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PROJECT PROPOSAL: JORDAN

This document consists of the comments and recommendation of the Fund Secretariat on the following project proposal:

Refrigeration

- Phase-out of HCFC-22 and HCFC-141b from the manufacture of unitary air-conditioning equipment at Petra Engineering Industries Co.

UNIDO

PROJECT DESCRIPTION

Introduction

1. UNIDO, on behalf of the Government of Jordan, has submitted to the 59th Meeting a demonstration project entitled “Phase-out of HCFC-22 and HCFC-141b from the manufacture of unitary air-conditioning equipment at Petra Engineering Industries Co.” Project preparation funding for this project had been approved at the 56th Meeting. The enterprise is a large manufacturer of air-conditioning equipment, consuming 125 metric tonnes (6.9 ODP tonnes) of HCFC-22 and 10.8 metric tonnes (1.2 ODP tonnes) of HCFC-141b. The funding requested for the implementation of the project is US \$4,452,461 plus support cost of US \$333,934. UNIDO has informed the Secretariat that Jordan is consuming 882 metric tonnes of HCFCs in the sector. The agency submitted the project initially to the 58th Meeting but subsequently withdrew it because of the policy issues unresolved at that time. UNIDO has re-submitted the project to the 59th Meeting.

2. UNIDO points out that the immediate impact of the project is to phase-out the use of 125 metric tonnes of HCFC-22 (6.9 ODP tonnes) and 10.8 metric tonnes of HCFC-141b (1.2 ODP tonnes) by converting to HFC refrigeration technology and cyclopentane foam blowing technology, thereby contributing to the country’s obligation to freeze HCFC consumption by 2013 and to reduce it by 10 per cent in 2015. The enterprise’s HCFC-22 usage is significant compared to the country’s HCFC consumption, and it is expected that the reduction by this project would comprise the major part of the country’s reduction obligation in 2015.

3. In addition, the project would contribute to the regional phase-out activity to a great extent through the promotion of non-HCFC equipment to be launched by this leading regional supplier of HVAC equipment. Establishing the regional after-sales service channel for the use of non-HCFC equipment would pave the way to phase out HCFC equipment in the region, as the infrastructure for installations of equipment designed for non-HCFC refrigerants is important for the overall objective of the accelerated HCFC phase-out initiative.

Company profile

4. Petra Engineering Industries Co. (Petra Engineering) was founded in 1987 to cater mainly for the markets in Iraq and Kuwait. The fully locally-owned enterprise has grown rapidly and today the company is a major manufacturer of sophisticated, high quality commercial and industrial HVAC equipment. The enterprise has more than 1,500 technical and managerial employees and distribution offices in nine countries in the West Asia region and Europe.

Products

5. Petra Engineering manufactures a wide range of HCFC products, as shown in the following table:

Products	Specification
Air cooled water chiller	125 kW to 1.58 MW semi hermetic reciprocating shell and tube evaporator V-type condenser coils
Air cooled water chiller	158 kW to 1.78 MW screw compressor shell and tube evaporator V-type condenser coils

Products	Specification
Air cooled water chiller low noise	158 kW – 1.55 MW semi hermetic screw shell and tube evaporator V-type condenser coils
Residential water chiller	7 kW – 193 kW
Water cooled water chiller	24.6 kW – 720 kW hermetic scroll compressor shell and tube evaporator
Package AC unit	105 kW – 193 kW hermetic scroll or reciprocating compressor
Rooftop package unit, variable air volume	hermitic scroll
Package AC unit	42 kW – 324 kW semi hermetic compressor
Air handling unit	1,700 – 680,000 cubic meter/h
Blower coil unit	2,550 - 16,300 cubic meter/h
Ducted split unit	42 kW – 598 kW semi hermetic compressor
Ducted split unit	4.4 kW – 10.5 kW hermetic compressor
Ducted split unit, low capacity	4.2 kW – 17.6 kW hermetic compressor
Water source unit	5.3 kW – 113 kW
Wall mounted package unit	(not provided)
Fan coil unit	340 - 2,040 and 1000 - 5,100 cubic meter/h
Mini split unit	2.6 kW – 14.8 kW
Mini split, cassette type	5.3 kW – 13.8 kW
Mini split, free standing type	5.3 kW – 14.8 kW

6. Upon request, Petra Engineering submitted a list of the relevant types of equipment. In total, the company manufactures more than 60 different types of refrigeration equipment that will be affected by the conversion.

