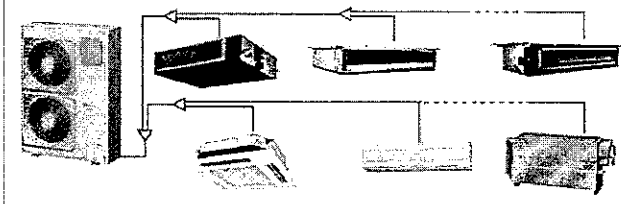
f) Unitary air-conditioners

Unitary air-conditioner is a kind of equipment providing air treatment to close space, room or area. It mainly includes refrigeration system and air circulation installation, and heating, humid and ventilation device as well. Types of unitary air-conditioner include unitary air-conditioner, rooftop air-source air-conditioner, ducted air-conditioner, computer room air-conditioner, clean operating room air-conditioner, constant temperature and humidity air-conditioner, dehumidifier air-conditioner, etc. Refrigeration capacity of unitary air-conditioner varies from several KW to several hundred KW. It can be easily installed and used and therefore has a wide application.



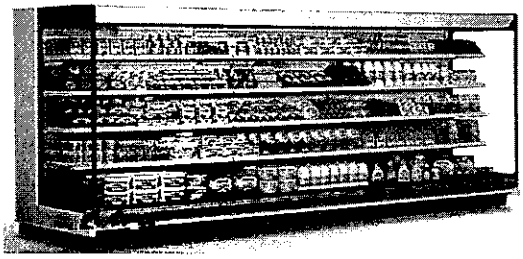
g) Multi-connected air-conditioners (heat pump)

Multi-connected air conditioners (heat pumps) are composed of different types and capacity of evaporator which connected with one or several outdoor air-cooled condensing units, serving one or several areas. Multi-connected air-conditioner (heat pump) units can be controlled indoors independently. The units have flexible design, relatively small, and suitable for shopping malls, villas and commercial buildings.



h) Freezer and cold storage equipment

To save foods tend to decay by freezing or refrigeration. There are many kinds of freezing and refrigeration equipments including food display case, transport refrigeration unit, ice maker, quick freezer equipment, cold store, etc.



i) Vehicle air-conditioners

Vehicle air-conditioners include train and automobile air-conditioners. As the refrigerant substitute for vehicle air-conditioners is researched by the vehicle air-conditioner sector, it is not included in the investigation. The phase-out management plan for vehicle air-conditioner only includes manufacturing of train air-conditioners.

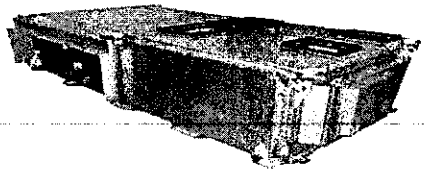


Table 2-1: Sector Background

Sub-sector	Products Description	Application/ End-use	Typical Capacity Range (kW)	Estimated Installed manufacturing capacity (units/year)	Actual production (units in 2008)	Average HCFC-22 charge/unit (kg)	HCFC consumption in 2008 (metric tonnes)
1. Compressors	Reciprocating (semi-hermetic)	Freezing and cold-storage, air-conditioner	3kW~500kW	150000	120000		
	Scroll	Small and medium sized air-conditioner, heat pump water heater, cold-storage.	7kW~75kW	2500000	2400000		
	Screw	Medium and large sized freezing and cold-storage equipment and air-conditioning equipment	50kW~1500kW	30000	28000		
	Centrifugal	Large sized air-conditioner	1000kW~4500kW				

Sub-sector	Products Description	Application/ End-use	Typical Capacity Range (kW)	Estimated Installed manufacturing capacity (units/year)	Actual production (units in 2008)	Average HCFC-22 charge/unit (kg)	HCFC consumption in 2008 (metric tonnes)
2. Condensing Units	Consisting of compressor, condenser tank and accessories,	Freezer and cold storage	0.5kW~2600kW	200000	150000	23	3450
3. Small-sized water chiller	refrigerating capacity≤50kW	small scale hotel, office building, restaurant and hospital, etc. for commercial use	7kW~50kW	110000	90000	12	1050
4. Industrial and commercial Chiller	refrigerating capacity>50kW	larger scale office building, stadium, shopping mall, hotel, plant and restaurant	50kW~12250kW	170000	150000	120	18020

Sub-sector	Products Description	Application/ End-use	Typical Capacity Range (kW)	Estimated Installed manufacturing capacity (units/year)	Actual production (units in 2008)	Average HCFC-22 charge/unit (kg)	HCFC consumption in 2008 (metric tonnes)
5. Heat pump water heater	adopt refrigeration circulation to make hot water	hotel, restaurant, dormitory, swimming pool and beauty parlor	3kW~100kW	180000	130000	13	1700
6. Unitary air conditioner	includes unitary air-conditioner, rooftop air-source air-conditioner, ducted air-conditioner, air-conditioner for computer room, clean operating room, constant temperature and humidity dehumidifier, etc	Small scale hotel, office building, restaurant, hotel, engine room, plant, etc.	7kW~200kW	1850000	1700000	9	14630

Sub-sector	Products Description	Application/ End-use	Typical Capacity Range (kW)	Estimated Installed manufacturing capacity (units/year)	Actual production (units in 2008)	Average HCFC-22 charge/unit (kg)	HCFC consumption in 2008 (metric tonnes)
7. Multi-connected air conditioner	a refrigeration circulation system composed by one or several outdoor air-cooled plants connecting with several indoor units	Small and medium scale shopping mall ,villa or office buildings, etc.	5kW~150kW	80000	60000	18	1100
8. Freezer and cold storage equipment	food display case, transport refrigeration, ice maker, quick freezers, cold store, refrigerated warehouse, beverage cooling equipment, etc	Supermarket, shop, air conditioned refrigeration warehouse, restaurant, kitchen of hotel	0.5kW~1400kW				600
9. Transport Air conditioning	Train conditioner	Carriage and driver's cabin	3kW~50kW	18000	13000	6	80

II.3 DATA COLLECTION METHODOLOGY

2.3 China Refrigeration and Air-conditioning Industry Association (CRAA) were responsible for the survey of HCFCs consumption in the ICR sector. Experts from FECO and Beijing University participated in the field survey. The overall purpose of the survey is to figure out the industry framework, current manufacturing situation and HCFC consumptions. The survey targets were the manufacturers in 9 sub-sectors as described in previous section. Four aspects of information were collected:

a) Product categorization of refrigerating and air-conditioning equipment using HCFCs and list of detail regarding producers and manufacturers in the ICR sector;

b) Amount of refrigerating and air-conditioning equipment using HCFCs, production capacity and sales revenue;

c) HCFCs consumption of all equipments in production sector from 2006 to 2008;

d) Research progress of HCFCs substitute technology.

2.4 The methodology adopted for collecting of HCFCs consumption data was as follows:

a) The survey was conducted by questionnaire and on-site survey in parallel.

b) The above-mentioned 9 sub-sectors are identified by industry information collection platform and member database under the CRAA, as well as its product certification and manufacturing certification database. Large and medium-size manufacturers are included generally, with some representative small-size ones covered.

c) The questionnaires were sent to a total of 434 enterprises for their detailed information, including enterprise name, contact person, add, cell phone, fax and email, etc. The enterprises selected were located mainly in developed regions. Those from central and western regions were also included. These enterprises covered municipal, provincial, city and county level. 150 questionnaires were returned. The surveyed enterprises were located in 16 provinces and municipal cities. It can be seen from the table that they are mainly located in central east and central south of China, which are the production base for refrigeration and air conditioner.

Table 2-2: Regional distribution of the surveyed enterprises

No.	Province	Number of questionnaires distributed	Number of responses received
1	Jiangsu	102	44
2	Guangdong	83	22
3	Shandong	44	17
4	Zhejiang	63	16
5	Shanghai	51	18
6	Beijing	25	12
7	Liaoning	11	4
8	Sichuan	5	4
9	Chongqing	4	3
10	Anhui	8	2
11	Hubei	4	2
12	Henan	11	1
13	Fujian	3	2
14	Hebei	2	1
15	Shanxi	2	1
16	Tianjin	1	1
17	Hunan	5	
18	Hei Longjiang	4	
19	Shanxi	2	
20	Guangxi	1	
21	Guizhou	1	
22	Xinjiang	1	
23	Yunnan	1	
Total		434	150

d) On-site surveys were carried out at 68 enterprises in April to June 2009 by 7 survey teams. These 68 enterprises were carefully selected to ensure a general balance of enterprise region, sub-sectors, and their scale of operation. The on-site survey mainly focused on the enterprises that have not received any funding from the MLF. While the field survey covered enterprises of all ranges, most attention was given to the enterprises with large consumption of HCFCs and variety of products as they are the targets for phase-out under the ICR sector plan for phase I.

e) Since most enterprises are multi-production based, with diversity of products series, all together 195 product lines were involved.

f) On-site survey of product line for different type included: 20 product lines of HCFCs refrigerating compressor; 17 product lines of HCFCs compressor condensing unit; 23 product lines of HCFCs small sized chiller (heat pump) unit; 49 product lines of HCFCs chiller (heat pump) for ICR use; 23 product lines of HCFCs heat pump water heater; 32 product lines of HCFCs unitary air-conditioner; 16 product lines of HCFCs multi-connected air-conditioner (heat pump) unit; 14 product lines of HCFCs cold storage and freezing equipment (including food cold display, quick freezer, ice maker, transport refrigerating, cold store etc.); 1 product line of HCFCs train air-conditioner;

g) Of the 150 enterprises who returned the feedbacks, 17 were engaged in air-conditioning terminals and component manufacturing; the other 133 were involved in refrigerant consumption. **The analysis below is focused on the 133 ICR products manufacturers with HCFCs consumption.**

II.4 Basic Information

2.5 Of the 133 enterprises, 81 are domestically-funded enterprises (60.9%); 31 joint-venture (23.3%), 21 foreign capital (15.8%).

2.6 30 enterprises have registered capital below 10 million RMB (22.6%), 72 between 10 million and 100 million RMB (54.1%), 31 more than 100 million RMB (23.3%).

2.7 The surveyed enterprise totaled 55.4 billion RMB in sales volume in ICR equipment in 2008. 60 have sales volume below 0.1 billion (45.1%), 53 between 0.1 and 1 billion RMB (39.9%), 20 over 1 billion RMB (15%).

2.8 65 enterprises were founded before 1999 (48.9%), 103 were before 2003 (77.4%), 116 were before 2005 (87.2%), 125 were before 2007 (94.0%). See Table below for detail.

Table 2-3: Dates of establishment

Year	Nationally owned	JV	Foreign capital	Total
By 31 Dec1999	37	19	9	65
By 31 Dec 2000	44	20	9	73
By 31 Dec 2001	46	20	9	75
By 31 Dec 2002	53	24	10	87
By 31 Dec 2003	62	29	12	103
By 31 Dec 2004	66	31	12	109
By31 Dec 2005	71	31	14	116
By 31 Dec 2006	75	31	17	123
By 21 Sep 2007	76	31	18	125
By 31 Dec 2008	81	31	21	133

2.9 Of the 133 enterprises, 22 are engaged in refrigerating compressor, 25 in compressor condensing unit, 32 in small sized chiller (heat pump), 82 in ICR chiller (heat pump), 32 in heat pump water heater, 50 in unitary air-conditioner, 22 in multi-connected air-conditioner (heat pump), 28 in ICR freezer and cold storage equipment, and 1 in train air-conditioner. Some enterprises participate in production for multiple subsectors, and therefore the sum of number of enterprises in all subsectors exceeds 133.

Table 2-4: Number of manufacturers in sub-sectors

No.	Product category	Number of enterprises
1	Refrigerating compressor	22
2	Compressor condensing unit	25
3	small sized chiller (heat pump)	32
4	ICR water chiller (heat pump)	82
5	heat pump water heater	32
6	unitary air-conditioner	50
7	multi-connected air-conditioner (heat pump)	22
8	Freezer and cold storage equipment	28
9	train air-conditioner	1

2.10 48 surveyed enterprises used less than 10 tons of HCFCs, 52 used between 10-100 tons, and 33 used more than 100 tons.

2.11 Of the 133 enterprises, 7 had engaged earlier in CFCs conversion projects. See list in Annex II.

2.12 In 2008, in these 133 enterprises, 31,332 tons of refrigerants were consumed, in which, 18,569 tons of HCFCs was consumed, accounting for 59.3% of total amount of refrigerant. It is up by 61.5% compared with 2004, with annual growth rate 12.7%.

2.13 Of the above, 18,241 tons are for R22 (58.2%), 316 tons for R123 (1.0%), 12 tons for R142b (0.1%), 3,482 tons for R134a (11.1%), 2,794 tons for R410A (8.9%), 384 tons for R407C (1.2%), 57tons for R4044A (0.2%), 6,046 tons for R717 (19.3%).

2.14 According to the analysis above, R22, R123 and R142b are the three major HCFCs being used in 2008. R22 consumption accounted for 98.2% of total HCFCs consumption, R123 accounted for 1.7%, and R142b accounted for 0.1%.

Table 2-5: HCFC consumption in enterprises in 2008

Refrigerant	Nationally owned	Joint venture	Foreign-fund	Total	Percentage
R22	9,860	7,103	1,278	18,241	98.2%
R123	9	0	307	316	1.7%
R142b	12	0	0	12	0.1%
Total	**9,881**	**7,103**	**1,585**	**18,569**	**100.0%**

II.5 PRODUCTION CAPACITY AND OUTPUT

2.15 Based on the survey focusing on 133 enterprises and the annual statistics of CRAA, the production capacity and the production output volume of HCFC-based equipments for each sector is estimated as follows:

a) Refrigerating compressors

Reciprocating compressors

More than a dozen domestic enterprises are engaged in manufacturing of the reciprocating compressor, mainly including semi-hermetic compressor, hermetic compressor and open style compressor. According to CRAA's survey, 150,000 reciprocating compressors were produced in 2008, among which 120,000 compressors adopt R22 and others use NH3, R134 and R404A as main refrigerant.

Scroll compressors

Enterprises of scroll compressors are highly concentrated. There are no more than 10 enterprises involved in this sub-sector, mainly joint ventures and wholly foreign capital enterprises. CRAA's survey and statistics shows that 2.8 million scroll units were produced in 2008, among which 2.4 million adopt R22 as refrigerant and the rest adopt R410A and R407C as main refrigerant.

Screw compressors

More than a dozen producers are in this sub-sector. CRAA's survey and statistics shows that in 2008, output of screw refrigerating compressor was more than 38,000, among which 28,000 units adopt R22 as refrigerant and the rest adopt R134a as main refrigerant with few using NH3 and R407C as refrigerant.

Centrifugal compressors

Locally manufactured centrifugal compressors are applied to centrifugal chiller unit products made in-house, and are not for sale as a single product. The conversion of HCFCs centrifugal refrigerant compressor is combined with the centrifugal chiller unit. So the conversion of HCFCs centrifugal compressor and that of centrifugal water chillers will be carried out together. The HCFCs centrifugal compressor itself will not be converted as a separate product.

b) Compressor condensing units

CRAA survey data shows that there are about 200 domestic manufacturers in this sub-sector, with more than 50 scaled enterprises. Most compressor condensing units are produced mainly by compressor manufacturers, with a small number produced by construction engineering companies who purchase compressors and turn them into compressor condensing units. In 2008, there were 150,000 compressor condensing units produced using R-22.

c) Small-sized water chillers (heat pumps)

More than a dozen manufacturers are involved. CRAA's survey and statistics shows that 90,000 units using R-22 were produced in 2008.

d) Industrial & commercial water chillers (heat pumps)

According to CRAA survey, the market of reciprocating chiller unit (heat pump) is partly occupied by screw chiller unit (heat pump) and scroll chiller unit. The output of reciprocating chiller unit (heat pump) descend gradually, about 3,000 reciprocal chillers (heat pump) using R-22 were produced in 2008.

Scroll chiller unit belongs to small or medium sized refrigerant air conditioning equipment which is widely applied in the sector of industrial and commercial refrigeration with more than 100 manufacturers. According to CRAA survey, 120,000 scroll chillers (heat pump) using R-22 were produced in 2008.

Screw chiller unit belongs to medium or large sized refrigerant air conditioning equipment which is widely applied in the sector of industrial and commercial refrigeration with more than 100 manufacturers. According to CRAA survey, 27 thousands screw chiller (heat pump) using R-22 were produced in 2008.

