Environment Public Authority
الهيئة العامة للبيئة

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مشروع تنفيذ

دراسة استدلالية لبدائل المواد المستنفذة لطبقة الاوزون في انظمة التكيف

الهيئة العامة للبيئة

و

برنامج الأمم المتحدة الإنمائي

دولة الكويت

عبدالله أحمد الحمود الصباح
رئيس مجلس الإدارة
المدير العام

الهيئة العامة للبيئة

الأمم المتحدة
United Nations

22 فبراير 2017

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أنه في يوم الأربعاء الموافق 22 فبراير 2017

تم توقيع البدء بمباشرة تنفيذ مشروع الدراسة الاستدلالية لبدائل المواد المستنفدة لطبقة الاوزون في أنظمة التكيف بين كل من:

1 ـ الهيئة العامة للبيئة:

ويمثلها في التوقيع على هذا المشروع

الشيخ/ عبدالله أحمد الحمود الصباح بصفته المدير العام للهيئة.

والكائن مقرها في الشويخ الصناعية 2 ـ ق1 شارع حسين بن علي الرومي ـ مبنى 2 ـ بجانب وزارة الاعلام ـ دولة الكويت : ص. ب: 24395 الصفاة ـ الكويت 1304

ت:ـ 22208310 (965 +) فاكس : 22208410 (965+)

2 ـ برنامج الأمم المتحدة الإنمائي (مكتب الكويت)

ويمثلها في التوقيع على هذا المشروع

زينب التويجي بنجلون ـ المنسق المقيم للأمم المتحدة ـ الممثل المقيم لبرنامج الأمم المتحدة الإنمائي ـ مشرف ـ المربع الدبلوماسي ق7 ـ بيت الأمم المتحدة ـ دولة الكويت: ص.ب: 2993 الصفاة ـ الكويت 13030 ـ ت: 25308000 (965 +) فاكس: 25399358 (965+)

الطرف الأول	الطرف الثاني
الهيئة العامة للبيئة	**برنامج الأمم المتحدة الانمائي**
الشيخ/ عبدالله أحمد الحمود الصباح	السيدة/ زينب التويجي بنجلون
مدير عام الهيئة العامة للبيئة ورئيس مجلس الإدارة	المنسقة المقيمة لبرنامج الأمم المتحدة الإنمائي
التوقيع:	التوقيع:

عبدالله أحمد الحمود الصباح
رئيس مجلس الإدارة
المدير العام

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

PROJECT COVER SHEET - NON-MULTI-YEAR INVESTMENT PROJECTS

COUNTRY: KUWAIT

PROJECT TITLE: Demonstration Project for HCFC-free low-GWP technology performance in air-conditioning applications (capacity above 8 TR)

IMPLEMENTING AGENCY: UNDP

PROJECT DATA			
Sector:	Air-conditioning sector		
Sub-sector:	Residential / Commercial acs (More than 8 TR)		
ODS use in sector (2014 metric tonnes):			**3373.63**
Project impact (metric tonnes : a portion of equv.):			**2500**
Project duration:			36 months
Project Costs:	Incremental Capital Costs(including contingencies):	US$	**343,000**
	Incremental Operating Costs:	US$	0
	Total Costs:	US$	**343,000**
Local ownership:			100%
Exports to non-A5 countries:			0%
Request grant		**US$**	**343,000**
Counterpart fund		**US$**	**NA**
Cost-effectiveness (US$/kg-ODS):			
Implementing agency support costs:		**US$**	**24,010**
Total Cost to Multilateral Fund:		**US$**	**367,010**
Status of counterpart funding (Yes/No):			NA
Project monitoring milestones included (Yes/No):			Yes

PROJECT SUMMARY

This demonstration project, upon successful completion, will establish the suitability of HCFC-free low-GWP technology performance in air-conditioning applications (capacity above 8 TR) in high ambient temperature conditions. The capacity of equipment are chosen in accordance with the type of existing equipment used in Kuwait. The project will cover installation of equipment using HFC-32 and R-290 based technology in Kuwait in identified locations and testing their performance over time. The project would be implemented by the National Ozone Unit of Kuwait with technical support from experts and Kuwait Institute of Scientific Research. Input from other projects in the regional will be used while structuring the implementation modality of this project.