Production facilities

7. The enterprise has a range of facilities, of which a significant number will need conversion activities. An overview of the overall facilities and those sub-divisions affected by the conversion is provided below.

Facility	Sub-divisions, tasks
R & D and testing	
Sheet metal forming plant	
Coil production plant	-Vertical coil expander -Fin press -Hair-pin bender
Fan and pipe workshop	
Assembly line	-Rooftop package unit assembly line -Package unit assembly line -Air handling units assembly line

Facility	Sub-divisions, tasks
	-Large capacity chiller assembly line -Small chiller production line -Fan coil units production line -Mini split unit production line -Condensing unit production line
Powder coating facility	
Polyurethane foaming facility	

Consumption of HCFC-22 refrigerant and HCFC-141b blowing agent

8. Petra Engineering uses the HCFC-22 refrigerant in 60 different types of air-conditioning equipment (chillers, package air-conditioners, ducted split units, mini split units and air-handling units); UNIDO advised that the majority of products are charged with HCFC-22 in the factory, while approximately five per cent of the products with larger capacity are delivered without refrigerant and charged on location. The project description provided the HCFC-22 consumption over the last three years for the 60 types of products, limited to those systems charged on location. HCFC-141b is used as a foam blowing agent for the injection foam insulation material for package air-conditioners and air-handling units. The enterprise also manufactures insulation panels of various sizes. The annual production quantity of seven standard panels and the associated HCFC-141b use was also provided by UNIDO.

Technology selection

9. The enterprise looked at several alternative technologies in terms of their environmental performance. Petra Engineering is proposing to replace its use of HCFC-141b with cyclopentane foaming equipment. For the choice of refrigerant, the company has undertaken a detailed review of the technology options available at the present time in the context of their market acceptability and product range. In conclusion Petra Engineering has selected R-410A to replace R-22 in packaged, ducted split and mini-split air-conditioning systems and other unitary equipment due to the potential for higher efficiency and ease of servicing. This will however require some significant redesign of components particularly for the regional market due to high ambient temperatures. For chillers Petra Engineering has selected R-407C to replace R-22.

10. The company specifically pointed out that, although it is unlikely that new alternatives other than the above HFCs will appear on the market before 2012, it is possible to change the alternative technology during implementation in case of new developments; Petra Engineering mentions specifically the following points:

- (a) Improvement of component technology for certain alternatives (R-410A particularly);
- (b) Modification of industrial standards for flammable refrigerants; and
- (c) Appearance of low GWP substances (e.g. now, low-GWP HFC).

Conversion activities foreseen in the project proposal

11. UNIDO requests funding for development, redesign and manufacturing of prototypes for trials. This is, according to UNIDO, necessary in particular because of the energy-efficiency gains which could and should be realized. The project proposal also specifies that despite the lower theoretical performance of, in particular, HFC-410A, energy-efficiency improvements through application of better technology have been realized in many air-conditioning products developed in non-Article 5 countries.

12. The enterprise plans to manufacture a number of demonstration units for technology testing for some of the equipment, in total adding up to ten models, or broadly 17 per cent of the models they will have to convert. The enterprise foresees the need for both laboratory as well as field tests. The costs requested for redesign and prototyping amounts to US \$670,000, to be conducted by the enterprise on the basis of a contract between UNIDO and the enterprise for the related work.

13. At present the foaming is conducted with pre-blended polyol, while according to the present state-of-the-art, cyclopentane needs to be mixed in-situ at the factory. Consequently, the conversion foresees a storage facility, pre-blending units, and foaming machines plus certain safety measures. The total associated cost in the proposal is US \$165,000.

14. The company proposes substantive changes to their heat exchanger production. It is envisioned to change the tooling and testing equipment for the heat exchanger production to accommodate the higher working pressures of HFC-410A. These activities amount to a cost of US \$730,000.

15. UNIDO further proposes to purchase new charging units for liquid charging of HFC-407C, a blend which tends to de-mix in conventional charging machines. Finally, the leak testing equipment also needs to be replaced. The modifications to the assembly line in the proposal amount to a total of US \$170,000. UNIDO proposes further to upgrade the equipment of the service technicians at Petra Engineering including new vacuum pumps, leak detectors, recovery units and other items, leading to a total cost of US \$397,900 for 20 sets of tools. Training of technicians is also foreseen in the proposal.

