Award 63444
8051

United Nations Development Programme

Country: China

Project Document

Project Title	Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd.
UNDAF Outcome(s):	Government and other stakeholders ensure environmental suitability, address climate change, and promote a green, low carbon economy.
Expected CP Outcome(s):	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):	To provide an environmentally safe and cost-effective alternative for enabling replication of this technology in similar applications and enterprises in the XPS Foam Sector in China contributing to the viability of a large number of enterprises in this sector, and result in reductions in HCFC consumption of 12.3 ODP tonnes.
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, the Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd. (CPR/FOA/64/DEM/507) was approved by the Executive Committee with UNDP as the implementing agency. Total approved funding from MLF was US $ 1,973,300. This demonstration project, upon successful completion, will establish the suitability of CO_2 with methyl formate co-blowing technology as a viable replacement to HCFC-22/HCFC-142b technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd. The project will provide an environmentally safe and cost-effective alternative for enabling replication of this technology in similar applications and enterprises in the XPS Foam Sector in China contributing to the viability of a large number of enterprises in this sector, and result in reductions in HCFC consumption of 12.3 ODP tonnes, contributing to compliance with the 2013/2015 control targets. It will also lead to net annual emission reductions of 420,250 tonnes CO2-eq.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 – 2013**	Total resources required	1,973,300US$
Key Result Area (Strategic Plan):		Total allocated resources:	
		• Regular	
Atlas Award ID:		• Other:	
		o MLF	1,973,300US$
Start date:	1 December 2011		
End Date	31 May 2013		
Management Arrangements	NEX	In-kind Contributions	-

Agreed by FECO/MEP: _____

Agreed by UNDP: Napoleon Navarro

LIST OF ABBREVIATIONS

CFC Chloro Fluoro Carbons
HCFC Hydro Chloro Fluoro Carbons
CP Country Programme
ExCom Executive Committee of the Multilateral Fund
FECO Foreign Economic Cooperation Office
GWP Global Warming Potential
HCFCs Hydrochlorofluorocarbons
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
XPS Extruded Polystyrene

I. SITUATION ANALYSIS

1. OBJECTIVE

The objective of this project is to assist Government of China implement the "Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd." (hereinafter XPS Demonstration project)

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.

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 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 is involved with 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.

XPS Demonstration Project

The XPS Foam Sector in China has experienced remarkable growth in the past several years. The 2009 estimated HCFC consumption in the sector was about 41,000 metric tonnes. Based on information from surveys, there are about 20 indigenous manufacturers of XPS extrusion lines and an estimated 500 manufacturers of XPS foam in the sector.

Another defining characteristic of this sector is that most of the polystyrene raw material used in XPS foam manufacturing originates from recycled polystyrene scrap of unknown composition and contaminants. Recent zero-ODP XPS foam technologies introduced by multinational corporations are expensive and have been closely guarded in terms of intellectual property. Due to this, these technologies are not cost-effectively accessible for most of XPS foam enterprises of China and may not be compatible to operate with a high proportion of recycled polystyrene scrap. It would be a challenge for the Chinese XPS industry. There is thus, a clear and present need for a cost-effective and environmentally safe technology alternative for the XPS foam sector of China, in order to remain sustainable and maintain product quality.

To work out a cost-effective and sustainable alternatives to HCFC-22/HCFC-142b technology that could be implementable in the large number of predominantly SMEs in the XPS foam sector, the XPS Demonstration project was prepared and submitted for the consideration of the 62nd Meeting of the Executive Committee after due review and endorsement by the Government. The Executive Committee approved the XPS Demonstration project in 64th meeting in July 2011 at a funding level of US $ 1,973,300. The agreement between the ExCom and Government of China indicated the XPS Demonstration project aims to phase out 12.3 ODP tons upon its completion.

II. STRATEGY FOR XP SDEMONSTRATION PROJECT IMPLEMENTATION

The XPS Demonstration project is designed for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd (hereinafter Feininger). Feininger is recognized as one of the leading companies in the XPS industry in China with excellent management and high quality products. Feininger has obtained the Class-A Tax Credit Certification Award promulgated by the Internal Revenue Service and the Local Taxation Bureau of Nanjing, Jiangsu. It has also obtained ISO 9000, ISO 14001 and CE certifications. The enterprise has been engaged in research and development in XPS foams, XPS manufacturing machinery and auxiliary equipment such as XPS recycling machines,

for several years.The detailed procedure of conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology at Feininger has been explained in the Annex III. The following plant and process changes will be needed for implementing the conversion:

- One high-pressure CO_2 metering system
- Two high-pressure metering systems for methyl formate and the third blowing component
- Real time feedback and adjust mixer with high efficiency and accurate flow control for the three blowing agents.
- Primary high-intensity 150 mm (38:1) mixing screw package
- Primary mixing screw barrel
- Secondary 200 mm (34:1) cooling screw package
- Secondary cooling screw barrel
- Extrusion die
- High pressure hydraulic screen exchanger
- Static mixer
- Control system
- Explosion-proofing
- Ventilation and fire safety systems

III. TIME FRAME/MONITORING MILESTONES

Overall time plan for implementation of the project during the 18 months is given in the table below:

Table 1

MILESTONE/MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Start-up of project activities	X														
Project document for signature	X	X													
Project Contract to be signed with enterprise		X	X												
Retrofit to Extruder			X	X	X	X	X	X							
Blowing agent supply system					X	X	X	X	X	X	X	X			
Ventilation and fire safety system			X			X	X	X							
Trial runs											X	X	X	X	
Training and technical assistance												X	X	X	
Assessment and verification														X	X