Centrifugal chiller unit belongs to large sized refrigerant air conditioning equipment which sub-sector is centralized with 10-12 enterprises. According to CRAA survey, 3,480 centrifugal chillers (heat pump) were produced in 2008 by a dozen enterprises, with R-134a used mainly. There are two enterprises which produce centrifugal chiller units adopting R123 and produced more than 500 units in 2008.

e) Heat pump water heaters

Heat pump water heater sub-sector has developed fast recently. Survey shows that there are at least 200 enterprises in this sub-sector, with over 50 scale enterprises. More than 130,000 units using R22 were produced in 2008.

f) Unitary air-conditioners

There are many type productions of unitary air-conditioner. Over a hundred enterprises are involved. Survey shows that 1.7 million unitary air-conditioners using R-22 were produced in 2008.

g) Multi-connected air-conditioners (heat pumps)

The sub-sector manufacture of Multi-connected air-conditioner (heat pump) is highly centralized. CRAA survey shows that 60,000 multi-connected air-conditioner (heat pump) using R-22 were produced in 2008.

h) Freezer and cold storage equipment

Equipments in this sub-sector covers quite a number of areas, including food display case, transport refrigeration unit, ice maker, quick freezer, freeze dryer,

cold store, controlled atmosphere warehouse and beverage dispenser etc.. Their refrigerating capacities differ greatly. Quite a number of manufacturers are engaged in this sub-sector, mostly small-scale. According to CRAA survey, R-22 consumption in this sub-sector stands at 600 tons in 2008.

i) Train air-conditioners

Manufactures in this sub-sector are highly centralized in several enterprises. Survey shows that 13,000 units of train air-conditioners using R-22 were produced in 2008.

2.16 The production output in 2008 for each sub-sector is summarized as shown in table 2-6:

Table 2-6: Sub-sector level production output (2008)

No.	Product Category/Sub-sector		Production (unit/set)
1	R22 compressor condensing unit		150,000
2	R22 small-sized water chiller(heat pump)		90,000
3	Medium & large sized industrial and commercial chiller (heat pump)	R22 reciprocating chiller(heat pump)	3,000
		R22 scroll chiller(heat pump)	120,000
		R22 screw chiller(heat pump)	27,000
		R123 centrifugal chiller(heat pump)	>500
4	R22 heat pump heater		130,000
5	R22 unitary air-conditioner		1,700,000
6	R22 multi-connected air-conditioner		60,000
7	R22 Train air-conditioner		13,000

II.6 HCFC DATA ESTIMATION

2.17 According to ***Survey Report of Basic Information for the Phase-out of HCFCs in China's ICR Sector***, HCFCs refrigerant includes R-22, R-123 and R-142b, HFCs refrigerant includes R-134a, R-410A, R-407C and R-404A, and natural refrigerant is R717.

2.18 On-site survey and questionnaire feedback from 133 enterprises shows that 31,332 metric tonnes of refrigerant were consumed in 2008, of which 18,569 tons were HCFCs.

2.19 Based on the on-site survey and questionnaire's feedback, two approaches are adopted to deduce and estimate the HCFCs consumption for overall ICR sector: one is based on weighted-average charging amount by sub-sector, one is based on total sales revenue of overall sector.

2.20 Approach based on weighted-average charging amount by sub-sector: According to the output volume and refrigerant charging amount of each sector deduced from the 133 enterprises surveyed, the weighted-average charging amount of various of products at each sector were estimated. And then, combined with overall annual statistics data by sub-sector, the HCFC refrigerant consumption for overall sector is calculated. The formula is as follows:

$$S = \sum_{i=1}^{n} L_i \bullet A_i$$

S----Total consumption of refrigerant of the industry

Li----Output volume of the i-th sub-sector

Ai----weighted-average charging amount of single unit for the i-th sub-sector

2.21 Approach based on total sales revenue of overall sector: the analysis shows that there is a relatively fixed ratio on proportion between sales revenue and refrigerant charging. According to the ratio between the total of refrigerant charging amount and the total of sales revenue of the survey enterprises, then combined with the annual sales revenue of overall sector, the HCFC refrigerant consumption for overall sector is calculated. The formula is as follows:

$$S_n = \frac{P_n}{P_d} S_d$$

Sn----total consumption of refrigerant of the whole industry

Sd----HCFCs consumption amount of the enterprise surveyed

Pn----total output volume of whole industry

Pd----output volume of the enterprise surveyed

2.22 According to the first approach, the HCFCs consumption for overall ICR sector in 2008 is about 40,380 metric tons. According to the second approach, the HCFCs consumption for overall ICR sector in 2008 is about 40,890 metric tons. Only 510 tons difference between two approaches. In addition, the result deduced from above two approached was also cross-checked by analyzing of the national consumption data of R22 based on HCFC-22 production top-down method. Therefore, the HCFC consumption for overall ICR sector in 2008 is deduced as the average value of two approaches, 40,630 metric tons, of which 40,280 tons were R-22, accounting for 99%, with other HCFCs representing only 1%. This amount also includes 320 tons of R-123 and 30 tons of R-142b.

Table 2-7: 2008 HCFCs consumption by sub-sector

No.	Refrigerant	Product categorization	Charge amount (metric tonnes)
1	R22	Compressor condensing unit	3,450
2		Small sized chiller (heat pump)	1,050
3		Industrial & commercial water chiller (heat pump)	17,700
4		Heat pump water heater	1,700
5		Unitary air-conditioner	14,600
6		Multi-connected air-conditioner (heat pump)	1,100
7		Freezer and cold storage equipment	600
8		Train air-conditioner	80
9	R123	Centrifugal chiller	320
10	R142b	Unitary air-conditioner	30
Total			**40,630**

III. EXISTING POLICY FRAMEWORK

3.1 Under the leadership of the Chinese Government and the guidance of the Leading Group for ozone layer protection, the ozone layer protection work in China has gradually been standardized and institutionalized. A comprehensive policy framework has been initially formed for overall control and management of ODS production, consumption, import and export. The framework has played very important roles in controlling the growth of ODS production and consumption, promoting research, development and replication of alternatives and alternative technologies, and ensuring China to meet the phase-out targets under the MP.

3.2 As of April 2010, the Chinese government has formulated and issued more than 100 policies and regulations on ozone layer protection. The relevant provisions of ODS phase-out was included in the revised "Air Pollution Prevention and Control Law of the PRC" approved in April 2000. In June 2004, the MEP (then State Environmental Protection Administration) issued "Law, administrative regulations, and continue to implement the administrative licensing items (28 items)", which included provisions on management and issuance of ODS production, import and export licenses. Meanwhile, each sector has also formulated a number of technical standards for HCFC alternatives.

3.3 The new "Regulation of ODS Management" has been issued by the State Council in April 2010 and became effective on June 1, 2010 after a five-year period of preparation and review. This Regulation will serve as a solid legal basis for sustainable ODS phase-out. The following Table 3-1 provides a snapshot on the existing policies and regulations relevant to HCFCs phase-out.

Table 3-1: Existing Policies and Regulations Relevant to HCFCs Phase-out

Category	Details	Issued	W.e.f.	Implementing agency	Issue Agency
Law	Air pollution prevention and control	2000	2000	MEP	National People's Congress
National Regulation	Regulation on ozone depleting substances management	2010	2010	MEP	State Council
Production control	Ban on CFCs production	2007	2007	Local EPBs	MEP
	Circular on strict control of new, innovation or expansion of HCFCs production facilities	2008	2009	Local EPBs, Local DRCs	MEP
Consumption control	Ban of the use of CFCs as blowing agent	2007	2008	Local EPBs	MEP
	Notice on control of new production facilities that use HCFCs	2009	2009	Local EPBs	MEP
Import and export control	Management methods on import and export of ODS	1999	1999	Local EPBs, Local DRCs, Customs	MEP, MOC, GAC
	Regulation on strengthening ODS import and export management	2000	2000	Local EPBs, Local DRCs, Customs	MEP, MOFTEC, GAC
	Catalogue of controlled ODS import and export (third batch)	2004	2004	Local EPBs, Local ICBs, Customs	MEP, MOC, GAC
Information management	Circular on the Nation-wide application of sewage registration- adding ODS in the declaration and registration of pollutant emission	1997	1997	Local EPBs, Relevant industry departments	MEP
	Circular on use of database for ODS declaration and registration	1997	1997		
Supervision management	Circular on issues on EIA for MP projects	1995	1995	Local EPBs	MEP
	Circular on strengthening role of local EPBs in ozone layer protection	1997	1997		
	Circular on issuance and trial implementation of the guidelines for MP projects (trial)	1996	1996		
	Circular on further enhancing the punishment of illegal production and sale of ODS	2004	2004		
	Circular on strengthening the management of ODS phase-out	2007	2007		

Category	Details	Issued	W.e.f.	Implementing agency	Issue Agency
Environmental label	Technical requirement for environmental labeling products -- ODS alternatives	2005	2006	Local EPBs	MEP
Alternatives management	List of Recommended ODS alternatives (Updated to involve new information)	2007	2007	Local EPBs, Relevant industry departments	MEP

IV. ALTERNATIVE TECHNOLOGIES

4.1 Decision XIX/6 adopted at the 19th MOP calls for parties to select HCFC substitutes with minimum environmental impact by considering impact on climate, satisfying health and safety requirement and taking account of economics. This serves as a guide for the MLF ExCom, that is, when making decision on projects and plans concerning HCFCs phase-out, priority should be given to energy efficiency, environmental protection, safety and economy, in addition to zero ODP.

4.2 CRAA is actively searching for the substitute refrigerants and technology routes which are suitable for China's situation. A HCFC substitute technology expert committee was set up, to communicate on issues such as policy establishment, technology selection, conversion projects, and action plan, and contributed to the conversion of ICR sector by resolving the existing problems.

IV.1 FACTORS IN SECTION OF SUBSTITUTE TECHNOLOGY

4.3 In choosing substitute refrigerants, comprehensive consideration should be given to the characters of the refrigerant and the refrigerating system, including energy conservation, environmental protection, safety, economy etc.

a) Characters of the refrigerant: Substitute refrigerants should have good physical, chemical and thermodynamics characters, such as compatibility with materials in existing systems, good solubility in oils, and widely available matching lubricant for compressors. The refrigerant should work under temperature and pressure conditions that match its applications, and chemically stable. The refrigerant should also be of great refrigeration characteristics, such as low adiabatic coefficient, high unit refrigeration volume, and low viscosity.

b) Energy conservation: Refrigeration and air-conditioning systems with substitute refrigerants should be of relatively high theoretical efficiency, so as to reduce energy consumption.

c) Environment friendliness: Substitute refrigerant should have zero ODP and low GWP. At the same time, their total equivalent warming impact (TEWI) and life cycle climate performance (LCCP) values should be lower, indicating smaller overall impact on the climate change.

d) Safety: As refrigerating equipment has wide application in various fields of national economic and people's life, safety and health issues such as their flammability, toxicity and irritancy must be thoroughly considered, to ensure the safety and reliability during the use. .

e) Economy: The substitute refrigerants should be inexpensive and widely available. In addition, the costs of materials, manufacturing, installation, running, and maintenance should be low.

IV.2 ANALYSIS OF EXISTING SUBSTITUTES

4.4 Detailed analysis of existing substitutes are as follows:

HFCs

a) R134a has zero ODP and a GWP of 1430. Inflammable, nonpoisonous, and odorless, R134a is safe to use in products such as refrigerators, freezers, and large screw chillers. The physical and thermodynamic properties of R134a are significantly different from R22, and thus R134a needs to use a different lubricant. It has higher flow pressure drop and poorer heat transfer coefficient, and the unit refrigeration volume is 35% lower than that of R22. To get the same refrigeration volume as R22, sizes of compressors and heaters with R134a should be increased which make the price of R134a products considerably higher due to increased material and manufacture costs.

b) R410A has zero ODP and a GWP of 2100. It is an azeotropic mixture composed of 50% R32 and 50% R125. It has a large unit refrigeration volume and good heat transfer performance and fluidity. R410A is a popular substitute mainly used in small- or medium-sized air-conditioning equipment and some small types of refrigeration equipment. Its working pressure is 60% higher than that of R22, which leads to higher demand for system design, manufacture and quality control. Besides, the price of R410A is more expensive due to its patent protection.

c) R407C has zero ODP and the GWP is 1800. It is a zeotropic mixed refrigerant which consists of 23% R32, 25% R125 and 51% R134a. Its working pressure is similar to that of R22. It is used in medium or small types of air-conditioning equipment. Its unit volume is large, but heat transfer performance is poor. R407C is a zeotropic mixture with high temperature glide, which leads to changes in the ratio of its components when leak occurs, causing negative impacts on the servicing and performance of the system. The price of R407C is expensive due to its patent protection, similar to R410A.

d) R404A has zero ODP and the GWP is 3900. It is a quasi-azeotropic refrigerant consisting of 44% R125, 52% R143a and 4% R134a when measured by mass. It is suitable for circumstances with medium-low temperature, while the working pressure is similar to that of R502. Its main disadvantage is its high GWP, which is more than twice that of R22.

e) R507 has zero ODP, and a GWP of 4000. It consists of 50% HFC-125 and 50% HFC-143a. Its refrigeration capacity and efficiency are similar to those of R502. Its favorable performance of heat transfer is suitable for applications in the low or medium temperature refrigeration field. But its main drawback is its high GWP, which is more than twice that of R22.

f) R32 has zero ODP and a GWP of 675. It is the main component of R410A, and the working pressure equals to that of R410A. It has good thermal conductivity, large refrigeration capacity and high theoretical efficiency. Under the condition of equal refrigeration volume, the recharge volume of R32 is only two third of that of R22. R32 is a mature and stable refrigerant which is easy and cheap to obtain. The exhaust temperature of R32 system is relatively high and needs to be reduced by technological measures. R32 is moderately flammable, needs micro-combustion destructive tests, risk evaluation and measures taken to reduce leak rate before adopted for practical applications. As the greenhouse effect has become an issue of global concern, R-32 received worldwide attention, given its lower GWP (around 1/3 of R-410A) and sound refrigerating performance. It enjoys a promising future of application. The substitute technology expert committee of China's ICR sector have conducted a comprehensive evaluation of various refrigerants, considering aspects such as thermodynamic and physical properties, energy saving, environmental protection, safety and economy. R32 has received common attention and appreciation in the process. From available analysis results, within a certain range of charge amount and certain product categories, R32 applications have considerable potential and a promising prospect. But considering the flammability of R32 and lack of experience of commercial applications even in developed countries, China should actively execute R32 demonstration projects, and conduct flammability tests and risk evaluations for R32 applications. If technological issues such as the flammability and high exhaust temperature can be resolved, R32 has the potential to become an important substitute in the first phase of the conversion from HCFCs.

Natural refrigerants

a) NH3 has zero ODP and the GWP is lower than 1. It is a traditional natural refrigerant with small flow resistance, good heat conductivity, large unit refrigeration capacity, high theoretical efficiency, moderate pressure, ease in leak detection and low price. At present, NH_3 is used in large models of low temperature refrigeration and freezing equipment, but being classified as B2 in the refrigerant safety category for its flammability and strong toxicity, it is not suitable for occasions with dense population and strict requirements of safety.

b) CO_2 has zero ODP, and the GWP is 1. It is an excellent natural refrigerant that is chemically stable, safe to use, nontoxic, non-corrosive, non-flammable, inexpensive and compatible with many types of lubricants and materials. It has relatively high unit refrigeration capacity, good heat transfer performance and high fluidity. It's drawback is that the running pressure, nearly reaching 10 MPa, is much higher than traditional refrigeration systems, causing special demand for system and accessory design and leading to much higher cost of the system. Besides, the problem of working efficiency under the circumstance of large pressure difference is quite manifested.

c) R290 has zero ODP and a GWP of 3, with no toxicity, high theoretical efficiency, good environmental properties and thermal properties. But due to the strong flammability, its applications are limited. Given the large recharge amount in ICR equipment, safety concerns could not be solved if R-290 is used in current technology conditions. The ICR sector will actively track the trend of alternative technology development, and conduct study and safety evaluation on using hydrocarbons as alternative refrigerants when the opportunity emerges, to examine the possibility of future application.

Table 4-1: ODP and GWP of potential refrigerant substitutes

No.	Type	ODP	GWP*
1	R134a	0	1430
2	R410A	0	2100
3	R407C	0	1800
4	R404A	0	3900
5	R507	0	4000
6	R32	0	675
7	NH_3	0	<1
8	CO_2	0	1
9	R290	0	3

Source: ASHRAE

IV.3 SUBSTITUTE ROUTE

4.5 Currently, no perfect R-22 substitute that has 0 ODP, low GWP, high energy efficiency while being safe has been identified in the world. Given current technological progress, there will be a number of substitutes used in different sub-sectors. It will be almost impossible to have only one type of refrigerant replacing all R-22 applications. The existing HFCs substitutes belong to greenhouse gases with strict emission prohibition under the Kyoto Protocol. Therefore, they will be controlled and phased out gradually due to their high GWP.

4.6 For China's ICR sector, there are many uncertainties in the choice of substitute technology routes. In choosing substitute refrigerant, the expert committee on substitute technologies for the ICR sector is keeping close track of international trend in R&D of HCFC-22 substitute, and actively carrying out analysis, study and evaluation of substitute refrigerants and technologies.

The expert committee will take full account of energy efficiency and effective emissions reduction of CO2 in the overall life cycle of refrigerant. Balancing various considerations, including the maturity and availability of the alternatives, it will choose affordable alternatives and substitute technologies that cater to different working temperature and pressure, so as to be in line with China's actual condition and industrial development, and ensure continual and stable development of the sector.