If successful, the demonstration project will contribute towards reduction in consumption of HCFC-22 based air-conditioning installations besides reduction in installation of R-410A based equipment. This will have an impact on approximately 50,000 households consuming 50 TR each (approx.) of air-conditioning that would be constructed in the future, besides replacement of existing equipment using HCFCs and HFCs. The consumption in air-conditioning applications in the country in servicing as of the year 2015 is about 2500 MT and a significant portion of this will be addressed by this project.

Prepared by: UNDP in consultation with National Ozone Unit and industry **Date:** March 2016

PROJECT OF THE GOVERNMENT OF KUWAIT

Demonstration Project for HCFC-free low-GWP technology performance in air-conditioning applications (capacity above 8 TR)

Objective

The objective of this proposed demonstration project is to install commercially available of air-conditioning equipment in selected locations in residential areas in Kuwait with HCFC free low-GWP technologies (e.g., HFC-32, R-290), test performance of these equipment in prevailing conditions in Kuwait over two seasons of summer and disseminate test results to other interested stakeholders – both national and international.

HPMP Stage-I is under implementation in Kuwait. While implementing HPMP Stage-I, it was observed that the country faces a significant challenge (like other similar countries in the region and across the globe) on adoption of low GWP ozone friendly air-conditioning equipment. Specific activities to address this are not included in the HPMP Stage-I document as HPMP Stage-I focuses more on compliance with HCFC phase-out targets. Therefore, this demonstration project is expected to be helpful for the Government of Kuwait and other developing countries having similar operating conditions.

Sector Background

Introduction

Air-conditioning is a very important need for countries in the Middle East like Kuwait where ambient temperature can cross 50 degrees centigrade or more during summer months. Currently, HCFC-22 is widely used in this region for their air-conditioning equipment households. Given the larger size of households in Kuwait, the capacity of these equipment is of the range of upto 30 TR or more. On an average, the equipment are much larger in capacity compared to air-conditioners used in other countries in Asia Pacific region.

Technologies air-conditioning applications for high ambient temperature have been a challenge. These have been highlighted and discussed in different for a since 2007. In the recent TEAP report presented in 26th MOP in Paris in November 2014, it has been highlighted that availability of HCFC free alternative technologies in air-conditioning applications is limited. It is known that low GWP safe to use options pose unique challenge. As of date, HFC-32 and R-290 based products are commercially available for high capacity equipment required for this project. There is limited information available on other low GWP options (e.g., HFOs, blends) as of date in terms of commercial availability.

It is known that some of the technology options mentioned in paragraph above are available in Article 5 countries. Their adoption is still limited due to a range of reasons including standards and market promotion of such options.

The market for these air-conditioning equipment is growing at high rate in Kuwait and this growth is mainly on account of increase in number of households in the country. To avoid dependence of HCFC-22 based equipment that would result in prolonged use of HCFC-22 in servicing, it is essential for the country to demonstrate performance of HCFC free low-GWP technologies for adoption in households. The results would be replicable not only in Kuwait but also in other countries in the region and other parts of the world, where high-ambient temperature conditions are experienced during summer months.

Brief project summary

The project would involve installation of air-conditioning equipment in selected locations in residential areas in Kuwait with HCFC free low-GWP technologies (e.g., HFC-32, R-290), testing performance of these equipment in prevailing conditions in Kuwait over two seasons of summer and dissemination of test results to other interested stakeholders – both national and international.

Alternative Technology Options

The following factors need to be considered for selection of the alternative technology:

Technical factors
- Processing characteristics
- Functionality in end-product
- Proven and mature technology
- Energy efficiency

Commercial factors
- Cost-effectiveness
- Reliable availability

Health and safety factors
- Low risk for occupational health
- Low risk for physical safety (flammability, etc.)