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:** Increased awareness among enterprises, especially SMEs, about corporate social responsibility and green work practices and technologies			
ATLAS Award ID:	00063444			
ATLAS Project ID:	00080517			
Intended Outputs	**Output Targets for 2011 to 2013**	**Indicative activities**	**Responsible Parties**	**Inputs (US $ 000)**
Output: To establish the suitability of CO2 with methyl formate co-blowing technology as a viable replacement to HCFC-22/HCFC-142b technology in XPS Foam Sector and to reduce 12.3 ODP tones of HCFC. **Baseline:** The HCFC consumption during 2010 at Feininger was 205metric tonnes (12.3 ODP tonnes). **Indicator:** Successful completion of the conversion for HCFC-22/HCFC-142b and meeting the reduction target of 12.3 ODP tonnes.	**Targets : 2011** Project Document signed. **Targets : 2012** - Contract with Feininger signed. - - Completion of equipment installation. - Implementation of using CO_2 with methyl formate co-blowing technology in one production line. **Targets : 2013** - Completion of conversion from HCFC-22/HCFC-142b based technology in one production line at Feininger. - Completion of performance verification. - Meeting the HCFC reduction target of 12.3 ODP tons.	**Technical Assistance and supporting implementation** - Technology transfer from external process expert - Process trials - Product evaluation and certification - Process and safety training - External safety audit - Performance verification and Technical assessment	FECO/MEP UNDP	243,665
		Implementation of Conversion - Signing Contract between FECO/MEP and Feininger - Complete the conversion plan - Equipment delivery and installation - Commissioning and trial runs	FECO/MEP	1,442,635
		Converted systems running - Procurement of new materials - Running and Maintenance	FECO/MEP	287,000
		Grand total		**1,973,300**

V. ANNUAL WORK PLAN

The table below presents the annual budget allocation during the project life cycle from 2011 to 2013.

Table 3

AWARD ID	00063444						
PROJECT ID	00080517						
Project Title	Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd.						
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**
Activity 1 : Technical Assistance and supporting implementation	FECO/MEP	63080	72100	Contractual Services	112,833	112,832	
	UNDP	63080	75100	Implementation supervision and support	18,000	0	
Activity 2 : Implementation of Conversion	FECO/MEP	63080	72100	Contractual Services	721,317	721,318	
Activity 3: Converted system running	FECO/MEP	63080	72100	Contractual Services			287,000
	Subtotal				852,150	834,150	**287,000**
	Total						**1,973,300**

VI. MANAGEMENT ARRANGEMENT

6.1 Implementation Modality

The agreement between the Chinese government and the ExCom will serve as the framework within which the XPS Demonstration project 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 National Coordination project as discussed in this ProDoc.

Under the PBP mechanism, the enterprise tasked to carry out the conversion would play the role as a key executer, which is responsible for all the activities related to the conversion (with supervision

of the technical expertise team hired by FECO and/or UNDP), including but not limited to: product redesign, procurement of raw material, components, equipments and consulting services as per the budget allocation table, modification of production line and product testing devices, etc., trial operation of production line. The procurement shall be organized fully in line with the marketing principle and related laws and rules in China, so that the goods and services procured are high quality, most reasonable price and suitable for product line conversion through a fair, transparent and justified procedure, to make sure the new alternative technology applied feasibly and successfully. The detailed arrangement/requirement on procurement will be defined in the contract between FECO/MEP and the Executor (enterprises).

6.2 Roles and responsibilities

UNDP is serving as the implementing agency to supervise the implementation of the XPS Demonstration project, specifically including the following:

- Providing assistance to ensure the smooth implementation through close coordination with FECO/MEP;
- Providing assistance on technical monitoring at Feininger, when required;
- Ensuring the submission of periodic implementation plans and reports to MLF accurately and on time;
- Monitoring the progress and carrying out supervision mission;
- Ensuring the Fund disbursed in accordance with the guidelines of the ExCom;
- Reporting the technical assessment to the ExCom.

FECO/MEP will be responsible for the overall implementation, coordination and management of the XPS Demonstration project, specifically including the following:

- Coordinating with Feininger to finalize the conversion plan;
- Ensuring the smooth implementation of conversion;
- Conducting technical monitoring to ensure the selected alternative technology has been appropriately applied;
- Facilitating performance verification and financial audit as required;
- Preparing the implementation plan and progress reports as per provision of the agreement between the Chinese government and the ExCom; and requirement from UNDP;
- Implementing, supervising and monitoring the conversion activities to ensure meeting the reduction target.

Feininger is the beneficiary company in this project. The company's roles and responsibilities will be fully defined in the contract with FECO/MEP.

6.3 Payment Schedule and Indicators

Payment Schedule for XPS Demonstration Project

Table 4

Payment Date (Indicative)	**Disbursement (US$)**	**Indicators/Milestones**
First disbursement No later than 15 Dec 2011	834,150	- Project Document is finalized and signed between FECO/MEP and UNDP.
Second disbursement No later than 30 Sep 2012	834,150	- Completion of equipment installation; -
Third disbursement No later than 31 May 2013	287,000	- Completion of Performance Verification and Technical Assessment
	1,955,300	

VII. MONITORING FRAMEWORK AND EVALUATION

7.1 Monitoring & Verification

The activities of Monitoring & Verification include the following:

a) Performance Verification:

Before each payment, FECO will invite independent experts to verify whether the set milestones related to the payments have been met satisfactory. The verification reports will be submitted to UNDP as the main supporting documents for the respective payment requests. The verification must be accepted by UNDP before any project payments.