4.7 When carrying out the conversion and phase out of HCFCs, the ICR sector of China will comprehensively consider the climate characteristics of alternative refrigerants within its life cycle, and do our best to select alternative refrigerants and substitute technologies that are energy-efficient, environment-friendly, safe and economic. On the 60th meeting of the ExCom, the Committee approved two demonstration projects submitted by China's ICR sector: one for conversion from HCFC-22 to HFC-32 technology in the manufacture of commercial air-source chillers/heat pumps, and the other for conversion from HCFC-22 to ammonia/CO2 technology in the manufacture of two-stage refrigeration systems for cold storage and freezing applications. On the foundations laid by the demonstration projects, the sector will try every possible means to promote refrigerants with lower GWP, such as R32, ammonia and CO2. The ICR sector of China will also revise and adjust the technology routes for its sub-sectors based on the research and evaluation progress, to ensure that each sub-sector is able to choose most environment-friendly and rational alternative refrigerants and technologies to the greatest extent.

4.8 ***Compressors:*** The selection of substitute refrigerant for compressors is determined according to the type of compressor and the application served.

a) Reciprocating compressors are mainly used in freezing and refrigerating equipment, and a few are used in small size air-conditioners. The mature refrigerants that are being applied domestically and abroad in reciprocating compressors include R134A, R404A, R507, ammonia and CO2. Ammonia and R134A are the more feasible choices for reciprocating compressors. High GWP fluids such as R404A and R507 are not recommended. Considering the environmental impact and technology availability, in the first phase of the conversion it is proposed to conduct research and demonstration projects that use R32 as the alternative refrigerant, and attempt to broaden the range of ammonia and CO2 applications.

b) Scroll refrigerating compressors are mainly used in small- or medium-size air-conditioner equipment and heat pump water heaters, with a few in freezing and refrigerating equipment and compressor condensing units. R410A is the currently available substitute refrigerant in small- and medium-size air-conditioning equipment. Adopting R410A as substitute refrigerant is a mature conversion technology that allows the realization of the substitute conversion for HCFCs in short time.

For refrigerating and freezing equipment, currently, the mature alternative refrigerants with actual applications include R134A and R404A. R134A is more preferred, as high GWP working fluids such as R404A are not recommended as alternatives for future applications. In certain occasions R410A can also be a possible choice. R32 has good environmental performance, thermal property and high theoretical efficiency. It is reasonable to use R32 as a substitute refrigerant in scroll compressors when the application technology becomes mature.

c) Screw compressors are mainly applied in medium- or large-size chiller units with some in condensing refrigerating units and freezing and refrigerating equipment. At present, R134a is a main substitute refrigerant applied in medium- and large-size chiller unit. In the fields of medium and large size freezing and refrigerating equipment and compressor condensing unit, NH_3, R507 or R134a are regarded as feasible substitute refrigerants. NH_3 has good environmental performance and thermal property in despite of its low flammability and toxicity. Its application range should be broadened. There are already enterprises researching the technology of NH_3/CO_2 cascading system to substitute R22 in the fields of refrigeration of low temperature, where technical difficulties exist due to the low temperature and high pressure of the CO_2 stage. Therefore the application research and demonstration project of technology should be actively carried out to build a foundation for the application of NH_3/CO_2 cascading system.

d) Centrifugal compressors are mainly applied in large size chiller units using R134a as refrigerant.

4.9 ***Compressor condensing units:*** At present, mature substitute refrigerants with applications in compressor condensing units include R134A, R404A, R507, NH3 and CO2. NH3 and R134A are the preferable choices of alternative refrigerant for compressor condensing units. Working fluids with high GWP, such as R404A and R507, are not recommended for future conversion. R410A is also a possible choice in some small size compressor condensing units. NH_3 has moderate flammability and low toxicity, but its good environmental performance and thermal property make it deserve focused research to broaden its range of applications. There are already enterprises researching the technology of NH_3/CO_2 cascading system to substitute R22 in the fields of refrigeration of low temperature, where technical difficulties exist due to the low temperature and high pressure of the CO_2 stage. Therefore the application research and demonstration project of technology should be actively carried out to build a foundation for the application of NH_3/CO_2 cascading system. R32 has good environmental characteristics and thermodynamic properties, and its theoretical efficiency is high. Considering environmental impacts and the availability of technology, it is proposed to start research and demonstration projects on R32 as a substitute refrigerant in the compressor condensing units sub-sector.

4.10 ***Small sized water chillers (heat pumps):*** R-410A and R-134a are possible substitutes in this sub-sector. As substitute refrigerants, R410A and R134a technology have matured globally.

HCFC conversion can be realized in short time through adoption of R410A and R134a. R32 has good environmental characteristics and thermodynamic properties. In the first phase of the conversion, considering its environmental impacts and technology availability, it is proposed to consider R32 as a potential direction of future alternative refrigerant in the small-size air conditioning sub-sector, including small sized chillers (heat pumps).

4.11 ***Industrial & commercial water chillers (heat pumps)***: Similar to the small sized chiller (heat pump) sub-sector, R-410A and R-134a are globally regarded as mature substitutes in the choice of substitutes for the industrial & commercial chiller (heat pump) subsector, allowing the conversion from HCFCs in relatively short time. R32 has good environmental and thermodynamic properties. Once the demonstration project using R32 succeeds and the technology becomes mature for application, R32 can be considered as a major direction in the choice of future alternative refrigerants for the industrial & commercial chiller (heat pump) sector. R134A is considered to be a practical choice of substitute refrigerant in large- or medium-size chiller units (heat pumps). Some enterprises are studying the application of R410 in these units.

4.12 ***Heat pump water heaters***: Selection of substitute refrigerants for heat pump water heaters is similar to that for small sized chiller (heat pump) units. At present R134a is considered internationally to be a mature refrigerant, and R410A is also practical to realize substitute conversion of HCFCs in the short term. R32 has good environmental and thermal properties and high efficiency. If the problem of high temperature exhaust can be resolved, it is possible to select R32 as a main substitute refrigerant in the future. In this subsector, a few foreign products have adopted CO_2 as the refrigerant for its good thermal and environmental performance, but its shortcoming is that the running pressure is much higher than traditional refrigerant system. It's advisable to carry out research for application of CO_2 or demonstration projects in this subsector.

4.13 ***Unitary air-conditioners***: The selection of substitute refrigerants for unitary air-conditioners is similar to that in the field of small sized chiller unit (heat pump). At present, R410A is regard as a mature refrigerant internationally, the adoption of which can realize the substitute conversion of HCFCs in short time. It's also feasible to choose R32 as a substitute refrigerant due to its good environmental performance and thermal property when its application technology is mature.

4.14 ***Multi-connected air-conditioners (heat pump)***: The substitute refrigerant selection for multi-connected air-conditioner (heat pump) units is similar to that of small sized chiller (heat pump) units. R410A is internationally regarded as a mature substitute refrigerant, the adoption of which can realize substitute conversion of HCFCs in short time. It's possible to choose R32 as the substitute refrigerant in some low capacity multi-connected air-conditioner (heat pump) units, given that the technology for its application becomes mature.

4.15 ***Freezer and cold storage equipment***: R-134a, NH_3, and R-507 are possible substitutes in the medium- and large-size freezing and refrigeration equipment. Among them, NH3 and R134A are preferred, while it is not recommended using high GWP working fluids such as R507. Despite its moderate flammability and toxicity, NH3 has sound environmental characteristics and thermodynamic properties, thus the NH_3 application should be expanded. Some enterprises have started study on using NH3/CO2 cascading systems in place of R22 systems for low temperature refrigeration. But there are technological difficulties caused by the low temperature and high pressure in the CO2 stage of the cascading system. To address that, studies on the application of NH3/CO2 cascading systems and related demonstration projects should be carried out, to lay the foundation for the application of the cascading technology. R134A, R404A and CO2 are mature and practical choices of alternative refrigerant for small-size freezing and refrigeration equipment. R134A is the advisable refrigerant for such equipment, while the use of high GWP working fluids such as R404A in the future is not recommended. In certain refrigeration equipment, R410A is also a possible alternative. In the first phase of the conversion, considering environmental factors and technology availability, it is suggested conducting research and demonstration projects on using R32 as a substitute refrigerant.

4.16 ***Train air-conditioners:*** The choice of substitute refrigerant for train air-conditioners is similar to that for small sized chillers (heat pumps). R-410A is a mature substitute globally, which allows conversion from HCFCs in the short term. R32 has good environmental characteristics and thermodynamic properties, and can achieve high theoretical efficiency. Should R-32 become technically practical and the demonstration project a success, it can be considered as a substitute option in this sub-sector.

4.17 Please refer to Table 4-2 for the available and potential substitutes for different product categories.

Table 4-2: Available and potential substitutes

No.	Product category	Proposed substitute
1	Compressor condensing unit	NH3, R134a, CO2, R410A, R32
2	Small sized chiller (heat pump)	R410A, R134a, R32
3	Industrial & commercial chiller (heat pump)	
	Medium sized	R410A, R134a, R32
	Large-sized	R134a, R410A
4	Heat pump water heater	R134a, R410A,R32, CO2
5	Unitary air-conditioner	R410A, R32
6	Multi-connected air-conditioner (heat pump)	R410A, R32
7	Freezer and cold storage	NH3, R134a, R404A, CO2, R410A
8	Train air-conditioner	R410A,R32

V. PHASE-OUT STRATEGY (STAGE-I)

V.1 BASIC PRINCIPLES FOR DEVELOPMENT OF PHASE-OUT STRATEGY

5.1 To develop the phase-out strategy for the ICR sector, the following general principles were considered:

a) The conversion of HCFCs application in ICR sector must take account of China's actual condition and not greatly affect development and economic growth.

b) In terms of the alternative technology selection, comprehensive assessment is required to review the characteristics of substitute, such as thermodynamics, energy efficiency, environmental protection, safety and economics. Close follow-up to mature substitute technology in the world will be required, and more effort on developing substitute refrigerant technology and alternative suitable for China's demand will be required.

c) As it was stated in previous chapters, there are more than a thousand manufacturers in the sector, even with over capacities and facilities in some certain manufacturers, but may have very low production volume and lack of technology at some medium and small enterprises. In order to reduce the overall investment and increase cost-effectiveness, it is considered that the conversion programs would be carried out in key enterprises with large sales volume, advanced technical capacities and sound profit. The remaining manufacturers will addressed in the next stage. Those not viable will be encouraged to close down or transfer its production capacities to other business field with the guidance of relevant national and industry policies.

d) The new alternative technology will be adopted in demonstrations project at earlier period and then promoted for real application in wider range, so as to minimize the investment risk. At the meantime, the conversion programs also would be carried out in parallel at the key, medium and large sized manufacturers to achieve the phase-out target of the ICR sector for phase I. In order to adopt a new technology, the large investment and human resources would be put on the modification of the existing production lines. To choose the large manufacturers, investment risks can be decreased to a certain extent and the benefits of the project can be maximized. Because the experiences and lessons gained from the conversion would be easier to be promoted in the sector due to its leadership and influences to other similar manufacturers.

e) Considering the uncertainties of the alternative technologies in ICR sector of global, the unified research and development on the alternative refrigerant and alternative technology will have to be organized at the sector level before promoting to all manufacturers in the entire sector, so as to accelerate the progress of R&D and saving the cost.

5.2 To make the action plan, particularly selecting the conversion program candidate, the following principles would be considered:

a) Take full consideration of cost factor and market application acceptability, and the conversion programs would be organized according to the rule "easy first, difficult later".

b) Based on the current status of industry development, determine the process and step of production conversion for different product category.

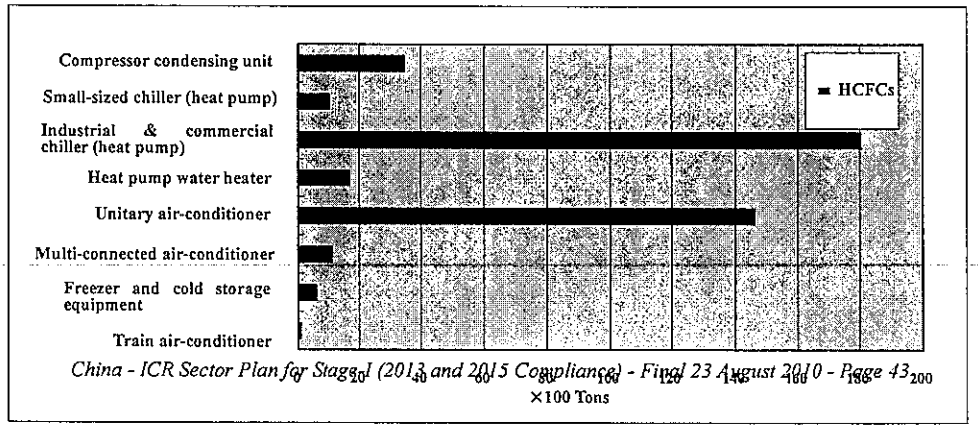
c) Conversion priority should be decided by considering maturity of substitute technology, availability and market acceptance.

d) According to the priority of the sub-sector, the priority for carrying out the conversion program shall be given to key players with large HCFCs consumption, strong capacity and sound operation practice.

V.2 Overall Strategy

5.3 The total consumption of HCFC-22 for ICR sector in 2008 was 40,630 MT and it is expected to reach the maximum level of 47,060 MT in 2012. According to the survey conducted during the preparation of this proposed ICR Sector Plan, there are about 1,000 industrial and commercial refrigeration and air-conditioner manufacturers all over the country. More than half of existing manufacturers is small-and-medium scale companies. HCFC-22 is used as a refrigerant for ICR products and air-conditioner manufacture.

5.4 Since the diversity of the product category, the Industrial and Commercial Refrigeration and Air-conditioning Sector in China could be mainly classified into 8 major sub-sectors, in addition to the compressor manufacture. And the majority of the HCFCs are concentrated on these 8 subsectors. In 2008, the largest consumption of HCFCs used for Industrial and Commercial Water Chiller (Heat Pump), which accounted for 44.3% of total. Second one is for Unitary Air-conditioners, which accounted for 36.0% of total consumption. Next is for Condensing unit accounted for 8.5%; For Heat Pump Water Heater accounted for 4.2%; For Multi-connected Air-conditioner accounted for 2.7%; Small sized Water chiller(heat pump) accounted for 2.6%; For Industrial and commercial freezer and cold storage equipment accounted for 1.5%; For Trains AC accounted for 0.2%.



5.5 The distribution of HCFCs consumption by product category and refrigerant is shown as below:

Table 5-1: 2008 HCFC consumption in different products

Refrigerant	Product categorization	Consumption (MT)
R22	Compressor condensing unit	3,450
	Small sized water chiller (heat pump)	1,050
	Industrial & commercial water chiller (heat pump)	17,700
	Heat pump water heater	1,700
	Unitary air-conditioner	14,600
	Multi-connected air-conditioner (heat pump)	1,100
	Freezer and cold storage equipment	600
	Train air-conditioner	80
R123	Centrifugal chiller	320
R142b	Unitary air-conditioner	30
Total		**40,630**

5.6 From the table above, HCFC-22 accounted for about 99%, and all other HCFCs including HCFC-123 and HCFC-142b only accounted for about 1%. Obviously, HCFC-22 is the most widely used refrigerant in ICR sector.

5.7 The overall HCFCs phase-out strategy in the ICR sector is to adopt a sectoral phase-out schedule similar to the Montreal Protocol HCFC phase-out schedule. Phase-out priority will be given to the sub-sectors where market incentives, large phase-out capacity, and low GWP alternative technology. To ensure sustainable phase-out and a level-playing field for enterprises for respective sub-sectors, policy and regulatory measures will be put in place to ensure complete phase-out in each sub-sector.

5.8 HCFC phase-out will aim at larger enterprises as they are limited in number and more manageable for FECO to ensure compliance in 2013 and 2015. Experience and lessons learned from larger enterprises will be disseminated to small-and-medium scale enterprises. Phase-out at larger enterprises would serve as demonstration cases for small-and-medium scale enterprises to follow.

5.9 HCFC-22 phase-out strategy will give priority to low GWP alternatives as much as possible. This is to avoid further conversion in case high GWP chemicals are controlled in the future. In this regard, the overall ICR Sector Strategy will consist of a series of HCFCs phase-out activities. Implementation of these activities in certain sub-sectors will be made in a chronological order depending to the extent possible on the availability of low GWP technologies, technical and financial capacity of enterprises in various sub-sectors, management capacity of FECO, executing agency of the ICR Sector Plan, and availability of funding from the Multilateral Fund.

5.10 HCFC-22 phase-out in the consumption sector will be supported by HCFC-22 phase-out in the production sector. According to the experience from CFC phase-out, sustainable phase-out of CFCs in the consumption depends largely on the supply restriction imposed on the production sector. China plans to submit its production phase-out sector plan including HCFC-22 to the ExCom in 2011-2012. The production phase-out schedule will take into account the effort being made in the consumption sector. In addition, import and export of HCFC-22 will also be strictly controlled and monitored by the Import/Export Office established within FECO.