Environmental factors
- Direct ozone impacts
- Direct and indirect climate impacts

Some of the zero-ODP alternatives to HCFC-22 currently available for air-conditioning applications are given below.

Substance	GWP	Application	Remark
R-410A		Residential / commercial acs	Widely available commercially. High GWP technology option compared to some of the alternatives available in the market. Energy efficiency is high and improved energy performance models are under development.
R-407C		Residential / commercial acs	Widely available commercially. High GWP technology option compared to some of the alternatives available in the market. Energy efficiency is high and improved energy performance models are under development.
R-32		Residential / commercial acs	Commercially available though not as widely as R-410A or R-407C. Mildly flammable refrigerant and has lower GWP compared to HCFC-22, R-410A and R-407C. Energy efficiency is high and improved energy performance models are under development.
R-290		Residential / commercial acs	Commercially available though not as widely as R-410A or R-407C. Flammable refrigerant and has a very low GWP. Energy efficiency is high and improved energy performance models are under development.

Note: Other options such as Ammonia, HFOs, CO2 and blends are not considered as these products are not commercially available for procurement and testing for Kuwait conditions.

Given the main project objective, the technology options that would be considered for demonstration are HFC-32 and R-290. It is known that:

a. Products suiting Kuwait requirements in terms of capacity and equipment technology are currently being produced in different countries in the region.

b. Equipment using these technologies can be procured from international markets and installed for testing purposes in Kuwait conditions.

c. Technical personnel in Kuwait involved in this project can be trained and equipped to use these equipment and measure performance of this equipment. This includes servicing of these equipment if necessary.

Project Background

The project was developed in close consultation among Kuwait Industrial and Scientific Research, technical experts in refrigeration and air-conditioning, UNDP staff and NOU. The project implementation structure was designed with expertise of KISR and with inputs from NOU and UNDP. Technical experts provided technical inputs relating to the type of equipment to be tested and performance assessment process for the different equipment proposed.

Project Description

As mentioned earlier, the project is designed for testing existing commercially available equipment using HFC-32 and R-290 based technologies. The equipment to be tested will include 8 TR equipment using R-32 and mini chillers with a capacity of 40 TR using R-290. The rationale for choosing the above equipment are:

- Usage characteristics and capacity of equipment typically used in Kuwait
- Availability of equipment in international and local markets using low GWP technologies
- Need for testing roof-top units or equivalent using R-290 based technology – this being helpful in safe operation of equipment
- Feasibility of maintenance and testing equipment using local technicians – this is also an important parameter while disseminating test results on utilisation of equipment.

More detailed specification of equipment would be finalized prior to bidding process. For managing this project, a Project Technical Steering Committee that includes technical experts and NOU will be constituted.

Under the proposed project, the following equipment are proposed to be bought.

Refrigerant	Capacity in TR	No. of units
HFC-32	10 TR	3 equipment or equivalent
R-290	40 TR (Mini Chiller)	1 equipment
Total	**Not applicable**	**4 equipment**

The equipment will be installed in the following sites:

(a) One equipment in one Mosque
(b) One commercial / public establishment close to sea shore
(c) Two other locations including KISR and one in household location as found feasible

These locations have been chosen in consultation with technical experts, NOU and KISR. This would be representative of operational conditions prevailing in Kuwait and project boundary conditions defined for demonstration project in terms of scope and budget.

It must be noted that climate monitoring equipment is required for measuring local climate close to the location of installation of equipment. This has an impact on performance of air-conditioning equipment both cooling capacity and energy consumption levels.