The Performance Verification shall establish:

- If the target of HCFC 22/HFCF-142-b phase out which is defined in the project approved by the ExCom has been achieved.
- If Feininger has completed the conversion as planned.
- If the alternative technology has been applied in Feininger as agreed.
- If the technical assistance has been appropriately conducted and obtained achievements by Feininger which are defined in the conversion plan.

b) Technical Assessment

Before the last instalment of payment, FECO and UNDP will invite independent experts to verify whether the selection and application of alternatives in practice are suitable and feasible. The assessment report will be submitted to FECO and UNDP.

c) Financial Audit:

NEX Audit will be organized by UNDP during the project implementation upon UNDP's audit arrangement in the project years. For any issue identified during the auditing process, FECO shall take corresponding correction/improvement measures as per the audit findings and recommendation. Meanwhile, the payment will be suspended depending on the nature of the issues concerned until the acceptable/satisfactory results are worked out.

The financial audit aims to verify:

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

d) Review Meetings, reports, missions

Quarterly Review and Annual Review Meeting will be organized by FECO and participated by the company if necessary.

Quarterly/Semi-annual Project Review Reports and a final Project Report will be submitted to UNDP at least 10 days before the review meetings and by the end of project operation by 2013.

FECO and UNDP will organize a joint Monitoring and Evaluation mission to the Project executer during this project operation. The mission can be combined with the verification mission accordingly. The M&E schedule will basically follow the timeline of payment schedule.

e) Documents record.

A copy of the signed contract between FECO/MEP and the project executor (Company) shall be filed for record at UNDP CO.

7.2 Quality Management for Project Activity Results

OUTCOME: To provide an environmentally safe and cost-effective alternative for enabling replication of this technology in similar applications and enterprises in the XPS Foam Sector in China contributing to the viability of a large number of enterprises in this sector, and result in reductions in HCFC consumption of 12.3 ODP tones.		
Output: The following outputs/activities contribute to achieving the outcome above. • The conversion is designed, planned, monitored and reported correctly and timely. • The conversion is implemented and completed as planned. • The converted system is commercial running with alternative technology and HCFC phase out amount verified.		
Result 1	**The conversion is designed, planned, monitored and reported correctly and timely.**	Start Date: 1 Dec 2011 End Date: 31 May2013
Purpose	Ensuring the smooth and successful conversion implementation.	
Description	• Prepare the implementation plan. • Finalize of Project Document. • Provide technical assistance as needed during the project implementation.	
Quality Criteria	**Quality Method**	**Date of Assessment**
Implementation plan and the deliverables under TA contracts are submitted on time.	Deliverables of TA contracts and monitoring and reporting conducted on time.	After each contract, No later than 31 May 2013
Result 2	**The conversion is implemented and completed as planned.**	Start Date: 1 Jan 2012 End Date: 31Mar 2013
Purpose	Ensuring the accurate and timely conversion implementation as planned.	
Description	• Finalize conversion plan; • Complete of commissioning and trial runs; • Complete equipment installment; • Achieve HCFC 22/HFCF-142b phase-out as defined in the project approved by the ExCom.	
Quality Criteria	**Quality Method**	**Date of Assessment**
Contract between FECO/MEP and Feininger signed	Conversion contract	1 Mar 2012
Conversion plan developed	Conversion plan	31 Mar 2012
Equipment installed	Verification report	31 Dec 2012
Trial run of production line	Verification report	31 Dec 2012
Result 3	**The converted systems is running with feasible technology and verified HCFC phase out amount**	Start Date: 1 Jan 2013 End Date: 31May 2013
Purpose	Successfully demonstrating CO_2 with methyl formate co-blowing technology for phasing out HCFC 22/HFCF-142b at Feininger.	
Description	• Verify running and production processes. • undertake and approve a technical assessment report and establishment of the suitability of CO2 with methyl formate co-blowing technology as a viable replacement to HCFC	

	22/HFCF-142b technology in XPS Foam Sector	
Quality Criteria	**Quality Method**	**Date of Assessment**
Conversion Performance Verification	Performance verification report	31 May 2013
Technical feasibility Assessment	Technical assessment report	31 May 2013

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: Final version of XPS Demonstration Project Document approved by the 64th Excom

ANNEX- III: Incremental Capital Costs

ANNEX- IV: Incremental Operating Costs

ANNEX-I

RISK ANALYSIS

Description	Date identified	Type	Impact and Probablity (Low 1 to High 5)	Counter Measures	Owner
Delay in completion of project deliverables such as conversion plan, progress report and verification report to MLF etc.	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 commissioning and trial runs.	Project initiation date	Operational	Probability - 3 : Impact - 4	Consultation with specialist technical experts on technical options, closely monitoring technical developments.	FECO/MEP UNDP

ANNEX-II

Final version of XPS Demonstration Project Document approved by the 64th Excom

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

PROJECT COVER SHEET

COUNTRY: CHINA

PROJECT TITLE:	**IMPLEMENTING AGENCY:**
Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd.	UNDP

NATIONAL COORDINATING AGENCY: Foreign Economic Cooperation Office, Ministry of Environment Protection

LATEST REPORTED CONSUMPTON DATA FOR ODS ADDRESSED IN THE PROJECT:

A. Article-7 Data (ODP Tonnes for 2009):

Annex-C, Group-I substances (HCFCs)	17,997.68

B. Country Programme Sectoral Data (ODP Tonnes for 2009):

Substance	**Total**
HCFC-22	11,030.80
HCFC-141b	5,535.50
HCFC-142b	1,417.68
Others	13.70

ODS CONSUMPTION REMAINING ELIGIBLE FOR FUNDING (ODP Tonnes) :	N/A
CURRENT YEAR BUSINESS PLAN:	Included

PROJECT DATA

Sector:	XPS Foams		
Sub-sector:	N/A		
ODS use in sector (2009 ODP tonnes):			2,419
ODS use in sub-sector/application (2009 ODP tonnes):			N/A
Project impact (ODP tonnes):			12.3
Project duration:			18 months
	Incremental Capital Costs:	US$	1,533,000
	Contingencies:	US$	153,300
	Incremental Operating Costs:	US$	328,476
	Total Costs:	US$	1,973,300
Local ownership:			100%
Exports to non-A5 countries:			0%
Requested grant:			**1,973,300**
Cost-effectiveness (US$/kg-ODS):			9.63
Implementing agency support costs:		US$	147,998
Total cost to Multilateral Fund:		US$	2,121,298
Status of counterpart funding (Yes/No):			Yes
Project monitoring milestones included (Yes/No):			Yes

PROJECT SUMMARY

This demonstration project, upon successful completion, will establish the suitability of CO_2 with methyl formate co-blowing technology as a viable replacement to HCFC-22/HCFC-142b technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd. The project covers development for the new process technology, equipment modifications and additional equipment, safety measures, laboratory testing, product trials, evaluation and in addition, development of modified designs of extrusion lines and related auxiliary equipment suited for this technology and implementation of this technology in XPS manufacturing at this enterprise.

Impact: The successful implementation of this demonstration project will provide an environmentally safe and cost-effective alternative for enabling replication of this technology in similar applications and enterprises in the XPS Foam Sector in China contributing to the viability of a large number of enterprises in this sector, and result in reductions in HCFC consumption of 12.3

ODP tonnes, contributing to compliance with the 2013/2015 control targets. It will also lead to net annual emission reductions of 420,250 tonnes CO_2-eq.

Technical Assessment: The project has been reviewed by UNDP Foam Sector Reviewer. The project has been supported subject to some comments, which have been addressed. The technical review is attached separately.

Prepared by:	UNDP in consultation with FECO and industry	**Reviewed by:**	Mary Courtney, UNDP Foam Sector
Date:	02 October 2010 (Final)	**Date:**	02 October 2010

PROJECT OF THE GOVERNMENT OF THE PEOPLES REPUBLIC OF CHINA

Demonstration project for conversion from HCFC-22/HCFC-142b technology to CO_2 with methyl formate co-blowing technology in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd.

Objective

The objective of this demonstration project is to establish the suitability of CO_2 with methyl formate co-blowing technology as a viable replacement of the currently used combination of HCFC-22 and HCFC-142b as blowing agent in the manufacture of XPS foam at Feininger (Nanjing) Energy Saving Technology Co. Ltd. The project will be implemented in conjunction with the Sector Plan for HCFC phase-out in the XPS Foams Sector, submitted simultaneously.

Sector Background

The XPS Foam Sector in China has experienced remarkable growth in the past several years. Due to the steep growth in the construction industry, demand for XPS foam boards for building insulation has increased significantly, ascribed also to enhanced energy-efficiency standards for buildings. The 2009 estimated HCFC consumption in the sector was about 41,000 metric tonnes. Based on information from surveys, there are about 20 indigenous manufacturers of XPS extrusion lines and an estimated 500 manufacturers of XPS foam in the sector.

Another defining characteristic of this sector is that most of the polystyrene raw material used in XPS foam manufacturing originates from recycled polystyrene scrap of unknown composition and contaminants. Recent zero-ODP XPS foam technologies introduced by multinational corporations are expensive and have been closely guarded in terms of intellectual property. Due to this, these technologies are not cost-effectively accessible for most of XPS foam enterprises of China and may not be compatible to operate with a high proportion of recycled polystyrene scrap. It would be a challenge for the Chinese XPS industry. There is thus, a clear and present need for a cost-effective and environmentally safe technology alternative for the XPS foam sector of China, in order to remain sustainable and maintain product quality.

Enterprise Background

Feininger (Nanjing) Energy Saving Technology Co. Ltd. was established in 2002 and it is one of the major manufacturers of Extruded Polystyrene (XPS) foam and Extruded Polystyrene (XPS) foam machines in China. The enterprise also manufacturers Extruded Polystyrene (XPS) foam boards with thickness from 20 mm to 100 mm. Other products include Extruded Polyethylene (XPE) foam boards and sheets, XPS foam pipe sections and PVC pipes. Feininger currently employs 143 persons, of which about 50 are technical.

Feininger has been recognized as one of the leading companies in the XPS industry in China with excellent management and high quality products. The enterprise has 26 patents, covering almost all the core technologies in XPS manufacturing. Feininger has been identified as a national high technology enterprise. It has obtained the Class-A Tax Credit Certification Award promulgated by the Internal Revenue Service and the Local Taxation Bureau of Nanjing, Jiangsu. It has also obtained ISO 9000, ISO14001 and CE certifications.