V.3 PRIORITIZATION OF SUB-SECTORS (STAGE-I)

5.11 Through the analysis of above, the phase-out activities should be concentrated on a selective group of sub-sectors. At the meantime, few phase-out conversion activities could also be carried out in other sub-sectors which relatively low GWP alternatives exist, which are expected to deliver a signal to the industry that the conversion would take place also but at later stage, the following key factors are taken into account:

a) HCFC consumption amount;

b) Feasibility of alternative technologies;

c) Market acceptability and competition;

d) Technical and financial capacity of manufacturer in ICR sector;

e) Role of demonstration project;

f) Management capacity of the executing agency;

g) Funding availability from MLF and long-term phase-out strategy.

5.12 Taking into account of the factors above, the analysis on priority of the sub-sectors was conducted and the main result is stated below:

a) ***Refrigeration compressor***: is the heart and core component of refrigeration and air-conditioning equipments. The new compressor by adopting newly refrigerant is the basis for replacement of refrigerant in other sub-sectors. Therefore, the compressor should be the most preferential sub-sector to be converted. The alternative technology adopted should be in compliance with the alternative technology for other application sub-sectors.

b) ***Unitary Air-conditioner:*** the output power of the unitary air-conditioners produced so far in China normally is between 3 HP to 80 HP. About 14,600 metric tons of HCFC-22 was consumed in this sub-sector, accounted for 36% of total HCFCs consumption. At present, R410A is the most mature alternative technology for unitary air-conditioner. It has been put into real application in the industry. However, its GWP is relatively high.

R32 as a single-component, its working pressure basically similar to R410A, with large volumetric cooling capacity and theoretical efficiency, is a substitute alternative that has potential application value and possibility. Currently, a number of manufacturers, research and science institutes are working on the application research of the R32 and one R32 demonstration project has been funded by the MLF to explore and validate the technology. If any key progress could be made, R32 would be a good choice for the conversion in this sub-sector. Compared with the conversion from R22 to R410A, there is no bigger difficulty for R32, but the key problem is how to solve the safety issues incurred by the low flammability. In the sector plan proposed, it has planned to revise the product standard and the regulations on manufacture, transportation, installation, servicing and application. In addition, based on the experiences and lessons gained from the successful implementation of R32 demonstration project, R32 could be adopted as alternative refrigerant to unitary air-conditioner as long as it is technical feasible. As a flammable refrigerant, the charging ceiling of R32 is specified clearly in the standard IEC60335-2-40. According to this standard, the experts pointed out that R32 could be applied on the 10 HP and below unitary air-conditioner. Therefore, for those unitary air-conditioner over 10 HP, it is still considered to adopt the R410A as the alternative refrigerant, so as to ensure the phase-out target could be achieved. Considering the development situation of the sub-sector and the progress on substitute alternative, it is planned to give priority to unitary air-conditioner sub-sector in 2011 to 2015. It is expected to phase-out 5033 metric tons in this sub-sector at phase I, accounted for 34% of HCFC consumption of the sub-sector in 2008.

c) ***Multi-connected air-conditioner:*** 1,100 metric tonnes were consumed in this sub-sector. The production of the products in this sub-sector is highly concentrated in several manufacturers. R410A has already been a mature alternative technology applied in multi-connected air-conditioner (heat pump), and it is used as refrigerant in about 70% of the products in market. According to the development situation of the sub-sector and the progress on substitute alternative, it has planned to give priority to multi-connected air-conditioner (heat pump) sub-sector in 2011 to 2015, so as to complete the conversion in the products of the sub-sector as early as possible. It is expected to phase-out 800 metric tons in this sub-sector for Stage-I, accounting for less than 73% of HCFC consumption of the sub-sector in 2008.

d) ***Industrial & commercial water chiller (heat pump):*** screw chiller (heat pump) is the main series of product consuming HCFCs in the sub-sector. R134a is a mature alternative refrigerant for screw chiller (heat pump), but with high conversion cost. If convert the all the screw chiller (heat pump) from R22 to R134a, the direct manufacturing cost would increase by about 20%. At present, there are more than hundred of screw chiller (heat pump) manufacturers. At the Stage-I, it is not achievable to complete all the conversions of the production line for R22 based screw chiller (heat pump).

If only part of them convert, the owner of the production line converted to R134a will be at disadvantage in the market competition due to the increased manufacture cost and the original market share before conversion will be occupied by other manufacturers still using R22 as refrigerant. Taking into account the reason above and that the R134a is still not an ideal alternative, it is planned to carry out the conversion program for the screw chiller (heat pump) after 2015 and would be the priority sub-sector at the Phase II. On the other hand, if the R32 research applications break the technical bottleneck and the demo project completed successfully, FECO and CRAA will jointly organize the conversion activities on the R22 based scroll chiller (heat pump) at low cooling capacity, to maximize the R32 application as an alternative refrigerant. At the meantime, it is also considered to carry out several conversion programs by adopting R410A as alternative refrigerant to the scroll chiller (heat pump) at relatively larger cooling capacity at phase I, so as to ensure the phase-out target could be achieved. It is expected to phase-out 1650 metric tons in this sub-sector at Stage-I, accounted for 9% of HCFC consumption of the sub-sector in 2008.

e) ***Small sized water chillers (heat pump)***: About 1050 tons of R22 are consumed in this sub-sector. At present, R410A and R134a are two available alternative refrigerants for the products in this sub-sector. However, as the refrigerant, the energy efficiency of R134a is lower than that of R22 for small-sized water chiller (heat pump). There are real applications of R410A as the alternative refrigerant in industry, and actually no much more technical difficulty in its application, but GWP value is still a focus of dispute for international community. R32 also has the potential application value and possibility to be used in small-sized water chiller (heat pump). If the research on its application can break the bottleneck and the R32 demonstration project is successful, to adopt R32 as an alternative refrigerant in small-sized water chiller (heat pump) could be a great choice. Considering the development situation of the sub-sector and the progress on substitute alternative, it is planned to carry out several demonstrative conversion programs in this sub-sector at Stage-I, playing a role in public awareness acceptability. It is expected to phase-out 200 metric tonnes in this sub-sector at Stage-I, accounting for 19% of HCFC consumption of the sub-sector in 2008.

f) ***Heat Pump water heater:*** About 1700 tons of R22 are consumed in this sub-sector. At present, R134a is the available alternative refrigerant for HCFC conversion in short time. R32 has good environmental performance and thermal conductivity, with high theoretical efficiency. As long as the problems of micro-combustion and exhaust temperature are solved well, R32 also can be a good choice for application in heat pump water heater. Considering the development situation of the sub-sector and the progress on substitute alternative, it is planned to carry out several demonstrative conversion programs in this sub-sector at Stage-I. It is expected to phase-out 200 metric tonnes at Stage-I, accounting for 12% of consumption of the sub-sector in 2008.

g) *Freezer and cold storage equipment*: About 4,000 tons of R22 are consumed in these two sub-sectors. According to the survey, NH3 is a mature technology, which has already accounted for 70% more or less of total refrigerant charging containing in the products in the market in these two sub-sectors. Due to the flammability and toxicity of NH3, its application range is limited at a certain extent. The working space in these sub-sectors is trying to develop and expand the application scope of NH3. Currently, an enterprise is working on the application research of NH3/CO2 in low temperature refrigeration. If the natural refrigerants are promoted and developed well, they will contribute to the HCFC phase-out task for phase I. Similarly, R32 also has potential application value and possibility in compressor condensing unit and freezer and cold storage sub-sectors. Once its technical problems are solved, R32 could also be a good choice for these two sub-sectors. It is expected to phase-out 400 metric tons in this sub-sector for Stage-I, accounting for 10% of HCFC consumption of the sub-sector in 2008.

5.13 Based on the estimated HCFCs consumption in 2012, phase-out of 4160 metric tons of HCFC-22 from the 2012 consumption level is required in order to return to the sectoral consumption baseline in 2013. And reduction of 4290 metric tons of HCFC-22 is required to meet the 10% reduction in 2015. Therefore, the total reduction target of HCFC-22 consumption is 8450 metric tons for phase I.

5.14 According to the *Basic Information Survey Report on HCFCs Phase-out in ICR Industry*, the HCFCs consumption in 2008 foreign capital shares is about 1585 metric tons. It is supposed that the average industry growth for 2009 and 2010 are 3% and 5% respectively, therefore, the HCFCs consumptions for foreign capital shares in 2009 and 2010 are calculated 1633 and 1714 metric tons, the average is about 1674 metric tons.

5.15 According to the funding guidance of MLF, the non-A5 shareholding is not eligible for funding, however, the phase-out of HCFCs consumption by 10% reduction compared to its average consumption in 2009 and 2010 by non-A5 owned companies will be required and they will have to rely on its own resources. The government will initiate the consumption quota management system when it is needed. The quota system would be the main control measure to ensure the phase-out of this part. Government and association will also actively formulate incentive policies and regulations to encourage the foreign enterprise to reduce the HCFC consumption at least by 10%, so as to contribute to the phase-out target in phase I.

5.16 In addition to the phase-out by non-A5 owned companies, 55 conversion projects (including two demonstration projects which were approved at 60th ExCom meeting for implementation of MP, one is for Tsinghua Tongfang Artificial Environment Co Ltd, one is for Yantai Moon Group Co. Ltd.) are expected to be carried out in sub-sectors below, to achieve remaining reduction task in Stage-I. The phase-out tasks are distributed by sub-sector, and the phase-out priority between the sub-sectors is identified also.

Table 5-2: Phase-out task distribution by sub-sector (Stage-I)

Sub-sector	By 2013	2014-2015	Total	Sub-sector Percentage	Priority
Non-A5 owned enterprises	82	85	167	10	
Compressor2					Priority
Unitary air-conditioner	2,698	2,335	5,033	34	Key Sector
Multi-connected air-conditioner	400	400	800	73	Priority
Industrial and commercial water chiller (heat pump)	500	1,150	1,650	9	Launch
Small-sized water chiller (heat pump)	1,303	70	200	19	Launch
Heat pump water heater	100	100	200	12	Launch
Compressor condensing unit and freezer and cold storage equipment	2,504	150	400	10	Launch
Subtotal	4,078	4,205	8,283		
Total	**4,160**	**4,290**	**8,450**		

Notes:

1. The consumption amount in 2008 is adopted as the calculation basis.
2. No direct HCFC consumption in compressor.
3. According to decision 60/39, 61.9 metric tons will be phased out by Tsinghua Tongfang Artificial Co., Ltd., and it will be deducted from the starting point for sustained aggregate reductions
4. According to decision 60/40, 250 metric tons will be phased out by Yantai Moon Group Co., Ltd., and it will be deducted from the starting point for sustained aggregate reductions.

V.4 CONVERSION PROJECTS

5.17 Refrigeration compressors are the heart and the key component of refrigeration and air-conditioning equipment. The adoption of new substitute refrigerant in compressors is the basis of the conversion in other subsectors. As a result, the subsector of HCFCs refrigeration compressors should be given the priority to carry out the conversion. The compressor after conversion based on what refrigerant should be decided by the refrigerant applied in each subsector. Because small and medium-sized HCFCs refrigeration and air-conditioning equipment is the focus of the conversion for first phase I, accordingly, the compressors as a component of the small and medium sized refrigeration and air-conditioning equipment will be the focus of conversion for the compressor sub-sector. In 2011-2015, it is planned to carry out two compressor conversion programs, one conversion program of scroll refrigeration compressors from R22 to R32 (which will phase out 100,000 sets of R22 scroll refrigeration compressors in 2011-2013), one conversion program of reciprocating refrigeration compressors from R22 to R32, which will phase out 5,000 sets of R22 reciprocating compressors, by adopting of R32 second stage compressor technology in 2014-2015.

5.18 The conversion in manufacturing excluding the subsector of compressor would take three steps.

a) Firstly, actively carry out the demonstration projects on new technologies. It has launched the demo projects on conversion of HFC-32 replacing HCFC-22 in small-sized commercial air-source chiller/heat pump at Tsinghua Tongfang Artificial Environmental Co., Ltd and R22 substitution in NH3/CO2 Cascade Refrigeration System by Yantai Moon Co., Ltd. The experience accumulated from the substitution and conversion by the two enterprises will be promoted to other key enterprises.

b) Secondly, to achieve the freezing target of 2013, the overall management and implementation mechanism of the sub-sectors shall be adopted, while the phase-out capability building will be enhanced. The mechanism includes consolidated plan and management of substitution and conversion projects, implementation in batches, monitoring and coordination, etc. The unitary air-conditioner shall preferentially be the key sub-sector executing HCFCs phase-out and conversion activity from 2011 to 2013, to phase out HCFC 2,698 metric tons, accounting for 65% of the reduction for achieving the freezing target in 2013. The priority of sub-sector in implementing HCFCs phase-out activity will be given to multi-connected air-conditioner (heat pump), to phase out HCFC 400 tons, accounting for 10% of the reduction for achieving the freezing target in 2013. In the sub-sectors of small-sized water chiller (heat pump), industrial and commercial water chiller (heat pump), heat pump water heater compressor condensing unit and freezing, and refrigeration equipment, a few phase-out and conversion activities will also be initiated to enable 950 tons of HCFCs consumption reduction, in order to deliver a signal to whole industry that the phase-out activities in these four to five sub-sectors will coming soon in very near future. According to the actual situation of sub-sectors, MEP/FECO and CRAA will finally choose the conversion project from the candidate enterprise list for conversion at Stage-I in Annex-III. Those enterprises, with large amount of HCFCs consumption, good producing conditions and excellent operation status, will be selected with priority to carry out feasibility analysis and apply for conversion project from 2011 in accordance with the HPMP. On the condition of the MLF funding available on time, all of the conversion projects in these sub-sectors would be finished before 2013, which will provide support for realization of the freezing target in 2013. The phase-out of HCFCs consumption by foreign capital economic composition will rely on its own resources.

c) Thirdly, to achieve the target of 10% reduction in 2015, the overall management and implementation mechanism of the sub-sectors shall be adopted as well. The unitary air-conditioner shall preferentially be the key sub-sector executing HCFCs phase-out and conversion activity from 2014 to 2015. The priority of sub-sector in implementing HCFCs phase-out activity will be given to multi-connected air-conditioner (heat pump). Through conversion and phase-out

activities in the above two sub-sectors, 2,735 tons of HCFCs will be phased out, accounting for about 64% of the 10% reduction target of HCFCs consumption in 2015. In other sub-sectors, a few phase-out and conversion activities will also be initiated to enable 1,470 tons of HCFCs consumption reduction. Considering development of substitute in these sub-sectors, MEP/FECO and CRAA will summarize experience of conversion and phase-out activities from actions of step one and two and disseminate it to other key enterprises, further improve the overall management and implementation mechanism of the sub-sectors, adjust technical route properly and improve project implementation modality, so that the implementation of conversion and phase-out activities will be more effective. In accordance with the principle for enterprise selection to implement phase-out project, MEP/FECO and CRAA will visit and choose enterprises that will undertake conversion projects, organize the enterprises to carry out feasibility analysis, apply for and implement conversion projects. On the condition of the MLF available on time, all of the conversion projects in these sub-sectors would be finished before 2015 to realize the target of 10% HCFCs consumption reduction.

V.5 LONG-TERM STRATEGY AND SUBSEQUENT STAGES

5.19 According to the decision made by the 19th Meeting of the Parties' for Montreal Protocol held in Montreal in September 2007, phase-out target of HCFCs for article 5 countries (i.e., developing countries) would be 10% of baseline in 2015, 35% in 2020, 67.5% in 2020 and 100% in 2030. The Chinese government decided that the phase-out schedule of HCFCs in industrial and commercial refrigeration and air-conditioning sector would be in accordance with the requirements of the Meeting. As calculated in Chapter I, freezing target for ICR sector in China is 42,900 metric tons, then reduction target for each phase from 2015 to 2030 can be summarized as below in table 5-3.

Table 5-3: Reduction targets after 2015

Year	2015	2020	2025	2030
Maximum. Consumption	38,610	27,890	13,940	0
Reduction target	8,450	10,720	13,950	13,940

5.20 The subsequent stages of ICR Sector Plan will be submitted to the ExCom in 2014. Experience and lessons learned from the ICR Sector Plan (Stage-I) will be employed as a basis for development of the future stages.