The main technical parameters that would be monitored for the evaluation of the performance of HFC-32 package should facilitate two methods for cooling load estimation. Hence they include:

1. Outdoor-air dry-bulb temperature,
2. Dry-bulb temperature and Relative humidity of air stream at the upstream and downstream of evaporator or cooling coil,
3. Air flow rate through the evaporator,
4. Liquid-line temperature (downstream of the condenser),
5. Liquid line pressure (downstream of the condenser),
6. Suction line temperature (upstream of the compressor),
7. Suction line pressure (upstream of the compressor),
8. Refrigerant mass flow rate downstream of the condenser,
9. Power consumption of the whole unit.

On the other hand, the performance of the R-290 mini chiller will be monitored by means of the following parameters:

a. Outdoor-air dry-bulb temperature,
b. Chilled water temperature upstream of the chiller,
c. Chilled water temperature downstream of the chiller,
d. Chilled water flow rate upstream or downstream of the chiller, and
e. Power consumption by the chiller.

The dynamic cooling load calculated by means of the above parameters will be compared to that presented by the chiller's built-in monitoring system.

Parameter	Instrumentation for measurement	No. of Units	Variable Index
Data Acquisition	OMB-DAQ-3000 Series: 1-MHz, 16-Bit USB Data Acquisition Modules	4	All ACs
	OMB-PDQ30: Analog input expansion module, adds 48SE/24DE channels to OMB-DAQ-3000 Series	3	All Packages
	OMB-CA-96A: OMB-DAQ-3000 Series to OMB-PDQ30 cable, 0.6 m	3	All Packages
	OMB-CA-179-5: USB cable, 5 m	4	All ACs
	OMB-CN-153-12: Spare terminal block	3	All Packages
	OMB-TR-2U: External power supply	4	All ACs
	OMB-PDQ10: DIN rail mounting adaptor for OMB-DAQ-3000	4	All ACs
Thermocouples	SA2C-K-120: Type K, 15 x 50 mm curved surface sensor, 3 m lead wire, stripped ends	14 (8+6)	4,6,b,c

Parameter	Instrumentation for measurement	No. of Units	Variable Index
Air Velocity (i.e. flow rate)	HHF-SD1: Data logging airflow meter with SD card-hot wire type	1	3
	SC-SD: Soft carrying case	1	3
	ADAPTER-SD: AC adaptor	1	3
	2GB-SD: Spare 2 GB SD memory card	1	3
Temperature/RH Transmitters	HX93BV0: Wall mount temperature / Relative Humidity Transmitter, 0 to 1 volt.	4	1,a
Temperature/RH Transmitters	HX93BV2-RP1: Remote Probe Temperature / Relative Humidity Transmitter, 0 to 10 volt output with 3 m (10') cable.	6	2
	PSR-24L-230: Regulated power supply, European plug, 230 Vac input, 24 Vdc output, 400 mA, stripped leads, CE	10	1,2,a
Pressure Transducers	PXM309-070G10V: Cable model, 70 bar range, gage pressure, 0 to 10 Vdc output	6	8,10
	PXMW-4: Sealing washer for G 1/4 thread, Stainless steel with FKM seal	12	5,7
Flow Meter	FDT-35: 18 to 830 LPM (5 to 220 GPM) range, 1-1/2' ANSI carbon steel/stainless steel pipe (check Pipe Size)	1	d
	FDT-31-C: 2 to 100 LPM (0.5 to 25 GPM) range, 1/2' copper pipe (check Pipe Size)	3	8
	FDT-30-PC CABLE: PC Communications Cable (recommended for first time buyers allows programming of the FDT-30 series with a PC)	1	8,d
	FDT-30-CABLE CLAMP: Water tight cable clamp	4	8,d
	FDT-HT-GREASE: Acoustic couplant for sensor mounting, max temperature 200°C (392°F) 56.7 g (2 oz) tube	1	8,d
Watt Transducer	PC5-114C: 3Ø3W AC WATT XDCR 0-600V/0-20A, 0-10Vdc, SELF PWR	4	9,e

Note: The monitoring equipment may need to be redesigned after the approval taking into consideration.