The enterprise currently uses a combination of HCFC-22 and HCFC-142b as blowing agents in XPS foam manufacturing, in the ratio of about 40:60,50:50. The annual HCFC consumption at Feininger in 2010 is tabulated below:

HCFC Consumption in 2010

Year	XPS Foam manufactured (m^3)	HCFC consumption (metric tonnes)
2010	137,500	495
Total	**137,500**	**495**

The enterprise currently operates two XPS foam manufacturing lines, both built in-house. The main technical parameters of the baseline equipment in these two manufacturing lines are tabulated below:

Parameter	Unit	Line 1/ SE 150/200*	Line 2/TE 75/200
Type	N/A	Single/Single Tandem	Twin/Single Tandem
Capacity	kg/hr	480-720	480-720
	m^3/day	300-450	300-450
Diameter of primary extruder	Mm	SE 150	TE 75
Diameter of secondary extruder	Mm	SE 200	SE 200
Power of primary extruder	kW	110	110
Power of secondary extruder	kW	75	75
Connected load	kVA	250	250
Electrical supply	Volts	380V/3 Ph/50 Hz	
XPS board thickness	Mm	20-100	
XPS board width	Mm	600, 900, 1200	
Blowing agents	N/A	HCFC-142b/22 (50:50)	HCFC-142b/22,142b
HCFC consumption**	Metric tonnes	205	290

**Line 1/ SE 150/200 will be converted to non-HCFC technology in this demonstration project. ** 2010*

The manufacturing line 1/SE 150/200 is a primary single-screw extruder/single-screw tandem extrusion system and line 2/TE 75/200 is a twin-screw extruder/single-screw tandem extrusion system. Compared with the primary single-screw (line 1), the primary twin-screw (line 2) has some advantages, such as steadier feeding, better dispersive and distributive mixing and better temperature control capability. These characteristics result in XPS foam with lower density and better insulation value. In the past three years, due to demand for improved product standards, the line 2/TE75/200 twin-screw system has been used for a larger share of the production. The existing extrusion line 1/SE 150/200 comprises of the following main equipment:

- Primary extruder 150 mm (36:1)
- Secondary extruder 200 mm (34:1)
- Pre-blending system for additives
- Two single stage blowing agent pumps delivering to the primary extruder
- Static mixer at the discharge of the secondary extruder
- Extrusion die and shaper
- Interconnecting piping and fitting
- Controls and indications

All of the above-mentioned equipment has been designed in-house and of 2002 vintage.

Feininger has rich experience in manufacturing a wide range of XPS foam-related products including the full range of XPS processing equipment. The enterprise has been engaged in research and development in XPS foams, XPS manufacturing machinery and auxiliary equipment such as XPS recycling machines, for several years. The enterprise also has technically competent staff and good management and is financially sound. It has a good market recognition and reputation. Any technology successfully adopted at Feininger provides a good opportunity for wider and more effective dissemination and adoption by the downstream users of XPS machinery and equipment provided by Feininger.

Based on these considerations, Feininger was considered to be the most suitable and appropriate for carrying out this demonstration project.

Alternative Technology

Selection

The main zero-ODP alternatives to HCFCs for the XPS foam sector include HFCs, CO_2 and Hydrocarbons. However, these technologies require a high level of process optimization and changes, significant investments up to several million dollars, and are closely guarded in terms of intellectual property rights by a very few large multinational corporations and can be potentially used by only very large enterprises under license or as subsidiaries of these corporations. The introduction of these alternative technologies is therefore a difficult challenge for the Chinese XPS foam industry. The challenge is to develop an alternative technology that can be environmental-friendly, easy and stably used by the large number of XPS foam enterprises in China, particularly because high levels of polystyrene scrap is used as raw material. This is critical because the sector is experiencing a high growth due to rapidly increasing demand in building and other infrastructural construction uses in China.

The selected technology for demonstration is CO_2 and methyl formate co-blowing technology (with additional co-blowing with Dimethyl Ether or similar compounds for improving properties) for the following reasons:

- CO_2 has zero ODP and GWP of 1, with a low cost and wide availability in China. It is also non- flammable and stable. It is thus favorable in terms of environment, health and safety. However CO_2 has a small molecule and tends to diffuse through the polymer structure quite easily. The insulation performance with CO_2 alone is therefore not favorable. CO_2 also requires high-pressure operation. Thus, CO_2 alone is not suitable and requires a co-blowing agent.

- Methyl formate is an industrial chemical which is widely and cost-effectively available. The thermal conductivity of methyl formate is low (10.7 m-W/m-K), which is quite close to that of HCFC-142b and HCFC-22 (10 m-W/(m-K and 11 m-W/m-K) respectively and much better as compared with other co-blowing agents such as ethanol (17.1 m-W/m-K) and HFC-152a (13.6 m-W/m-K. The co-blowing of methyl formate with CO_2 is thus expected to lead to a lower thermal conductivity of XPS foam as compared with CO2 alone or co-blown with ethanol or HFC-152a. Additionally, the combination will have very low GWP.

Methyl formate has a boiling point of 32^{O}C giving rise to some concerns on dimensional stability of XPS foam boards at room temperature. In order to customize and improve the physical, mechanical, thermal and flammable properties of the XPS foams to bring them on par with the current HCFC technology, a third co-blowing agent will need to be introduced, for example, Dimethyl Ether or other low-GWP blowing agents.

This combination thus promises to be a suitable alternative technology that can be widely adopted by the XPS foam enterprises in China and contribute to HCFC phase-out in this sector.