5.21 The following broad actions will be carried out after 2015:

a) To ensure the phase-out activities could be carried out smoothly, the capability building for HCFC phase-out has to be strengthened:

Capability building	Objective
Long-term effective management modality, legislation and monitoring measures and coordinate mechanism	Ensure the conversion programs and technical assistance activities carried out smoothly
Standard survey, establishment and revision timely	Regulate the practice in production, transportation, installation and servicing, and product quality and safety as well.
Information collection, data survey and communication, network system establishment and operation	Facilitate to summarize the data and the consumption quota system operation in the industry
Technical exchange and seminars on experiences and lesson from HCFC phase-out in Phase I, latest refrigerant substitute and technology	Disseminate the conversion programs modality and share the experience and lessons on alternative application between similar manufacture
Technical support team, such as industry association, research institute and standard establishment organization	As a public resource in industry to provide the technical support and assistance to the manufacturer
Technical training and marketing promotion	To ensure the alternative products produced and used safely and to facilitate the alternative products accepted by the market.

b) Long-term research on substitute technology: no completely ideal substitute refrigerant for ICR industry, with zero ODP and low GWP value, safety and high energy efficiency, has been discovered globally up to now. Considering the technical development status, it's almost impossible to replace R22 completely with only one kind of refrigerant. All kinds of current known substitutes of HFCs are listed as green-house-gas with restricted emission by Kyoto Protocol, and will be limited or phased out finally due to their relatively high GWP value. Therefore, rationality of substitute refrigerant selection will have impact on the conversion progress of HCFCs in ICR sector in China. As ICR and air-conditioning sector has various kinds of product and multi-trend of technology development, such characteristic should be considered during each stage of HCFC conversion. New substitute refrigerant and technology should be explored, and research, analysis and development of potential substitute should be carried out, so that reliable evidence and support could be provided for HCFC conversion during each stage.

c) Carrying out the demonstration project and product conversion activity actively: to actively develop demonstration project for application of new substitute refrigerant and substitute technology, summarize achievement, experience and lesson from the project and disseminate to enterprises in the sector, so that HCFCs conversion under the sector could be carried out with appropriate guidance. From 2015 to 2020, great importance will be attached to HCFCs phase-out and conversion in industrial and commercial chiller (heat pump), so that the phase-out target of 35% could be realized. After 2020, HCFCs phase-out and conversion in each sub-sector would be carried out across the board in order to realize the target of completely phase-out in 2030.

d) Ban on the use of HCFC-22 in the ICR sector will be put in place in 2030.

VI. PHASE-OUT ACTIONS (STAGE-I)

6.1 According to the phase-out strategy and targets outlined in Chapter V, the ICR Sector Plan (Stage-I) will consist of a series of investment and non-investment activities. All activities will be carried out in a chronological order to ensure maximum and timely impact of all the activities. The action plan for Stage-I, which will be carried out from 2011 to early 2015 includes the following: (i) programme management mechanism, (ii) policy and regulatory measures (iii) investment activities at industrial and commercial refrigeration and air-conditioning equipment manufacturers mainly in the compressor sub-sector, two selected sub-sectors (unitary air-conditioner, multi-connected air-conditioner (heat pump)), and in parallel at another four sub-sectors for several demonstrative programs (small-sized air-conditioner (heat pump), industrial and commercial chiller (heat pump), heat pump water heater, condensing unit and freezer and cold storage) (iv) technical assistance (TA) activities.

VI.1 PROGRAMME MANAGEMENT MECHANISM

6.2 The phase-out activities of HCFCs in ICR industry of China will learn from the successful experience and lessons accumulated from the CFCs phase-out program, adopt industrial comprehensive management and implementation mechanism. The mechanism is playing at both national and sector levels, to unify the research and development of the substitute technologies, organize conversion programs in batches, control and supervise the consumption of HCFCs, and to make full use of the resources of the industry to provide technical guidance to the HCFCs substitutes and conversion. The phase-out of HCFCs should be conducted with good coordination and step by step, so as to ensure the phase-out in the industry in time.

6.3 United Nations Development Programme (UNDP) is serving as the implementing agency to supervise the general implementation of the sector plan. UNDP will report the progress and apply for future funds to the Executive Committee.

6.4 Ministry of Environmental Protection will be working as the liaison with international agencies and other parties of the Protocol and the Secretariat. MEP will also be the Leader of State Leading Group for Ozone Layer Protection, and coordinating the management of HCFCs and key events concerning the implementation of Montreal Protocol, and constituting the national HCFCs management and control plans and policies; coordinating with General Administration of Customs, Ministry of Finance, State Administration of Taxation and regional environmental protection departments, and cooperating with related organizations to constitute HCFCs phase-out policies; comprehensively supervising and managing the events and activities in related with ICR industry; and evaluating and inspecting the implementation of the programs.

6.5 National ODS Import and Export Office and General Administration of Customs are jointly responsible for constitution and implementation of the import and export policies on HCFCs substances and substances consuming HCFCs. Ministry of Finance, State Administration of Taxation, and MEP are in charge of the constitution and implementation of the taxation policies on HCFCs substances and substances consuming; listing the environmental-friendly substitutes into the government green procurement list to get tax credits. Regional environmental protection departments are to examine the implementation of national policies in local area, and to inspect the HCFCs substitution and conversion, and to make sure the success of the phase-out and effectiveness of the related policies.

6.6 China Refrigeration and Air-conditioning Industry Association is participating in the overall management and implementation of HCFCs phase-out in ICR industry; providing comprehensive technical support to the overall phase-out and conversion of the industry; raising suggestion to related policies; coordination with related organizations; compiling the program implementation guidance and organizing project application on enterprises' level; compiling program action plan; cooperating with Foreign economic Cooperation Office (FECO) of MEP and UNDP on the supervision and management to the HCFCs phase-out and conversion projects of the industry; coordination on the connection, cooperation, and progress of the implementation; collecting and gathering the consumption, phase-down volume, import and export amount, and other date related to the HCFCs in the industry; providing effective information for MEP for their better understanding of the phase-out progress and related data.

6.7 Expert Committee on HCFCs Substitute Technology for China ICR Industry is responsible for tracing on the domestic and overseas development of substitute refrigerant and technologies, organizing research and evaluation towards substitute technologies, raising suggestion on technology selection, and providing theoretical and practical basis for the government's constitution of rebated policies.

6.8 Technical Committee for National Freezing and Air-conditioning Equipment Standardization is responsible for constitution and implementation of the standards on refrigeration and air-conditioning product performance after substitution.

6.9 National Industrial Products Manufacture License Office is responsible for the implementation of manufacture licenses mechanism of the refrigeration and air-conditioning equipment. Its subsidiary, Department of Refrigeration Equipment Inspection, is in charge of revising the detailed rules for implementation of the manufacture license for refrigeration equipment in accordance with the government' s update on ODS phase-out management policies and regulations.

6.10 China Refrigeration and Air-conditioning Equipment Service and Installation Qualification Certification Office is responsible for the qualification certification and management of HCFCs substitute equipment service companies.

6.11 A Project Management Office with full responsibility to implement the ICR Sector Plan will be established. 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 request is made as part of the ICR Sector Plan (Phase I).

6.12 The PMO will be responsible for carrying out following tasks:

a) Coordination with stakeholders in the public and private sectors that are relevant to the ICR sector;

b) Preparation or review of TORs for consultancy services to support implementation, and supervision of HCFC phase-out activities;

c) Preparation, implementation, and review of the work program for the ICR Sector Plan;

d) Preparation of relevant reports as required by Implementing Agencies and the ExCom;

e) Conducting monitoring and supervising works of the consultants, undertaking services necessary for implementation of the Sector Plan;

f) Financial management to ensure effective use of the MLF resources;

g) Development and maintenance of project management information system;

h) Facilitating project supervision or evaluation as may be required by Implementing Agency and the Monitoring and Evaluation Officer of the ExCom;

i) Facilitating performance and financial audit as required by the Project;

j) 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

k) Supervision and evaluation of conversion projects with assistance from technical experts to be engaged as part of the technical assistance component.

6.13 The PMO will be staffed by technical consultants, experts, procurement and financial management officers. The PMO will be responsible for developing a Project Operation Manual, which will describe detailed procedures for project implementation, management structure, accountability of various officers and departments within FECO. The Project Operation Manual should also describe a requisite institutional framework for effective implementation and monitoring of project activities, as well as formats/templates for monitoring and reporting. Most importantly, procurement and disbursement procedures must be clearly defined in the Project Operation Manual. This manual should be available before project implementation starts.

VI.2 POLICY AND REGULATORY FRAMEWORK

6.14 Enterprises in the ICR sector face several operating challenges which limit their willingness to phase out HCFC-22 on a voluntary basis: lack of readily available and low cost alternative technologies, limited capital resources, and the need to maintain quality, market share and profitability. Even though they can receive some financial assistance from the MLF, many enterprises are still reluctant, or lack motivation, to phase out HCFCs because they prefer the familiar and cheap existing techniques, and would be averse to the uncertainties and disadvantages of changing technological processes (with potentially higher operating costs, lower product quality, or higher safety and health concerns).

6.15 The Government will therefore establish a policy structure to complement MLF funding to ensure timely phase-out of HCFC in this sector. Only by establishing and enforcing enabling policies and regulations, can it influence decisions of ICR enterprises and consumers to participate actively and quickly in HCFC phase-out in the ICR sector. While the key policy instrument for HCFCs phase-out in the ICR sector will focus on the supply side, by controlling and monitoring the production and import of HCFCs, supporting policies to discourage the demand of HCFCs are also considered to be necessary.

6.16 The objectives of the phase-out policies are to: (1) ensure that the consumption of HCFCs in the ICR sector is reduced as scheduled; (2) provide incentives for enterprises to phase-out HCFCs and adopt environmental alternative technologies; (3) encourage the propagation of low cost, technically suitable alternatives to replace HCFCs; (4) promote the development and dissemination of substitute technology; and (5) ensure that the growth of the ICR sector is not affected by the proposed phase-out targets.

6.17 The following factors are relevant for a policy framework for the ICR sector:

a) Environmental Protection Law of the People's Republic of China;

b) The law for prevention and control of air pollution issued on April 29, 2000. It is stipulated in the article 45 that, "The Chinese government encourages and supports the production and consumption of ODS substitutes, the ODS production will be gradually reduced, and eventually the ODS production and consumption will be stopped ".

c) The national Regulation on ODS Management issued in April 2010;

d) Framework of policies for ODS phase-out in the Country Program prepared in 1999;

e) The need to maintain continuity and consistency of these policies with the existing policy and regulation system;

f) Adaptable to the characteristics of ICR sector;

g) Policy feasibility and ease for supervision and management; and

h) Economic efficiency and fairness;

6.18 In order to achieve the phase-out targets in 2013 and 2015, the policies and regulations that are expected to be prepared and issued under the ICR Sector Plan are summarized below:

a) Constitute specific rules for implementation of *Ozone Depleting Substances Management Regulation*, particularly in terms of production, using, import and export of HCFC based ICR equipment;

b) Fully execute the *Circular on Strict Control on the Newly-Built Manufacturing Facilities Using HCFCs (No. [2009]121)* issued by MEP in 2009, to prevent the enlargement of production capacity of products using HCFC-22.

c) At appropriate time, establish the *Quota Management System of HCFCs Consumption in ICR sector*, to prevent the reduction transferred from the converted enterprise to those enterprises not converted and ensure the real reduction at sector level;

d) Revise *Recommendation Catalogue for ODS Substitutes* and to list the new substitute refrigerant with zero-ODP and low GWP to the catalogue in 2011.

e) Strengthen the import management of the refrigeration equipment and compressor using HCFC-22. At appropriate time, release the *Ban on the import of the refrigeration equipment and compressor using HCFC-22, as well as the manufacture facility for refrigeration and air-conditioning product using HCFC-22.*

f) Establish incentive measures to encourage the application of environmental-friendly substitute refrigerant, by constituting preferential policies on the taxation, import and export management of non-HCFCs refrigeration equipment.

g) List those products adopting environmental-friendly substitute refrigerant to the government green procurement list, to promote the utilization of those products.

h) Study on establishment of a threshold/permission-based mechanism for industrial and commercial refrigeration and air-conditioning equipments market entry, and when appropriate, issue the ban on the use of industrial and commercial refrigeration and air-conditioning equipments based on HCFCs by sub-sector/ product application/end user gradually, aiming at reduction of the population of the HCFC-based equipments, so as to encourage the manufacturer to organize their phase-out activities. A preparation period will be granted to ensure that manufacturers and consumers understand the plan and take corresponding conversion actions.

i) List the environmental-friendly substitute technologies into ***State's Industrial Technology Policies*** made by National Development and Reform Commission, to encourage the research, development, and application of those technologies.

j) According to the phase-out timetable, list those outdated products as well as the substitute technologies and products into the "Phase-out section" and "Encouraging section" of *Guiding Catalogue of Industrial Structure Regulation* respectively, so as to promote the industrial restructuring.

k) Strength examination and supervision during the implementation of production license for refrigeration and air-conditioning products.

l) Promulgate regulations and policies which are specific for enterprises with foreign ventures so that these enterprises could complete HCFCs phase-out and conversion target as scheduled.

m) Encourage local governments to formulate and issue related local policies for regional phase-out.

VI.3 INVESTMENT ACTIVITIES (STAGE-I)

6.19 According to the priority of the sub-sectors and the phase-out target in 2013 and 2015, investment activities will aim at converting 2 compressor manufacturing lines and 53 product manufacturing lines using HCFC-22 in the selected sub-sectors. The detailed conversion plan is introduced below:

a) Refrigeration Compressors

6.20 It is decided to carry out two conversion projects for compressors. One is reciprocating refrigeration compressor conversion in 2014-2015, by adopting R32 second stage compressor at small-sized low temperature refrigeration application, will phase-out 5,000 sets of R22 reciprocating refrigeration compressors. One for scroll refrigeration compressor conversion from R22 to R32 in 2011-2013, will phase out 100,000 sets of R22 scroll refrigeration compressors.

6.21 At the meantime, as for the conversion of scroll refrigeration compressors from R22 to R410A, it is planned to mobilize manufacturers of scroll refrigeration compressors to complete the conversion according to market demands.

6.22 When screw refrigeration compressors are applied at low temperature refrigeration application, in most cases, manufacturers of compressor condensing unit and refrigeration equipment also produce screw refrigeration compressors itself. As a result, the conversion of screw refrigeration compressors can be carried out along with that of compressor condensing unit. Screw refrigeration compressors are normally applied at medium and large chiller (heat pump). Since the conversion of the medium and large chiller (heat pump) will be the key works for second stage, the conversion of screw refrigeration compressor will take place accordingly then. At Stage-I, it is planned to mobilize the existing R134a screw refrigeration compressor manufacturers to increase their production output volume, so as to meet the market demand required by the conversion of screw chiller (heat pump).

b) Unitary Air-conditioners

6.23 In this sub-sector, it's planned to phase-out 5033 metric tons of HCFCs before 2015 and 580,000 sets of HCFCs equipment, to develop 25 conversion programs. Among them, 14 will adopt R32 as the substitute refrigerant and others adopt R410A.

c) Multi-connected Air-conditioning (Heat Pump) Units

6.24 In this sub-sector, it's planned to phase-out 800 tons of R22 before 2015 and 44,000 sets of R22 equipment, to develop 4 conversion programs which adopted R410A as substitute refrigerant in these four conversion programs.

d) Industrial and Commercial Water Chiller (Heat Pump)

6.25 In Industrial and Commercial Water Chiller (Heat Pump) sub-sector, it's planned to phase-out 1650 tons of HCFCs before 2015 and to develop 17 conversion programs. Among them, it is planned to carry out 8 conversion programs of adopting R410A as substitute refrigerant for water chillers (heat pump) with relatively large refrigeration and phase out 800 tons of R22; to carry out 9 conversion programs of adopting R32 as substitute refrigerant for water chillers (heat pump) with relatively small capacity systems and phase out 850 tons of R22 refrigerant.

e) Small-sized Water Chiller (Heat Pump)

6.26 In this sub-sector, it's planned to phase-out 200 tons of HCFCs before 2015 and 16,000 sets of R22 equipment, to develop 3 conversion programs which will adopt R32 as substitute refrigerant.

f) Heat Pump Water Heater

6.27 In this sub-sector, it's planned to phase-out 200 tons of R22 before 2015 and 15,000 sets of R22 heat pump water heaters, to develop 2 conversion programs. Among them, for 1 program, R32 will be adopted as the substitute refrigerant and 100 tons of R22 will be phased out; for another 1 programs, R134a will be adopted as the substitute refrigerant and 100 tons of R22 will be phased out.

g) Compressor Condensing Unit & Freezer and cold-storage

6.28 In this sub-sector, it's planned to phase-out 400 tons of HCFCs before 2015 and to develop 2 conversion programs. Among them, it's planned to carry out one conversion program in 2011-2013, to adopt NH3/CO2 as substitute refrigerant for medium and large low temperature refrigeration, and to phase-out 250 tons of R22. To carry out one conversion program in 2014-2015, to adopt R32 as substitute refrigerant for small and medium sized compressing condensing units and freeze and cold-storages and phase out 150 tons of R22.

6.29 The conversion plan is also shown in Table 6-1. The substitute technologies that would be implemented are shown in Table 6-2.