16. The enterprise plans to execute promotion events at their distribution offices outside Jordan when the non-HCFC equipment will be launched. This activity will be supported by the National Ozone Unit (NOU). In addition, several events will be planned for non-HCFC equipment promotion, such as distribution of awareness brochures on Jordan's HCFC phase-out initiative. The proposal foresees expenditures of US \$10,000 for this activity.

17. UNIDO calculated incremental operating cost (IOC) on the assumption of a period of two years, and arrived at a total figure of US \$2,954,358 for items related to refrigerant (47.6 per cent), compressor (47.5 per cent), and accessories (4.9 per cent). IOC for the heat exchangers was not requested; it should be noted that conversion costs for the heat exchanger facility are being claimed separately (see paragraph 14 above).

18. UNIDO informed that the share of exports of air-conditioning equipment to non-Article 5 countries is 16 per cent, and proposed accordingly to reduce the overall funding by 16 per cent. An overview of the calculation is provided in below table:

Overview over the costs as proposed by UNIDO

No.	Item	Cost (US \$)
1.	Incremental Capital Cost	
1.1	Redesign and prototyping	670,000
1.2	Modification of heat-exchanger production line	730,000
1.3	Modification of foaming line	165,000
1.4	Modification of assembly line	170,000
1.5	After sales service improvement and training	397,900
	Sub-total	2,132,900
	Contingency	213,290
	Total ICC	2,346,190

No.	Item	Cost (US \$)
2.	Incremental operating cost for two years operation	
	due to	
2.1	Refrigerant	1,406,664
2.2	Compressor	1,402,857
2.3	Condenser	0
2.4	Evaporator	0
2.5	Refrigeration accessories	144,838
	Total IOC	2,954,358
3	Total project cost	5,300,548
4	Deduction by Export to non-Article 5 countries, 16%	848,087
5	Project cost by Multilateral Fund	4,452,460
6	Implementing agency support cost (7.5%)	333,934
7	Total grant requested (US \$)	4,786,394

Implementation arrangements

19. The project document informs that the NOU would be responsible for the overall project coordination and assessment. UNIDO as an implementing agency will be responsible for the financial management of the grant. Specification for any of procurement and contracts will be developed by UNIDO in consultation and agreement with the enterprise, and handled by the agency. Redesign, manufacturing of prototypes, testing and training of after-service personnel will be conducted by the enterprise management under a UNIDO contract. UNIDO is also to assist the enterprise in equipment procurement, technical information update, monitoring the progress of implementation, and reporting to the Executive Committee. Financial management will be administered by UNIDO based on the implementing agency's rules and regulation.

20. The time table foresees implementation over a 36-month time frame. However, the main conversion activities are based on an 18-month schedule, with mainly training, service and promotional activities taking place in the final months of the project duration.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

21. The Secretariat appreciates the initiative of UNIDO and the Government of Jordan to submit a project proposal for an investment project for the conversion of a company producing air-conditioning equipment. However, the Secretariat as yet is unable to report a conclusion to the discussions with UNIDO, and it is uncertain whether it will be possible to finalise these in the time remaining before the 59th Meeting. The review has, however, helped to identify a number of additional policy issues that the Executive Committee might wish to consider explicitly or through creating a precedent. The comments of the Secretariat, while focussing on the project at hand, try at the same time to generalise the related lessons for the Executive Committee to take into account in its deliberations.

Environmental issues

22. There are two major components of this project proposal, namely, the conversion of HCFC-22 (6.9 ODP / 125 metric tonnes) to HFC-410A and HFC-407C, and of HCFC-141b (1.2 ODP / 10.8 metric tonnes) to cyclopentane. Petra Engineering wishes to replace HCFC-141b by pentane. This will reduce the direct impact of the foam blowing agent emissions, from 7,700 tonnes of CO₂ equivalent to the climate to virtually nil.

23. Petra Engineering also wishes to replace HCFC-22 by HFC-410A and HFC-407C. Through UNIDO, the country and the enterprise were advised of the environmental impact of HFCs. These substances are already regulated under the Kyoto Protocol and the Parties to the Montreal Protocol are considering including these gases under the Protocol, according to proposals for an amendment submitted for consideration at the 21st Meeting of the Parties.