Moreover, such technology so far has not been known to be commercially employed in developed or developing countries or by multinationals elsewhere for XPS foams and is also not known to be subject to intellectual property rights limitations.

The technology will be provided through UNDP by internationally renowned XPS foam experts/firms, which have demonstrated hands-on knowledge and long experience in this field.

Impact

The introduction of CO2/Methyl Formate co-blowing (along with a third co-blowing agent for improved properties) will require plant and process modifications, as described elsewhere in the document.

An important issue that also needs to be seriously addressed is the flammability of methyl formate. The fire safety regulations of in China are stringent. Most enterprises manufacturing HCFC-based XPS foam in China currently do not have the necessary infrastructure for fire safety and the experience in handling flammable blowing agents. Additional and better flame-retardants will be needed to improve the fire properties of the XPS foam. Additional investments will be needed on fire safety equipment and systems. Safety training to plant personnel and an external safety audit will be needed.

Dissemination

Due to the unique situation of Feininger as a manufacturer of XPS foam as well as processing equipment, the development, demonstration and dissemination of this technology would be particularly facilitated. As an equipment manufacturer, this enterprise would be in a position to transfer this technology cost-effectively to a potentially large number of enterprises, who would be able to make XPS foam without using ODS-based blowing agents, while still being able to maintain the quality of products consistent with enhanced standards and remain techno-economically sustainable and viable.

Validation and subsequent adoption of this technology by most of XPS enterprises through an upstream route using an equipment manufacturer such as Feininger will make a significant contribution to HCFC reductions in this sector. Moreover, since this technology is expected to maintain the thermal conductivity of the products close to hat available with the current HCFC-based technology, with significant environmental benefits, it is expected to ensure sustainable conversions from the current HCFC technology.

Project Description

This demonstration project at Feininger (Nanjing) Energy Saving Technology Co. Ltd. will convert from a combination of HCFC-22 and HCFC-142b technology to CO_2/Methyl Formate co-blowing technology (along with a third co-blowing agent for improved properties). The conversion will be carried out on the Line 1/SE 150/200 extrusion foaming manufacturing line, because it is considered to be easier to retrofit and maintain. The technology if successful will be adopted for regular commercial production, and leading to reduction in consumption of 205 metric tonnes of HCFC-22 and HCFC-142b. At a future date, the enterprise will also adopt this technology on its other manufacturing line.

The impact on the plant/process due to the introduction of the new technology would need to be addressed by implementing plant modifications and introduction of new equipment, components and processes. Metering systems for CO_2, methyl formate and the third blowing component would need to be introduced. The extruder screws and barrels will need to be redesigned and replaced with ones suited for the new technology. Fire safety and appropriate control systems will need to be introduced. The following plant and process changes will be needed for implementing the conversion:

(i) One high-pressure CO_2 metering system comprising of the following:

- One duplex diaphragm pump with head cored for cooling, with a 5 hp AC motor
- One mass flow meter with PID control loop
- Variable speed inverter drive
- Pre-wired control panel mounted on metering stand
- 5 micron filtration
- System relief valve
- Glycerin filled panel mount gauges
- 7500 psi working pressure stainless steel piping and fittings
- Manual dump and shutoff valves
- Free standing welded steel frame

(ii) Two high-pressure metering systems for methyl formate and the third blowing component: Comprising of a diaphragm pump, flow meter, stainless steel piping, valves and fittings, controls and indications and safety features including ex-proof electricals.

(iii) Real time feedback and adjust mixer with high efficiency and accurate flow control for the three blowing agents. High efficiency mixing and accurate flow control are necessary to ensure that correct proportions of the blowing agent components are injected into the extruder. This will include flow meters and pressure sensors for one single component, a control terminal, a real time data transmission unit to feedback the data to the terminal, three proportioning valves to automatically adjust the flow of the three components according the instruction of the terminal.

(iv) Primary high-intensity 150 mm (38:1) mixing screw package with the following features:

- Base material SAE/AISI 4140 alloy steel, with nickel-alloy coating for wear resistance
- Spiral Maddox design for mixing section area
- High polish and chrome plating

(v) Primary mixing screw barrel
- Base material SAE/AISI 4140 alloy steel
- Nickel chrome plating
- Feeding section jacket barrel cooling
- Three injection ports for the blowing agents
- Strengthen sealing, mechanical and material design

(vi) Secondary 200 mm (34:1) cooling screw package with the following features:
- Base material SAE/AISI 4140 alloy steel
- Nickel chrome plating

(vii) Secondary cooling screw barrel
- Base material SAE/AISI 4140 alloy steel
- Nickel chrome plating
- 5 parts with jacket barrel cooling
- 5 Oil temperature controllers

(viii) Extrusion die: CO_2 has a lower solubility in the PS melt than HCFCs, so the working pressure of the extrusion foaming system should be high enough to suppress pre-foaming occurring when CO_2 is used. A new extrusion die which can bear the high pressure is necessary, including optimized heating control system to eliminate the temperature gradient.

(ix) High pressure hydraulic screen exchanger: The pressure of CO_2 extrusion foaming system is higher than that of HCFCs, so a new high pressure hydraulic screen exchanger should be introduced to bear the higher melt pressure, to avoid leakage, and to avoid pressure decrease.

(x) Static mixer: A new static mixer is necessary to installed next to the extrusion die at the upstream of extruder to homogenize the melt, eliminate the temperature gradient of the melt before the melt in to the die, and to control the die pressure. The current static mixer is not designed for the pressures expected.