Table 6-1: Conversion Plan

Sub-sector	Substitute Refrigerant	2011—2013		2014—2015		2011—2015	
		Reduction (MT)	No. of projects	Reduction (MT)	No. of projects	Reduction (MT)	No. of projects
Refrigeration compressor	R32, two-stage, reciprocating type	-	-	*	1	*	2
	R32, scroll type	*	1	-	-		
Unitary AC	R32	1000	5	1700	9	5033	25
	R410A	1698	8	635	3		
Multi-connected Air-conditioning (Heat Pump) Units	R410A	400	2	400	2	800	4
Industrial and Commercial Water Chiller (Heat Pump)	R32	200	2	650	7	1650	17
	R410A	300	3	500	5		
Small sized water chiller (heat pump)	R32	130	2	70	1	200	3
Heat Pump Water Heater	R134a	100	1	-	-	200	2
	R32	-	-	100	1		
Compressor Condensing Unit & Freezer and cold-storage	NH3/CO2	250	1	-	-	400	2
	R32	-	-	150	1		
Total		**4160**	**25**	**4290**	**30**	**8283**	**55**

Notes:

1) There is no direct consumption of refrigerants in compressor, but compressor is the key component of different types of refrigeration and air-conditioning equipment. Without supply of the compressor based on alternative refrigerant, the conversion of correspondent equipments cannot be achieved.

2) As explained in Para. 6.22, the conversion of the screw refrigeration compressor for low temperature application will conducted with the conversion of the condensing unit and freeze & cold-storages, therefore, it is not listed separately in the table above.

Table 6-2: Substitute refrigerant adopted in conversion project for each sub-sector

Sub-sector	R32	NH3 /CO2	R410A	R134a	Total
Refrigeration compressor	2				2
Unitary AC	14		11		25
Multi-connected Air-conditioning (Heat Pump) Units			4		4
Industrial and Commercial Water Chiller (Heat Pump)	9		8		17
Small sized water chiller (heat pump)	3				3
Heat Pump Water Heater	1			1	2
Compressor Condensing Unit & Freezer and cold-storage	1	1			2
Total	30	1	23	1	55

VI.4 TECHNICAL ASSISTANCE

6.30 With variety products in ICR equipment, many manufactures are at very different technical level. The current situation is that large amount of HCFCs are consumed in ICR sector, led to very heavy phase-out task. However, the international substitution technical route is still not clear, which makes the conversion work with great risks and difficulties. In order to accomplish the phase-out target timely, while carrying out the investment activities, it's very important to develop a series of technical assistance activities, mainly including: establishment of national technical support program, establishment and revision of technical standard, establishment of industrial information network system, public awareness, etc.

a) National Technical Support Programme

6.31 In order to figure out the technical solution for long-term phase-out strategy, as well as to provide technical consulting service as per demand of project implementation in Stage-I, a multi-functional national technical support programme is expected to be launched at national level.

6.32 Under the programme, several qualified research institutes, national certified testing center, national laboratories, or universities would be selected to undertake the specific tasks according to their technical advantages, mainly in five aspects:

- Follow-up the latest progress on substitutes
- Product application design and testing
- Preliminary research on potential refrigerant
- Technical supervision and guidance to conversion project
- Technical exchange and seminar

6.33 **Follow-up the latest progress on substitutes:** to collect relevant technical information and document and follow up the latest progress of research and application on substitute and alternative refrigerant both home and abroad, summarize the information and formulate into journal, and finally disseminate the information that is helpful to promote the new alternative products to the industry and encourage the enterprise doing research and development.

6.34 **Product application design and testing:** another important purpose to launch the program is that to help those medium and small sized enterprises who are lack of research capacities to overcome the technical difficulties brought by the phase-out conversion by doing some basic research and develop on typical product redesign in conformity with the new refrigerants, so as to ensure the conversion project could be carried out smoothly in such a tight timetable. At the meantime, to facilitate the revision and formulation of the technical standard and regulation on the place, several testing of product application are required to accumulate some data and information in advance. The standard and regulation would be the technical guarantee for promoting of the new alternative based products in the market.

6.35 **Preliminary research on potential refrigerants:** Although R32, NH3, R410A and R134a are chosen as the alternative refrigerant for Stage-I, except NH3, the other three refrigerants still have GWP. Therefore, it is really necessary to enlarge the application scope of NH3, CO2 and explore the possibility to adopt HC and other unknown refrigerants in ICR: Under the program, it is designed to conduct preliminary research on the potential refrigerants and unknown refrigerant. Several testing platforms are required.

6.36 **Technical supervision and guidance to conversion projects:** because the ICR sector adopted the sector management and mechanism, a specialized technical executing agency will be selected to assist government and PMO in organizing the phase-out conversion projects and activities. The main tasks of the technical executing agency are: provide its technical suggestion in compiling of the project implementation guideline which includes the selection standard of program executive agencies, program implementation procedure, standard for program evaluation and supervision; provide the technical consulting to the manufacturer who apply for the conversion project; conduct technical evaluation; and compile the progress report for each conversion project as per the requirement of PMO.

6.37 **Technical exchange and seminar:** in order to follow up the research progress of HCFCs alternative abroad and disseminate the experiences of HCFCs substitution in the industry, a series of technical researches and exchange activities are needed, mainly including: organizing technical workshop and seminar, participating at international related seminar and academic meeting, technical supervision and guidance from developed countries and areas, etc. 1) Organizing technical workshop and seminar: call for domestic and international organizations, governments, industry associations, institutes, world famous MNCs and manufacturers to update progress on research and exchange ideas 2) Send industry experts to attend international HCFCs substitute seminar and academic meetings and workshops held by related international

institutes and national and regional organizations to learn the latest international substitute refrigerant and technology, so as to promote China's HCFCs substitution process. 3) Invite international experts from developed countries and regions to visit China, introduce and apply their successful substitution experience to the HCFCs conversion programs, guiding refrigerant substitution work.

b) Establishment of Technical Standards and Regulations

6.38 The current technical standard system of ICR industry includes standards for refrigeration and air-conditioning product, performance and product safety, as well as regulations on installation and service. All these standards apply to the refrigeration equipments adopting existing refrigerant. After adopting substitute refrigerant, the standards should be revised in conformity with the substitute products for their better marketing promotion. Meanwhile, the adoption of new refrigerant would raise higher requirement to the product design, production, transportation, installation, service and utilization of refrigeration and air-conditioners. To fulfill these demands, a series of regulations should be revised and established. The establishment and implementation of these supporting standards would regulate each section of the production and application of refrigeration and air-conditioners, prevent accidents, and speed up the promotion and application of substitute refrigerant and technologies.

6.39 The standards and regulations to be revised and established mainly include two categories: product safety standard and product application standard. The details are listed in the table below:

Table 6-3: Technical Standards and Regulations

Sr. No.	Description	Category	Qty	Status
1	Safety Requirements for Machinery Refrigeration System of Refrigeration and Heating	product safety standard	1	Revision
2	Safety Requirements for Unitary Air-conditioners	product safety standard	1	Revision
3	Safety Requirements for Positive Displacement and Centrifugal Water Chillers (Heat Pump)	product safety standard	1	Revision
4	Safety requirements for product design, production, transportation, storage, installation and servicing in conformity with alternative refrigerant	product safety standard	3	New

Sr. No.	Description	Category	Qty	Status
5	Product standard for compressors	Product application	2	Revision
6	Product standard for unitary AC	Product application	2	Revision
7	Product standard for ICR water Chiller	Product application	1	Revision
8	Product standard for small-sized air conditioner	Product application	1	Revision
9	Product standard for heat pump water heater	Product application	1	Revision
10	Product standard for multi-connected air-conditioner	Product application	1	Revision
11	Product standard for freezing and cold-storage	Product application	1	New

c) Industrial Information Network System

6.40 The establishment of effective industrial information network system is necessary to acquire the accurate update on HCFCs phase-out to fulfill the demand on data report by MEP-FECO, international organizations, and Parties of Montreal Protocol, as well as to improve the management of the phase-out. The most key function is to collect the data and information that will serve as basis for the government to make the consumption quota distribution plan each year. The information system shall provide data basis for summarizing and as the support to the next step works, and overall supervision on the implementation of HPMP as well.

6.41 The main activities for establishing industrial information network system include three components: establishing data dynamic management registration system, establishing information network reporting and database system, and utilization, maintenance and management of information network system.

6.42 *Establishing data dynamic management registration system*: based on the real situation of industrial and commercial refrigeration and air-conditioning industry, enterprises and products, and in cooperation with the implementation of MEP's policies, to set up data, information report format and requirements, establish corporate communication mechanism and make registration system of industry ODS consumption and data dynamic management.

6.43 *Establishing information network report and database system*: related data will be easily entered into the information network system and be revised in accordance with related requirements. The information network system can output data and statistics according to actual inquiry, count and analyze requirements, and generate statistic form as required.

6.44 *Utilization, maintenance, and management of information network system*: develop user operation instructions and information network system maintenance guide; hold online training classes; introduce the system and its operation steps, and communicate with users to ensure the timeliness and validity of data source; conduct effective maintenance and management of database and information network so as to ensure the normal operation of the information network system.

d) Public Awareness and Training

6.45 The publicity plan of ICR industry would be made in line with China national HCFCs phase-out publicity plan, and to widely promulgate the policies, laws and regulations, as well as phase-out management plan, concerning zone layer protection, and to raise the awareness of the related organizations and personnel on the importance of ozone layer protection, and to enhance the marketing promotion of HCFCs substitute products.

6.46 Publicity on government level: according to the mechanism of national implementation office, publicizing materials will be distributed to relevant departments; make efforts to include substitute products into national green purchase catalog and give tax preferential to substitute products, so that the government will play a leading role in promoting of HCFC substitute products.

6.47 Publicity on enterprise level: utilize all kinds of platform and resources in industry, such as association magazines, newspapers, websites, expos, marketing promotion and on-site visit to enterprises, publicize substitute products and technology, to increase enterprise's awareness on HCFCs substitute equipment and necessity and their initiative of producing HCFCs substitutes as well.

6.48 Publicity on the level of sales people, design institutes, and users: make use of various publicizing methods and activities, increase the awareness of ozone protection to sales people, design institutes and users and introduce the advantages of substitute products.

6.49 Public: increase the public awareness of ozone degeneration and ODS, and ozone protection and encourage the participation and supervision of the whole society.

6.50 The publicity targeting group, strategy and measures are summarized in the table below:

Table 6-4: Public Awareness Measures

Target group	Publicity materials	Print media	Publicity meetings	Substitution products exhibition	Professional Network media	Public Ads
Government authorities	yes		yes			
Enterprises	yes	Yes		yes	yes	
Sales people, design institutes	yes	Yes		yes	yes	yes
End-users	yes					yes

Notes:

Publicity materials: manual, poster, CD, etc.

Publicity meetings: press conference, related ceremony and event in industry;

Print media: professional journals, publication and magazine, etc.

Professional Network media: related website in industry;

Products exhibition: China Refrigeration Expo and other related international forum and exhibitions.

Public Ads: newspaper, radio and TV program, etc.

VII. INCREMENTAL COST ANALYSIS

7.1 The Stage-I phase-out costs include investment costs and non-investment costs. Investment costs include incremental capital cost (ICC) and incremental operating cost (IOC). Non-investment costs include the cost for: (i) project management mechanism, (ii) policy and regulatory measures (iii) technical assistance (TA) activities.

VII.1 INVESTMENT COSTS

a) Cost analysis for typical manufacturing line conversions

7.2 ICC for conversion projects at enterprise level in ICR sector mainly include: (1) system, component and process redesign, (2) prototype testing, (3) production line conversion, (4) prototype production trials and testing, (5) product quality inspection, finishing and testing, (6) process and safety training and (7) safety facilities modifications. IOC for conversion project at enterprise level in ICR sector is mainly for compensating the increased cost for the raw material, component and accessories after adopting new alternative technology.

7.3 To establish the typical cost estimates and analysis, the following premises and assumptions are made: (1) No technology upgrades incurred by technical conversion and substitute conversion; (2) The production capacity would not increase; (3) Price of the industrial and commercial refrigeration and air-conditioning equipments using alternative technology would not increase compared with that of the R22 product. (4) Incremental costs shall be calculated based on the prices prevailing in 2009.

7.4 Because there are many sub-sectors, and each with several types of products, the alternative refrigerant and technical route for different products are very different. Hence, only those refrigerant technologies might be widely applied are chosen for estimating of the conversion cost. One typical and representative manufacturing application is selected for each sub-sector, to consider the total cost for conversion of each line and the cost effectiveness. The cost breakdown and analysis based on ground situation is attached as Annex-IV. These costs are then converted to a US$/kg-ODS basis and are summarized by alternative technology and sub-sector as in the table below (cost for conversion of compressor production is separately shown):

Table 7-1: Incremental Cost Estimation by Technology and Sub-Sector

Sub-sector	R32		R410A		R134a		NH3/CO2	
	ICC	IOC	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	13.7	10.6	8.0	9.1	-	-	-	-
Small-sized Water Chiller/heat pump	14.0	10.9	-	-	-	-	-	-
Heat Pump Water Heater	14.2	10.8	-	-	7.6	9.6	-	-
Condensing Unit & Freezer and cold-storage	13.7	9.7	-	-	-	-	-	-

b) Actual Cost for Conversion

7.5 To achieve the freeze target in 2013 and 10% reduction target in 2015, a total of 55 conversion projects are proposed for funding, to phase-out 8,283 metric tons of HCFCs (in addition to the phase-out of 167 metric tonnes of HCFCs from non-A5 owned foreign enterprises). As mentioned in the notes to table 5-2, 311.9 metric tonnes of HCFC-22 will be deducted from 8,283 metric tons, considering two demonstration projects have been approved at 60th ExCom meeting. Therefore, 55 conversion projects for phasing out of 7,971.1 metric tonnes of HCFCs will be implemented under this sector plan.

7.6 According to the actual unit costs based ground situation and the consumption to be phased out in each sub-sector, the actual cost for conversion is US$ 185.45 million (see details in Table 7-2).

7.7 Considering that the 133 surveyed enterprises were large HCFC consuming enterprises, with robust management and well known in the industry, they are in line with the preliminary principle for selecting the candidates for implementation of the 55 projects. It follows that the candidates for above 55 conversion project will be selected from 133 surveyed enterprises and whose production lines were put into operation before 21 September 2007. According to the *Basic Information Survey Report on HCFC Phase-out in ICR Industry* and statistics by CRAA for these 133 enterprises, the HCFC consumption at joint venture companies accounted for 17%. For one scroll compressor conversion project, the foreign capital calculated based on the average ratio of three JV companies, is about 55%. For one reciprocating compressor conversion project, one domestic company would be selected.

7.8 The eligible costs after deducting the impact of non-A5 ownership are tabulated below:

Sub-sectors/Year	2011—2013	2014—2015	Total
Compressor	6.57	3.49	10.06
Other six sub-sectors	61.92	76.99	138.91
Grand total	**68.49**	**80.48**	**148.97**

Table 7-2: Actual Cost for Conversion of 55 Production Lines

No.	Sub-sector	2011—2013				2014—2015				2011—2015			
		Proposed Reductions	ICC	IOC	Sub-total	Proposed Reductions	ICC	IOC	Sub-total	Proposed Reductions	ICC	IOC	Sub-total
1	Compressor	N/A	14.60	N/A	14.60	N/A	3.49	N/A	3.49	N/A	18.09	N/A	18.09
2	Unitary air-conditioner	2,698	28.59	25.64	54.24	2,335	29.92	23.78	53.70	5,033	58.51	49.42	107.93
3	Multi-connected air-conditioner (heat pump)	400	3.56	3.40	6.96	400	3.56	3.40	6.96	800	7.12	6.80	13.92
4	Industrial & commercial water chiller (heat pump)	500	5.14	4.85	9.99	1150	12.91	11.44	24.35	1,650	18.05	16.29	34.34
5	Small-sized water chiller (heat pump)	68	0.95	0.74	1.70	70	0.98	0.76	1.74	138	1.93	1.51	3.44
6	Heat pump water heater	100	0.76	0.96	1.72	100	1.42	1.08	2.50	200	2.18	2.04	4.22
7	Condensing units, freezers & cold storage equipment	0	0.00	0.00	0.00	150	2.06	1.46	3.51	150	2.06	1.46	3.51
Total		**3,766**	**53.6**	**35.59**	**89.21**	**4,205**	**54.34**	**41.92**	**96.25**	**7,971**	**107.94**	**77.52**	**185.45**

Notes: (1) All amounts in million US dollars (2) Reductions shown are in metric tonnes (3) Incremental operating costs are calculated for one year; (4) No direct HCFC refrigerant consumption in or phase-out in refrigeration compressors; (5) As explained in Para 6.22, the conversion of the screw refrigeration compressor for low temperature application will conducted with the conversion of the condensing unit and freeze & cold-storages, accordingly, the related cost for screw compressor has been included in the cost for conversion of condensing units, freezers and cold-storage equipment.

c) Requested MLF grant funding

7.9 According to the ExCom Decision 60/44 on HCFC phase-out funding guidelines, incremental operating costs for projects in the air conditioning sub-sector will be considered at US $6.30/metric kg of HCFC consumption to be phased out at the manufacturing enterprise and in the commercial refrigeration sub-sector will be considered at US $3.80/metric kg of HCFC consumption to be phased out at the manufacturing enterprise. The adjusted cost effectiveness are summarized below:

Sub-sector	R32		R410A		R134a		NH3/CO2	
	ICC	IOC	ICC	IOC	ICC	IOC	ICC	IOC
Unitary AC	14.5	6.3	8.3	6.3	-	-	-	-
Multi-connected AC /heat pump	-	-	8.9	6.3	-	-	-	-
Industrial & Commercial Chiller/heat pump	13.7	6.3	8.0	6.3	-	-	-	-
Small-sized Water Chiller/heat pump	14.0	6.3	-	-	-	-	-	-
Heat Pump Water Heater	14.2	6.3	-	-	7.6	6.3	-	-
Condensing units, freezer and cold-storage eqpt	13.7	3.8	-	-	-	-	-	-

Note: The cost for conversion of compressor production line is made separately.