For each outdoor AC unit, a small air-conditioned cabin should be installed near to it in order to accommodate its associated monitoring system. Furthermore, a PC is required for each monitoring system in order to be linked with the data acquisition unit. The costs of the air-conditioned cabins and PCs should be considered. Similarly, the main duct section of each HFC-32 package unit should be equipped with a fire damper and its cost should be considered in the budget. The supplier of the HFC-32 package units should make provision for pressure sensors (downstream of the condenser and downstream of the evaporator).

For providing quality information on performance of the equipment, multi-channel data logger with transient unit measuring key parameters every 5 minutes) is proposed to be used. It is also proposed to have an on-line data monitoring system for this project.

To ensure that the product performance is tested in an effective manner, a training program will be conducted with the project technical team mainly from KISR. This training program would be conducted in close association with technical experts and equipment supplier technical personnel.

The project performance would be reviewed on a quarterly basis by PTSC which would be established for the project. The PTSC would report its findings to the higher Government authorities and UNDP.

Dissemination of project findings is an important element of this project. As a part of this project, the following information outreach activities are planned.

- Dissemination of findings of this project during the regional network meetings and international meetings (as found appropriate).

- Regional workshop on results of the demonstration project in terms of product performance and additional supportive interventions relating to policies and regulations for facilitating adoption of the technologies.

Project Costs and Financing

The total funding request from MLF amounts to US $ 343,000. Details are provided in Annex-I. The project envisages co-financing from industry and technical experts which is in-kind (i.e., time and resources spent for the project).

Implementation

Project Monitoring Milestones

The project milestones and timelines from the date of receipt of funds is given in the table below. The estimated period over which the project would be completed is 30 months i.e., 10 quarters.

MILESTONE/MONTHS	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Start-up of project activities	X											
Procurement of equipment	X	X										
Installation and training		X	X									
Performance monitoring (over 2 seasons)			X	X	X	X	X	X	X	X	X	
Results information dissemination – network meetings								X	X	X	X	X
Sub regional workshop											X	X

Management

The project will be under the overall management and coordination of the National Ozone Unit, Government of Kuwait. UNDP will be the implementing agency for the project, which will provide international coordination and technical assistance as needed. KSIR would be the technical executing agency which would undertake installation monitoring, commissioning, technical performance monitoring of test equipment in this project and management of sub-regional technical workshop for this project. KSIR would work under direct supervision of NOU.

The project would employ Performance-based Payment (PBP) mechanism in its implementation. Under the PBP mechanism, the project activities would be assessed on achievement of different milestones and payments would be made against those milestones.

The procurement shall be organized fully in line with procedures followed by Government, so that the goods and services procured are high quality, most reasonable price and suitable for the purposes of the project activity. The detailed arrangement on procurement will be defined in the contract between Government of Kuwait and UNDP.

Verification

1) **Periodical Performance Verification.** Before each payment, NOU of Kuwait and UNDP will review the progress of activities based on documents and site visits/site visit reports. Upon satisfactory completion of the project.

2) **Technical Assessment.** Before the last installment of payment, NOU and UNDP will invite independent expert(s) to verify the project outcomes.

Impact

The successful implementation of this demonstration project will provide information on performance of an environmentally safe and cost-effective alternative for enabling replication of the technology in Kuwait in air-conditioning applications for the indicated capacity. This project would specifically show product performance results of HFC-32 and R-290 based technologies which are currently available in the market. Further, any additional information on technology performance with other low GWP technologies (e.g., HFOs, low GWP blends etc.) would be carefully reviewed by technical experts and disseminated to the national stakeholders during the workshops held during this project.

For each equipment using HFC-32 in place of HCFC-22, the direct GHG emission reduction impact on initial charge and recharge assumed at 2 times in the initial charge over the life of equipment is given in the table below.