(xi) Control system: The pressure of CO_2 extrusion foaming system is higher; furthermore, new screws are also introduced, so the control system of the original installation cannot satisfy the new mechanical and processing demands. More accurate control and more detailed monitoring are necessary for the new equipment and processing. A distributed control system is introduced to control the processing parameters, such as extrusion temperature and pressure, screw revolution and thickness and width of the foam board more accurately.

(xii) Explosion-proofing: Since methyl formate is flammable, explosion-proof retrofitting will be required for all electrical motors and parts, as dictated by the local regulations.

(xiii) Ventilation and fire safety systems: The transform and construction of ventilation and fire safety system should follow the specifications of GB50016-2006:

- Forced ventilation system: In order to prevent flammable gas flow to the production areas and to prevent environmental pollution caused by hazardous substances, effective integrated ventilation and related control systems need to be installed. The ventilation system must make sure that concentration of methyl format lower than 4.5% LEL (lower explosion level) to ensure safety.

- Static protection system for storerooms, tanks, pipes, metering systems, motors, extruder barrels and auxiliaries:

  - Installation of lightning rod is required
  - All the places and equipment which are likely to produce static electricity such as blowing agent pipelines, supply and exhaust pipes, all equipment and air ducts should be grounded and provided with anti-static treatment.
  - All production operators and personnel should wear anti-static clothing and shoes.

- Highly sensitive detection, alarm and control system for methyl formate concentration at tanks, pipes, metering systems, extruders, etc will need to be provided. If the concentration is higher than LEL, the system will trigger alarms, launch the ventilation and quench system in maximum power, cut off the supply of methyl formate and cut off the power supply. The detectors should be installed at tanks, pipes, metering systems, extruders and products warehouse. A portable detector will use to monitor areas where the fixed ones cannot reach.

- Automatic quenching system: The automatic quenching system will need to be installed in production area, finished product warehouse and near raw materials storage. The automatic quench system includes smoke detector, thermograph and automatic sprinkler system. Once the smoke concentration and temperature exceed the safe value, the automatic sprinkler system will be launched to quench the flames or ignition sources.

- Emergency power supply independent of the power mains, will need to be provided for powering the ventilation system, static protection system, detection and alarm system and automatic quenching system

- Periodic inspection and calibration of safety facilities: Safety-related equipment is required to be checked and calibrated periodically by authorized inspectors in line with local and national regulations.

(xiv) Technology transfer and technical assistance from external process experts will need to be acquired, to implement the new formulations and to ensure transition to the new technology.

(xv) Trials will be needed for the new equipment and process. This will cover the cost of chemicals, raw materials (polystyrene, blowing agent, flame retardant, talc, master batch, etc), consumables and utilities required during trials/commissioning.

(xvi) External evaluation and certification will need to be conducted on foam samples, to ensure quality and market acceptability. This certification will be carried out through an accredit laboratory in the USA or from relevant Chinese institutions.

(xvii) The production personnel in the enterprise will require to be trained to be able to work with the new equipment, formulations, process and fire safety regulation. The training will be provided through process experts.

(xviii) An external safety audit will need to be carried out to ensure that the safety provisions are consistent with local regulations

(xix) The results of the technology demonstration will need to be documented, reported and disseminated to ensure wider adoption.

Investments will need to be made and provisions thereof included in the project budget, to cover the incremental costs of these changes.

These changes will also result in incremental operating costs, for which provision has been made in the project budget. The sources of incremental operating costs are as below:

- The solubility of CO_2 in polystyrene is lower than HCFCs, and the diffusion coefficient is higher, therefore the melt strength of polystyrene should be high enough to support the bubble expansion. So, about 30% new PS resin is necessary to be used in the formulation.

- The amount of flame retardant in the formulation will need to be higher than with the HCFC technology, because of the flammability of Methyl Formate. The applicable increment would be about 1.5 times more than before.

- To maintain the thermal conductivity of the XPS foam at levels available with the current HCFC technology, the thickness of the foam board will need to be increased by about 4% (ratio of CO_2 and co-blowing agents will be 75/25).

- Increase of equipment maintenance expenses after retrofit and additional insurance expenses after replacement will be encountered, which are estimated at 2% and 0.4% of the equipment cost.

Project Costs

The total cost of the demonstration project is estimated at US$1,973,300.

The **incremental capital costs** of US$ 1,533,000 include capital investments required for the equipment and process changes and associated costs as described above. **Contingencies** amount to US$ 153,300 for adequate funding of incremental capital costs (10%). The **incremental operating costs** are worked out at of US$ 287,000 represent the incremental operating costs for one year of post-project operation.

Funding Request

The total funding request to MLF representing eligible incremental costs is for US$ 1,973,300.

Implementation

Project Monitoring Milestones

MILESTONE/MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Start-up of project activities																		
Submission of project document for signature																		
Project document signature																		
Preparation and request for bids																		
Award of contracts																		
Equipment delivery and installation																		
Commissioning and trial runs																		
Training and technical assistance																		
Commercial production																		

Management

The project will be under the overall management and coordination of the Foreign Economic Cooperation Office, Ministry of Environment Protection of China. UNDP is being the implementing agency for the project, which will provide international coordination and technical assistance as needed.

Environmental Impact

The HCFC consumption in 2010 at Feininger (Nanjing) Energy Saving Technology Co. Ltd. was 495 metric tonnes. The successful implementation of this demonstration project on one manufacturing line will result in a reduction of HCFC consumption by 205 metric tonnes.