7.10 According to the cost effectiveness based on MLF guidelines and the consumption to be phased out in each sub-sector, the costs for funding conversion of 55 production lines are **US$ 157.78 million** (see details in table 7-3).

7.11 Considering the impact of non-A5 ownership and the MLF funding guidelines on cost effectiveness and IOCs, the net eligible funding request is summarized below:

Sub-sector/Years	2011—2013	2014—2015	Total
Compressor	6.57[1]	3.49	10.06
Other six sub-sectors	52.06	63.88	115.94[2]
Grand total	**58.63**	**67.37**	**126.00**

Notes:

1. National ownership of the scroll compressor enterprise is 45%

2. National ownership is average about 83% for all other six sub-sectors. The conversion cost is from the total cost (US$ 157.78 million) multiplied by the proportion of national ownership

Table 7-3: Eligible Costs for Conversion of 55 Production lines

No.	Sub-sector	2011—2013				2014—2015				2011—2015			
		Proposed Reductions	ICC	IOC	Sub-total	Proposed Reductions	ICC	IOC	Sub-total	Proposed Reductions	ICC	IOC	Total
1	Compressors	N/A	14.6	N/A	14.6	N/A	3.49	N/A	3.49	N/A	18.09	N/A	18.09
2	Unitary air-conditioner	2,698	28.59	17.00	45.59	2,335	29.92	14.71	44.63	5,033	58.51	31.71	90.22
3	Multi-connected air-conditioner (heat pump)	400	3.56	2.52	6.08	400	3.56	2.52	6.08	800	7.12	5.04	12.16
4	Industrial & commercial water chiller (heat pump)	500	5.14	3.15	8.29	1,150	12.91	7.25	20.16	1,650	18.05	10.40	28.44
5	Small-sized water chiller (heat pump)	68	0.95	0.43	1.38	70	0.98	0.44	1.42	138	1.93	0.87	2.80
6	Heat pump water heater	100	0.76	0.63	1.39	100	1.42	0.63	2.05	200	2.18	1.26	3.44
7	Condensing units, freezer & cold storage equipment	0	0.00	0.00	0.00	150	2.06	0.57	2.63	150	2.06	0.57	2.63
Total		**3,766**	**53.6**	**23.72**	**77.33**	**4,205**	**54.34**	**26.12**	**80.46**	**7,971**	**107.94**	**49.84**	**157.78**

Notes: (1) All amounts in million US dollars (2) Reductions shown are in metric tonnes (3) Incremental operating costs are calculated for one year; (4) No direct HCFC refrigerant consumption in or phase-out in refrigeration compressors; (5) As explained in Para 6.22, the conversion of the screw refrigeration compressor for low temperature application will conducted with the conversion of the condensing unit and freeze & cold-storages, accordingly, the related cost for screw compressor has been included in the cost for conversion of condensing units, freezers and cold-storage equipment.

VII.2 NON-INVESTMENT COSTS

7.12 The summary for non-investment costs is as follows (details in Annex-V):

No.	Description	Cost (US$)
1	Project implementation supervision, coordination and management	3,500,000
2	Policy and regulatory framework	480,000
3	Technical assistance:	
	(a) National Technical Support Programme	5,450,000
	(b) Technical Standards and Regulations	1,050,000
	(c) Industrial Information Network System	500,000
	(d) Public Awareness and Training	800,000
Total		**11,780,000**

OVERALL FUNDING

7.13 The overall funding request is as shown below:

No.	Description	Funding (US$)
1	Investment components	126,000,000
2	Non-investment components	11,780,000
Grand total		**137,780,000**

VIII. IMPLEMENTATION SCHEDULE AND MONITORING MILESTONES

Activity	2011				2012				2013				2014				2015				2016			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Investment Components																								
Project initiation documentation																								
Establish project management unit																								
Stakeholder consultations																								
Enterprise-level agreements																								
Technology conversions																								
Commissioning and trials																								
Phase-out in selected enterprises																								
Non-investment Components																								
Policy and regulatory framework																								
National technical support programme																								
Technical standards and regulations																								
Industrial information network system																								
Public awareness																								
Verification																								
Verification of phase-out																								

ANNEX-I
Estimation of Environment Benefits from HCFC Phase-out

1. Estimation of ozone layer protection benefits

Because of the zero ODP of adopted substitute, the ozone layer protection benefits equals the quantity of phased-out HCFCs in ODP tons, which equals the sum of the quantities of phased-out HCFCs multiplied by their respective ODP. It's formulated as follows:

$$Q_{ODP} = \sum_{i=1}^{n} M_{HCFCi} \bullet ODP_{HCFCi}$$

Where: Q_{ODP}——Quantity of phased-out HCFCs in ODP tons
M_{HCFCi}——Quantity of the i-th HCFC species being phased out in tons
ODP_{HCFCi}——ODP Value of the i-th HCFC species

It is calculated according to the above formula that ozone-depleting substances phased out during the first phase will generated an impact of 465 ODP tonnes reduction.

2. Estimation of greenhouse gas emission benefits

Direct GHG emissions

Direct GHG emissions reductions refer to the difference between greenhouse effect of the substitute and that of the replaced HCFCs. As different refrigerants have different GWP values, direct GHG emissions of a certain refrigerant equals to the amount of the refrigerant multiplied by its global warming potential (GWP). The GHG emission benefit is formulated as follows:

$$W_{GWP} = \sum_{i=1}^{n} M_{HCFC\,i} \bullet GWP_{HCFC\,i} - \sum_{i=1}^{n} M_{Non-HCFC\,i} \bullet GWP_{Non-HCFC\,i}$$

Where: W_{GWP}——Direct Greenhouse Gas emission reduction
M_{HCFCi}——Quantity of the i-th HCFC species being phased out
$M_{Non\text{-}HCFCi}$——Quantity of substitute for the i-th refrigerant
GWP_{HCFCi}——GWP Value of the i-th HCFC species phased out
$GWP_{Non\text{-}HCFCi}$——GWP Value of substitute for the i-th refrigerant

Based on the manufacturing conversion plan described in Section 5.2, it is calculated following the above formula that the direct GHG emission reduction after successful implementation of Stage-I would be 7,660,000 tons of CO2 equivalent.

Indirect GHG emissions

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 reduction of electricity consumption through the equipment lifetime and reduce indirect CO2 emissions. Since energy efficiency improvements are not the primary objective of this plan, impact of indirect GHG emissions cannot be accurately estimated at this time.

ANNEX-II

List of enterprises that completed CFC conversions

No	Name of enterprise	Project No.	Substitute	Phase-out (ODP tonnes)	Funding Approved (US$)
1	Jiangsu Xuemei Refrigeration Equipment Co., Ltd.	A-14-CIB	HCFC-22	285.00	2,797,500
2	Shanghai Refrigeration Machine Works	A-12-CIB	HCFC-22	170.00	2,710,000
3	Yantai Moon Group Co., Ltd.	A-13-CIB	R717	240.00	2,874,000
4	Zhejiang Commercial Machinery Factory	A-69-CIEC	HCFC-22	251.70	1,761,604
5	Chongqing General Industry Group Co., Ltd.	A-47-CIB	HCFC-22	190.00	1,859,531
6	Wuhan New World Refrigeration Industrial Co., Ltd.	A-51-CIB	HCFC-22	209.00	1,503,667
7	Nanjing Wuzhou Refrigeration Group Co., Ltd.	A-10-CIB	HCFC-22	255.00	2,890,000

Annex-III

Indicative List of Candidate Enterprises participating in Stage-I of the Plan

1. Compressors

(a) R22 reciprocating refrigeration compressors

No.	Enterprise name	Date of Establishment
1	Zhejiang Commercial Machinery Factory	1970
2	Nanjing Wuzhou Refrigeration Group Co., Ltd.	2003
3	Jiangsu Xuemei Refrigeration Equipment Co., Ltd.	2003

(b) R22 scroll refrigeration compressor

No.	Enterprise name	Date of establishment
1	Dalian Sanyo Compressor Co., Ltd.	1994
2	Xi'an Daikin Qing'an Compressor Co., Ltd.	1996
3	Guangzhou Hitachi Compressor Co., Ltd	2003

2. Unitary air-conditioners

No.	Enterprise name	Date of establishment
1	Gree Electric Appliances Inc. of Zhuhai	1989
2	Midea Commercial Air Conditioning Company	2000
3	Qingdao Haier Commercial Air Conditioning Company	1999
4	Ningbo AUX Electrics Co., Ltd.	2003
5	Sichuan Changhong Air Conditioner Co., Ltd.	1996
6	TCL Air Conditioner (Zhongshan) Co., Ltd.	2000
7	Nanjing Wuzhou Refrigeration Group Co., Ltd.	2003
8	Guangdong Chigo Air Conditioning Co., Ltd.	1996
9	Jiangsu Chunlan Air Conditioner Co., Ltd.	1995
10	Dezhou Yatai Group	1997
11	Guangdong Shenling Air Conditioning Equipment Co., Ltd.	2000
12	Guangdong Jirong Air-conditioning Equipment Co., Ltd.	1985
13	Guangzhou M. Universe Cooling-air Technology Development Co., Ltd.	1997
14	Wuxi Shenda Air Conditioning Equipment Co., Ltd.	1993
15	Yangzi Group Chouzhou Air Conditioner Co., Ltd.	2000
16	Zhejiang DunAn Artificial Environmental Equipment Co., Ltd.	1998
17	Qingdao Hisense Hitachi Air Conditioning System Co., Ltd.	2003
18	Hisense-Kelon Electrical Holdings Co., Ltd.	1998

2. Unitary air-conditioners (cont'd)

No.	Enterprise name	Date of establishment
19	Qingdao Aucma Whole Sets Refrigeration Equipment Co., Ltd.	2000
20	Sichuan YMK Refrigeration Equipment Co., Ltd.	2002
21	Sichuan Hope Shenlan Air Conditioner Manufacture Co., Ltd.	1997
22	Bright Air-Conditioning Co., Ltd.	2001
23	Shandong Grad-Chung-Hsin Air Conditioning Co., Ltd.	2000
24	Guangdong Siukonda Air Conditioning Co., Ltd.	1993
25	TICA (Nanjing) Air-conditioning Co., Ltd.	1999
26	Beijing GMTD Air Conditioning and Refrigeration Equipment Co., Ltd.	1999
27	Hefei Swan Refrigeration Technology Co., Ltd.	1974
28	Wuxi Tongfang Artificial Environment Co., Ltd.	2005
29	Ningbo Hicon Industry Co., Ltd.	2003
30	Wuxi Little Swan Central Air Conditioning Co., Ltd.	2000
31	Jingsu Jiangping Air Conditioning and purification Equipment Co., Ltd.	1988
32	Hangzhou Coolingstrong Air Conditioning Co., Ltd.	2002
33	Changzhou Xiwu Heating and Air Conditioning Co., Ltd.	1993
34	Zhejiang Xingxing Central Air Conditioning Equipment Co., Ltd.	2002

3. R22 multi-connected air-conditioner/heat pump

No.	Enterprise name	Date of establishment
1	Gree Electric Appliances Inc. of Zhuhai	1989
2	Midea Commercial Air Conditioning Company	2000
3	Qingdao Haier Commercial Air Conditioning Company	1999
4	TICA (Nanjing) Air-conditioning Co., Ltd.	1999
5	Guangdong Chigo Air-conditioning Co., Ltd.	1996
6	Ningbo AUX Electrics Co., Ltd.	2003
7	TCL Air Conditioner (Zhongshan) Co., Ltd.	2000
8	Qingdao Hisense Hitachi Air Conditioning System Co., Ltd.	2003

4. Industrial and commercial water chiller (heat pump)

No.	Enterprise name	Date of establishment
1	Chongqing Midea General Refrigeration Equipment Co., Ltd.	2004
2	Gree Electric Appliances Inc. of Zhuhai	1989
3	Qingdao Haier Commercial Air Conditioning Company	1999
4	Shandong Grad-Chung-Hsin Air Conditioning Co., Ltd.	2000
5	Dezhou Yatai Group	2000

4. Industrial and commercial water chiller (heat pump) - cont'd

No.	Enterprise name	Date of establishment
6	Shandong Vicot Artificial Environment Co., Ltd.	1997
7	Bright Air-Conditioning Co., Ltd.	2005
8	Zhejiang DunAn Artificial Environmental Equipment Co., Ltd.	2001
9	Guangdong Chigo Air Conditioning Co., Ltd.	1998
10	Guangdong Jirong Air-conditioning Equipment Co., Ltd.	1996
11	Guangdong Shenling Air Conditioning Equipment Co., Ltd.	1985
12	Chuzhou Yangzi Bitwise Central Air Conditioning Co., Ltd.	2000
13	HAYE(Shanghai) Refrigeration Machinery Co.,Ltd.	1998
14	TICA (Nanjing) Air-conditioning Co., Ltd.	1999
15	Ningbo AUX Electrics Co., Ltd.	2003
16	Kunshan Tecka Electrics Co., Ltd.	2003
17	Shandong Fuerda Air-conditioner Equipment Co., Ltd.	1998
18	Chongqing Jialing Refrigeration and Air Conditioning Equipment Co., Ltd.	1998
19	Wuxi Tongfang Artificial Environment Co., Ltd.	1993
20	Guangzhou M.Universe Cooling-air Technology Development Co., Ltd.	1997
21	Wuxi Shenda Air Conditioning Equipment Co., Ltd.	1993
22	Guangdong Siukonda Air Conditioning Co., Ltd.	1993
23	Hangzhou Coolingstrong Air Conditioning Co., Ltd.	2002
24	Sichuan Changhong Air Conditioner Co., Ltd.	1996
25	Sichuan YMK Refrigeration Equipment Co., Ltd.	2002
26	Zhejiang Xingxing Central Air Conditioning Equipment Co., Ltd.	2002

5. Small-sized water chillers/heat pumps

No.	Enterprise name	Date of establishment
1	Tsinghua Tongfang Artificial Environment Co., Ltd.	2000
2	Chongqing Midea General Refrigeration Equipment Co., Ltd.	2004
3	Zhejiang DunAn Artificial Environmental Equipment Co., Ltd.	1998
4	Gree Electric Appliances Inc. of Zhuhai	1989
5	Shandong Grad-Chung-Hsin Air Conditioning Co., Ltd.	2000
6	Dezhou Yatai Group	2000
7	Shandong Vicot Artificial Environment Co., Ltd.	1997

6. Heat pump water heaters

No.	Enterprise name	Date of establishment
1	Midea Commercial Air Conditioning Company	2000
2	Gree Electric Appliances Inc. of Zhuhai	1989
3	Guangzhou M.Universe Cooling-air Technology Development Co., Ltd.	1997
4	Beijing Tongfang Puri-Tech Co., Ltd.	2002
5	Zhejiang zhengli Hien Co., Ltd.	2000
6	Jiangsu Tenesun Electric Co., Ltd.	2003

7. Condensing units and cold storage/freezing equipment

No.	Enterprise name	Date of establishment
1	Yantai Moon Group Co., Ltd.	1956
2	Dalian Refrigeration Co., Ltd.	1993
3	Zhejiang Commercial Machinery Factory	1970
4	Jiangsu Xuemei Refrigeration Equipment Co., Ltd.	2003
5	Wuhan-New World refrigeration industrial CO.,LTD.	1957
6	Nanjing Wuzhou Refrigeration Group Co., Ltd.	2003

ANNEX-IV

Incremental Cost Calculations for typical manufacturing line conversions

1. Unitary Air Conditioners (HCFC-22 to R-410a or R-32)

The cost is calculated on the basis that: 1) annual production output volume is 10,000 sets of unitary air conditioners; 2) average annual HCFC-22 consumption is about 90 MT; 3) average charge amount of HCFC-22 is 9 kg.