Particulars	**In. ch.**	**GWP**	**Tons CO2 eqv.**
HCFC-22 for 10 TR	6 kg	1810	10.86
HFC-32 for 10 TR	4.2 kg	675	2.86
Savings (initial charge)			8.00
Savings (recharge equal to two times initial charge)			16.00
Total			**24.00**

For each equipment using R-290 in place of HCFC-22, the direct GHG emission reduction impact on initial charge and recharge assumed at 1.5 times in the initial charge over the life of equipment is given in the table below.

Particulars	**Initial charge**	**GWP**	**Tons CO2 eqv.**
HCFC-22 for 40 TR	24 kg	1810	43.44
R-290 for 40 TR	12 kg	0	0
Savings (initial charge)			43.44
Savings (recharge equal to 1.5 times initial charge)			65.16
Total			**108.60**

Depending upon the market adoption rate for the above products, the total savings of equivalent can be determined.

In addition to this, the project will yield the following additional benefits:

- Greater understanding of technical issues relating to HFC-32 and R-290 based air-conditioning equipment tested through the demonstration project.
- More hands-on knowledge on operations and maintenance of these equipment.
- Definition of appropriate policies and regulations for adoption of refrigerants with low and high flammability.
- Reduced demand for HCFC-22 in approx. 50,000 households (each household consumes about 50TR) that would be constructed in the next 8 years in Kuwait and strategic planning support to Government to adopt alternatives that are environmentally friendly in air-conditioning applications.

Annex 1
Project costs and funding request from MLF

Particulars	Unit cost (USD)	Units	Total
HFC-32 demonstration units – 10 TR capacity	6,000	3 units	18,000
R-290 demonstration unit – mini chiller (40 TR)	40,000	1 unit	40,000
Data logger along with monitoring equipment for 5 units	60,000	1 lot	60,000
Cabin for monitoring system near outdoor unit with air-conditioners	5,000	5 units	25,000
Training for staff for project management and monitoring	10,000	1 lot	10,000
Technical support for collating and analyzing test results (involving 1 Researchers, 1 Professionals, 1 Technicians and 1 Administrator)		1 Lot	100,000
Technical support from experts	500	80 units	40,000
Workshop – sub regional involving 15 countries	50,000	1 lot	50,000
Grand total			**343,000**
Funds requested from MFS			**343,000**
In-kind contribution from Government of Kuwait (in terms of time involvement of staff and local coordination)			25,000

Annex 2
Check on conformance with decision 72/40 on demonstration project

MFS criteria	Remarks relating to the project
In terms of a low-GWP alternative technology, concept or approach or its application and practice in an Article 5 country, representing a significant technological step forward;	Yes – the project promotes the technology options relating to R-32 and R-290 which are new to the market and have a potential to replace HCFC-22 and high GWP impact R-410A.
The technology, concept or approach had to be concretely described, linked to other activities in a country and have the potential to be replicated in the medium future in a significant amount of activities in the same sub-sector;	Replication potential exists in Kuwait and other countries with high Ambient temperature conditions. The project results will facilitate adoption of these technologies in a large area – both in middle east region and in other regions with similar conditions.
For conversion projects, an eligible company willing to undertake conversion of the manufacturing process to the new technology had been identified and had indicated whether it was in a position to cease using HCFCs after the conversion;	Not applicable – testing at site. Products are available and are proposed to be procured through international competitive bidding. From our understanding of the market, there would be interested companies in supplying these equipment.
The project proposals should prioritize the refrigeration and air-conditioning sector, not excluding other sectors;	Yes – air-conditioning sector
They should aim for a relatively short implementation period in order to maximize opportunities for the results to be utilized for activities funded by the Multilateral Fund as part of their stage II HCFC phase-out management plans (HPMPs);	Timeframe for implementation is driven by test results requirement. Testing is proposed over two summers and hence, a 36 month time-frame is proposed for the project
The project proposals should promote energy efficiency improvements, where relevant, and address other environmental impacts;	The project performance parameters include energy performance of the equipment. Given that the focus of the project is on performance of equipment, energy efficiency impact is directly measured and the results will be shared. Any ideas of improvement of energy efficiency will also be shared as an output from this project.