The ODP, GWP and MW data of HCFC-142b/-22, CO_2 and Methyl Formate are tabulated below.

Substanc	ODP	GW	Molecular weight
HCFC-142b/22 (50:50)	0.06	2050	93
CO_2	0	1	44
Methyl formate	0	0	60

Based on the above, the successful implementation of this project will result an annual reduction of minimum 12.3 ODP tonnes and annual emission reductions of 420,250 tonnes CO_2-eq.

Results

The successful implementation of this project will result in the following:

(a) Sustainable reductions in HCFC consumption in the XPS sector in China of 12.3 ODP tonnes, contributing to China's compliance with the 2013 and 2015 control targets

(b) Demonstration and availability of an environmentally safe and cost-effective alternative for enabling replication of this technology in similar applications and enterprises in the XPS Foam Sector in China

ANNEX-III

Incremental Cost Calculations

No.	Item/Description	Unit	Qty	Cost (US$)
1. Extruder Retrofitting				
1.1	Primary mixing screw 150 mm (38:1) package	Set	1	100,000
1.2	Primary mixing screw barrel and accessories	Set	1	150,000
1.3	Secondary cooling screw 200 mm (34:1) package	Set	1	120,000
1.4	Secondary cooling screw barrel and accessories	Set	1	180,000
1.5	Extrusion die (include die heating control system)	Set	1	15,000
1.6	High pressure hydraulic screen exchanger	Set	1	15,000
1.7	Static mixer	Set	1	25,000
1.8	Retrofit two sets of extruder control cabinets to ensure safety	Set	1	20,000
1.9	Distributed control system	set	1	100,000
1.10	Explosion-proof retrofit of main motor	Set	2	10,000
1.11	Explosion-proof retrofit of material mixing and transportation motor	Set	1	8,000
1.12	Explosion-proof retrofit of motor of traction and cutting equipment	Set	2	4,000
Subtotal				**747,000**
2. Blowing agent supply system				
2.1	Storage tank with accessories for CO_2, methyl formate and third blowing agent	Set	1	50,000
2.2	CO_2 metering system	Set	1	70,000
2.3	Methyl formate and the third blowing component injection and metering system	Set	2	100,000
2.4	Real time feedback and adjust mixer	Set	1	60,000
2.5	Blowing agent piping (high and low pressure)	Set	1	10,000
Subtotal				**290,000**
3. Ventilation and fire safety system				
3.1	Civil works, retrofit and treatment of all vulnerable areas	Set	1	80,000
3.2	Force ventilation system comprising fresh air fan, exhaust and air supply ducts	Set	13	35,000
3.3	Static protection device	Set	16	32,000
3.4	Gas detection and alarm system comprising detectors, wiring and interlocking	Set	15	45,000
3.5	Ex-proof retrofit of factory electricals	Set	12	40,000
3.6	Automatic quenching system (smoke detectors, thermograph and sprinklers)	Set	15	55,000
3.7	Hand-held fire extinguishers	Set	15	1,500
3.8	Emergency power supply (100 kw)	Set	1	15,000
3.9	Anti-static and anti-fire clothing and shoes for 20 operators	Set	20	2,500
3.10	Control cabinet for safety system	Set	1	20,000
3.11	Humidification system for workshop and warehouse	Set	1	10,000
Subtotal				**336,000**
4. Other				
4.1	Technology transfer from external process expert	Lot	1	25,000
4.2	Process trials	Lot	1	70,000
4.3	Product evaluation and certification	Lot	1	10,000
4.4	Process and safety training	Lot	1	5,000
4.5	External safety audit	Lot	1	5,000
4.6	Documentation, reporting and information dissemination (UNDP)	Lot	1	18,000
4.7	Project management (FECO)	Lot	1	98,665
4.8	External expert for monitoring and verification (FECO)	Lot	1	12,000

Subtotal	**243,665**
Total	**1,616,665**
Contingencies	69,635
Grand total	**1,686,300**

ANNEX- IV

Incremental Operating Costs

Item/Description	Unit	Before conversion			After conversion		
		Unit price (US$)	Formula/ amount	Total (US$)	Unit price (US$)	Formula/ amount	Total (US$)
New polystyrene resin	kg	1.46			1.46	30	43.8
Recycled polystyrene resin	kg	1	100	100	1	70	70
HCFC-22	kg	1.34	5	6.7			
HCFC-142b	kg	1.98	5	9.9			
Fire retardant	kg	4.34	1	4.34	4.34	2.5	10.85
CO_2	kg				0.07	4.5	0.32
Methyl formate	kg				1.5	1.5	2.25
Sub-total			111	120.94		108.5	127.22
Adjustment factor for increased thickness to compensate for higher thermal conductivity than HCFCs		1			1.04		
Cost of foam	US$/kg	1.09			1.22		
HCFC content of foam	%	9.01					
IOC	US$/kg HCFCs	1.44					
HCFC phase-out	Metric tonnes	205					
IOC due to materials	US$	295,524					
Increase of equipment maintenance expense after retrofit (2% of US$ 1,373,000)	US$	27,460					
Additional insurance expense after replacement (0.4% of US$ 1,373,000)	US$	5,492					
Total IOC	US$	328,476					

In accordance with ExCom Decision 60/44 (f) (v), the maximum eligible incremental operating costs for conversions involving HCFC-142b in the Foams Sector would be US$ 1.40/metric-kg. These work out to US$ 287,000 for a phase-out of 205 metric tonnes of HCFC-22/142b.