Incremental Capital Costs

No.	Item	Costs (US$)	
		R32	R410A
1	System, component and process redesign, prototype manufacturing and testing	400,000	350,000
2	Production line conversion		
	Modification of heat exchanger tube expanding and bending machine	130,000	30,000
	Finned tube dies	120,000	0
	Pressure testing equipment	12,000	12,000
	Refrigerant charging machine	66,000	50,000
	Helium leakage detector	74,000	74,000
	Vacuum pump	20,000	20,000
3	Modification of production assembly line	80,000	50,000
4	Quality inspection, finishing and testing	65,000	30,000
5	Modification of product performance testing equipment	70,000	40,000
6	Trial production	70,000	50,000
7	Process, safety and after-sales training	50,000	40,000
8	Safety device	150,000	0
Total		**1,307,000**	**746,000**
Incremental Capital Cost (US$/kg-ODS)		**14.5**	**8.3**

Incremental Operating Costs

No.	Item	Costs/unit (US$)	
		R32	R410A
1	Material cost		
	Compressor	+70	+50
	Compressor oil	+8	+9
	Electrical safety devices	+24	0
	Evaporator and condenser	-14	-14
	Pipes and accessories	+5	+5
	Refrigerant	-2.2	+25.3
2	Labor cost	+5.5	+4
Total		**96.3**	**79.3**
Incremental Operating Costs (US$/kg-ODS)		**10.7**	**8.8**

2. Multi-connected Air Conditioners (from HCFC-22 to R-410A)

The cost is calculated on the basis that: 1) annual production output volume is 5,500 sets of multi-connected AC; 2) average annual HCFC-22 consumption is about 100 MT; 3) average charging amount of HCFC-22 is 18.2 kg.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	420,000
2	Production line conversion	
	Modification of heat exchanger tube expanding and bending machine	30,000
	Finned tube dies	0
	Pressure testing equipment	12,000
	Refrigerant charging machine	50,000
	Helium leakage detector	74,000
	Vacuum pump	20,000
3	Modification of production assembly line	70,000
4	Quality inspection, finishing and testing	40,000
5	Modification of product performance testing equipment	60,000
6	Trial production	65,000
7	Process, safety and after-sales training	50,000
8	Safety devices	0
Total		**891,000**
Incremental Capital Cost (US$/kg-ODS)		**8.9**

Incremental Operating Costs

No.	Item	Costs/unit (US$)
1	Material cost	
	Compressor	+91
	Compressor oil	+18
	Electrical safety devices	0
	Evaporator and condenser	-24
	Pipes and accessories	+10
	Refrigerant	+51.2
2	Labor cost	+8
Total		**154.2**
Incremental Operating Costs (US$/kg-ODS)		**8.5**

3. Industrial and Commercial Water Chillers/Heat pumps

A. From HCFC-22 to R-32

The cost is calculated on the basis that: 1) annual production output volume is 3,500 sets of scroll industrial and commercial water Chiller (Heat pump); 2) average annual HCFC-22 consumption is about 85 MT; 3) average charging amount of HCFC-22 is 24.3 kg.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	310,000
2	Production line conversion	
	Modification of heat exchanger tube expanding and bending machine	130,000
	Finned tube dies	120,000
	Pressure testing equipment	12,000
	Refrigerant charging machine	66,000
	Helium leakage detector	74,000
	Vacuum pump	20,000
3	Modification of production assembly line	70,000
4	Quality inspection, finishing and testing	60,000
5	Modification of product performance testing equipment	55,000
6	Trial production	55,000
7	Process, safety and after-sales training	45,000
8	Safety devices	150,000
Total		**1,167,000**
Incremental Capital Cost (US$/kg-ODS)		**13.7**

Incremental Operating Costs

No.	Item	Costs/unit (US$)
1	Material cost	
	Compressor	+195
	Compressor oil	+18
	Electrical safety devices	+55
	Evaporator and condenser	-27
	Pipes and accessories	+13
	Refrigerant	-5.8
2	Labor cost	+10
Total		**258.2**
Incremental Operating Costs (US$/kg-ODS)		**10.6**

3. Industrial and Commercial Water Chillers/Heat pumps (Cont'd)

B. From HCFC-22 to R-410A

The cost is calculated on the basis that: 1) annual production output volume is 2,400 sets of scroll industrial and commercial water chiller (Heat pump); 2) average annual HCFC-22 consumption is about 85 MT; 3) average charging amount of HCFC-22 is 35.4 kg.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	280,000
2	Production line conversion	
	Modification of heat exchanger tube expanding and bending machine	30,000
	Finned tube dies	0
	Pressure testing equipment	12,000
	Refrigerant charging machine	50,000
	Helium leakage detector	74,000
	Vacuum pump	20,000
3	Modification of production assembly line	55,000
4	Quality inspection, finishing and testing	30,000
5	Modification of product performance testing equipment	35,000
6	Trial production	55,000
7	Process, safety and after-sales training	40,000
8	Safety devices	0
Total		**681,000**
Incremental Capital Cost (US$/kg-ODS)		**8.0**

Incremental Operating Costs

No.	Item	Costs/unit (US$)
1	Material cost	
	Compressor	+201
	Compressor oil	+36
	Electrical safety devices	0
	Evaporator and condenser	-43
	Pipes and accessories	+20
	Refrigerant	+99.5
2	Labor cost	+8
Total		**321.5**
Incremental Operating Costs (US$/kg-ODS)		**9.1**

4. Small-sized water chillers/heat pumps (HCFC-22 to R-32)

The cost is calculated on the basis that: 1) annual production output volume is 65,000 sets of small-sized water chiller; 2) average annual HCFC-22 consumption is about 80 MT; 3) average charging amount of HCFC-22 is 12.3 kg.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	300,000
2	Production line conversion	
	Modification of heat exchanger tube expanding and bending machine	130,000
	Finned tube dies	120,000
	Pressure testing equipment	12,000
	Refrigerant charging machine	66,000
	Helium leakage detector	74,000
	Vacuum pump	20,000
3	Modification of production assembly line	65,000
4	Quality inspection, finishing and testing	55,000
5	Modification of product performance testing equipment	50,000
6	Trial production	40,000
7	Process, safety and after-sales training	40,000
8	Safety devices	150,000
Total		**1,122,000**
Incremental Capital Cost (US$/kg-ODS)		**14.0**

Incremental Operating Costs

No.	Item	Costs/unit (US$)
1	Material cost	
	Compressor	+98
	Compressor oil	+11
	Electrical safety devices	+30
	Evaporator and condenser	-15
	Pipes and accessories	+7
	Refrigerant	-3
2	Labor cost	+6
Total		**134**
Incremental Operating Costs (US$/kg-ODS)		**10.9**

5. Heat pump water heaters (from HCFC-22 to R-134a)

The cost is calculated on the basis that: 1) annual production output volume is 5,000 sets of heat pump water heater; 2) average annual HCFC-22 consumption is about 75 MT; 3) average charging amount of HCFC-22 is 15 kg.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	250,000
2	Production line conversion	
	Modification of heat exchanger tube expanding and bending machine	0
	Finned tube dies	0
	Pressure testing equipment	12,000
	Refrigerant charging machine	50,000
	Helium leakage detector	74,000
	Vacuum pump	20,000
3	Modification of production assembly line	45,000
4	Quality inspection, finishing and testing	25,000
5	Modification of product performance testing equipment	30,000
6	Trial production	35,000
7	Process, safety and after-sales training	35,000
8	Safety devices	0
Total		**571,000**
Incremental Capital Cost (US$/kg-ODS)		**7.6**

Incremental Operating Costs

No.	Item	Costs/unit (US$)
1	Material cost	
	Compressor	+69
	Compressor oil	+15
	Electrical safety devices	0
	Evaporator and condenser	0
	Pipes and accessories	+2
	Refrigerant	+54.9
2	Labor cost	+3
Total		**143.9**
Incremental Operating Costs (US$/kg-ODS)		**9.6**

6. Compressor Condensing Units (From HCFC-22 to R-32)

The cost is calculated on the basis that: 1) annual production output volume is 8,000 sets of compressor condensing unit; 2) average annual HCFC-22 consumption is about 95 MT; 3) average charging amount of HCFC-22 is 11.9 kg.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	420,000
2	Production line conversion	
	Modification of heat exchanger tube expanding and bending machine	130,000
	Finned tube dies	120,000
	Pressure testing equipment	12,000
	Refrigerant charging machine	66,000
	Helium leakage detector	74,000
	Vacuum pump	20,000
3	Modification of production assembly line	80,000
4	Quality inspection, finishing and testing	50,000
5	Modification of product performance testing equipment	60,000
6	Trial production	70,000
7	Process, safety and after-sales training	50,000
8	Safety devices	150,000
Total		**1,302,000**
Incremental Capital Cost (US$/kg-ODS)		13.7

Incremental Operating Costs

No.	Item	Costs/unit (US$)
1	Material cost	
	Compressor	+89
	Compressor oil	+10
	Electrical safety devices	+20
	Condenser	-9
	Pipes and accessories	+3
	Refrigerant	-3
2	Labor cost	-2.9
Total		115.1
Incremental Operating Costs (US$/kg-ODS)		9.7

7. Compressors

A. Scroll Compressors (HCFC-22 to R-32)

The cost is calculated on the basis that the annual production output is 100,000 sets of scroll compressors.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	2,200,000
2	Production line conversion	
	Motor processing equipment	1,900,000
	Body/Shell processing equipment	1,320,000
	Scroll disk processing equipment	3,340,000
	Crankshaft processing equipment	550,000
	Upper and lower supporter processing equipment	260,000
	Oldham ring (crossing) processing equipment	350,000
3	Modification of production assembly line	1,580,000
4	Quality inspection, finishing and testing	
	Helium leak detection system (vacuum chamber air tightness test)	480,000
	Test drive	530,000
	Pressure testing equipment	50,000
	Destructive testing equipment	30,000
	Noise testing equipment	160,000
	Endurance testing equipment	320,000
	Electrical testing equipment	180,000
5	Modification of product performance testing equipment	640,000
6	Trial production	200,000
7	Process, safety and after-sales training	250,000
8	Safety devices	260,000
Total		**14,600,000**

7. Compressors (Cont'd)

B. Low-temperature Reciprocating Compressors (HCFC-22 to R-32)

The cost is calculated on the basis that: annual production output is 5,000 sets of reciprocating compressors for low-temperature applications.

Incremental Capital Costs

No.	Item	Costs (US$)
1	System, component and process redesign, prototype manufacturing and testing	640,000
2	Production line conversion	
	Body/Shell processing equipment	600,000
	Valve plate processing equipment	250,000
	Crankshaft processing equipment	60,000
	Connecting rod processing equipment	100,000
	Cutter	180,000
	Fixtures	50,000
	Dies	190,000
3	Modification of production assembly line	
	Tooling	80,000
	Motor assembly equipment	120,000
	Degreasing equipment	180,000
	Online testing	50,000
4	Quality inspection, finishing and testing	
	Helium leak detection system (vacuum chamber air tightness test)	240,000
	Pressure testing equipment	50,000
	Destructive testing equipment	30,000
	Trial runs for testing	70,000
	Electrical testing equipment	60,000
5	Modification of product performance testing equipment	320,000
6	Trial production	50,000
7	Process, safety and after-sales training	80,000
8	Safety devices	90,000
Total		**3,490,000**

ANNEX-V

Non-Investment Cost Calculations

A. Project Implementation, Supervision, Coordination and Management

No.	Description		Unit Costs	Total (US$)
1	Personnel	Program officers (8 persons)	US$ 25,000/ person, 5 years	1,000,000
		Program assistants (5 persons)	US$ 20,000/ person, 5 years	500,000
2	Travel	Enterprise plant visits and related travel	US$ 800/visit (two days)/person; total 125 visits US$ 100,000/year for 5 years	500,000
3	Coordination	Coordinating with relevant departments and authorities for project implementation.	US$ 50,000/year, 5years	250,000
4	Training	Project management and other training	US$ 50,000/year, 5years	250,000
5	Project completion and acceptance	Documentation, travel and meeting for project completion	US$ 50,000/year, 5years	250,000
6	Verification	Technical verification	US$ 100,000/year 5years	500,000
7	Miscellaneous	Contingencies	US$ 50,000/year, 5years	250,000
Total				**3,500,000**

Non-Investment Cost Calculations (Cont'd)

B. Project Policy and Regulatory Framework

No.	Description		Remarks	Total (US$)
1	HCFC consumption quota management system	Desk review and survey	Travel and experts' fees	50,000
		Stakeholder consultations	Four meetings US$ 20,000 each	80,000
		Development of regulations	Expert fees	50,000
2	Establishment of incentive measures	Feasibility study	Expert fees, travel	70,000
		Stakeholder consultations	Four meetings at US$ 20,000 each	80,000
3	Regulations for prohibition on HCFC-based equipment Manufacturing (preliminary work)	Planning, desk review, research and survey	Expert fee, travel	20,000
		Stakeholder consultations	One meeting	30,000
4	Certification and labeling system	Research, desk review and survey	Expert fees, travel	20,000
		Stakeholder consultations	Two meetings at US$ 20,000 each	40,000
		Feasibility study report	Expert fees, travel	40,000
Total				**480,000**

Non-Investment Cost Calculations (Cont'd)

C. Technical Assistance

National Technical Support Programme

No.	Content	Description	Remarks	Amount (US$)
1	Information collection and desk survey	Collect technical information and document and follow up on progress of research and application on substitute and alternative refrigerant both home and abroad, and formulate journal and disseminate to the industry	50,000$/year, 5years	250,000
2	Basic research on product application design	Research on the alternative refrigerants chosen for phase I and organize the product adoptive redesign (general), so as to disseminate the new technology to the industry, particularly to those enterprise lack of research capacity	150,000$ for each sub-sector	1,050,000
3	Product application testing	Organize the product application testing, provide reference to the enterprise for developing their own product serial and technical authorities which are in charge of formulation and approval of standard/regulation.	100,000$ for each standard, totally 15	1,500,000
4	Preliminary research on potential refrigerant	Research on the potential refrigerants, such as HC, CO2, and other emerging substitutes, the main works include: safety testing, thermophysical properties testing, performance testing, and preliminary evaluation of its product application.		500,000
5	Modification/ Building-up the testing platform	New safety testing platform (R32 & HC)		700,000
		Compressor performance testing platform		200,000
		Heat exchanger testing platform		100,000
		Assembled equipment testing platform		200,000
6	Technical exchange and seminar	Organize the international exchange and seminar	50,000/year	250,000
		Study tour and participate in the international forum and seminar	20,000/year	100,000
		International expert	20,000/year	100,000
7	Technical training	Formulation of training material,		50,000
		Organize training on national policies, technical standard/regulation, product redesign, technical solution for production and transportation of the equipment based on new alternative refrigerants.	50,000$ each year	250,000
8	Technical assistance and guidance	Conduct technical review on implementation of conversion projects as per PMO's requirement and provide technical support.	40000$ each year	200,000
Total				**5,450,000**

Non-Investment Cost Calculations (Cont'd)

C. Technical Assistance (cont'd)

Technical Standards and Regulations

No.	Description		Remarks	Total (US$)
1	Desk review and survey	Technical collection and analysis and on-site visits		5,000
2	Stakeholder Meeting	Participated by at least 50 representatives		20,000
3	Preparation of draft technical standard/regulation		Expert fee for preparing the draft	5,000
4	Preparation working group meeting	normally, 2 meeting (10 person) will be required for each standard/regulation;	including meeting room fee, travel, accommodation and consulting fee	10,000
5	Review and evaluation meeting	One meeting, participated by the standard committee member (40 persons), to evaluate the draft standard	including meeting room fee, travel, accommodation and consulting fee	30,000
Sub-total (per technical standard/regulation)				**70,000**
Total (for 15 technical standards/regulations)				**1,050,000**

Non-Investment Cost Calculations (Cont'd)

C. Technical Assistance (cont'd)

Industrial Information Network System

No.	Description		Remarks	Total (US$)
1	Establishing dynamic data reporting and management system	Desk review and research	Expert fee, travel	50,000
		Developing information formats, and logic matrix	Expert fee, travel	50,000
		Stakeholder consultation	Three meetings at US$ 20,000 each	60,000
2	Establishing information network system	Development of software	Expert fee	60,000
		Stakeholder consultation and training	Three meetings at US$ 20,000 each	60,000
3	Management and maintenance of network system	Annual costs for operating and maintaining the system	Hardware costs	20,000
			Overheads at US$ 40,000/year	200,000
Total				**500,000**

Non-Investment Cost Calculations (Cont'd)

C. Technical Assistance (cont'd)

Public Awareness

No.	Content	Description	Remarks	Total (US$)
1	Training meeting	Training courses on national policies, project implementation requirement to conversion enterprise	US$ 25,000 each, 2 training courses each year, total 10 for 5 years	250,000
2	Marketing Publicity program	Marketing promotion to the salespeople, design institute, end-users	US$ 25,000 each, 1 event each year , total 5 for 5 years	125,000
3	Substitution products exhibition	Organize workshop at the exhibition and provide assistance to the enterprise for displaying their new products	US$ 25,000 each, 1 event each year , totally 5 for 5 years	125,000
4	Publicity materials	Manual, poster, CD, etc.	50,000 for manual 30,000 for poster 40,000 for CDs	120,000
5	Print media	Public Ads on magazine and newspaper in industry		100,000
6	Network media	Introduce the research progress of HCFC alternatives		80,000
Total				**800,000**