24. The enterprise looked at several alternative technologies in terms of their environmental performance. A Life Cycle Climate Performance (LCCP) calculation was submitted where different refrigerant choices were compared. The Executive Committee might wish to recall the comments in previous documents of the Secretariat regarding the limited applicability of LCCP calculations and the related risk of comparisons of equipment with different levels of optimization; see also document UNEP/OzL.Pro/ExCom/59/51. The results of the calculations performed by the enterprise appear to show the best lifetime performance for HFC-410A, but the assumptions made¹ do not appear to be representing a fair and realistic approach for a comparison in the view of the Secretariat. However, the Secretariat wishes to point out that, while it does not share the view that HFC-410A is environmentally superior, the Secretariat recognizes there might be other relevant reasons why an HFC might presently appear to be the most appropriate solution as a replacement for HCFC-22 for this particular enterprise. Paragraph 36 discusses further the question whether this enterprise, is at this point in time, the most suitable vehicle for Jordan to reduce its HCFC-consumption; this question relates to the technology selection because of potential near-future technological developments in refrigeration and air conditioning, mentioned also in the project proposal as cited in paragraph 11 above.

Eligibility issues*Performance / Energy*

25. Refrigeration research publications in general as well as the thermo physical properties of the substances suggest that, in equipment with similar component characteristics, HFC-410A causes higher energy consumption than HCFC-22. In air-conditioning applications, the difference in energy efficiency between HCFC-22 and HFC-410A increases further with increasing ambient temperature. It should be noted that the customers of Petra Engineering are predominantly located in countries with consistently high temperatures; 50 per cent of the more than 700 installations mentioned on Petra's website are used in the West Asia region. While the LCCP calculations are somewhat ambiguous about whether the units would be more energy efficient or not, UNIDO informed in subsequent correspondence that indeed a reduction in energy efficiency would be expected if similar quality components are being used in an unchanged design, and consequently proposes to use components of a higher quality in redesigned equipment.

¹ Assumptions: Seven per cent better energy efficiency of the HFC-410A than HCFC-22; energy consumption for propane increased due to energy-intensive additional safety equipment; a refrigerant loss of only 30 per cent over the lifetime of the equipment, including the disposal of the product.

26. This has significant cost implications on:

- (a) the incremental operating costs, in particular for the compressor costs which appear to relate to the purchase of higher-quality compressors and would vary dependent on the energy efficiency of the compressor selected;
- (b) the costs of development and redesign, that would increase with higher demand on performance due to the significant redesign and more extensive testing needs of more energy-efficient equipment; and
- (c) the eligibility of the conversion of heat exchanger manufacturing; the heat exchanger manufacturing conversion activities appear to be largely related to the objective of improving the energy efficiency of the components.

27. In its decision 18/25, the Executive Committee decided that costs associated with avoidable technological upgrades should not be considered as eligible incremental costs and therefore should not be funded by the Multilateral Fund; an upgrade is defined as an improvement as compared to the baseline, in this case the HCFC air-conditioning equipment. For refrigeration and air-conditioning equipment, the baseline could be defined as:

- (a) The physical characteristics of the equipment as no more than the sum of the physical characteristics of its components, so that after a conversion the appearance of the equipment would remain largely unchanged;
- (b) The energy efficiency of the equipment would remain largely unchanged after conversion;
- (c) The energy efficiency as approximately compared to competing products after their conversion; at the moment a large share of the air-conditioning equipment using non-HCFCs has actually undertaken a major redesign and upgrading of components resulting in an improved energy efficiency despite in some cases choosing inherently less energy efficient refrigerants. It appears that the project proposal of UNIDO for Petra Engineering would favour this approach to determining the baseline; and
- (d) The climate impact of the equipment, so in a way that there would be no difference in climate impact of the equipment before and after the conversion, taking into account its energy efficiency and any direct emissions related to the HCFCs. Consequently, any replacement technology with a higher climate impact due to emission of its refrigerant and its GWP would be eligible for additional support to offset this higher impact through, for example, gains in energy efficiency.

28. It should be noted that the approach in paragraphs 27(c) above, which includes assessment of peer products, would in reality require the Executive Committee to set a target for improvements in energy efficiency and/or climate impact. The Executive Committee might see this as desirable and which could be funded within the limits of the support that the Multilateral Fund can provide. The indicator which has been developed by the Secretariat (see document UNEP/OzL.Pro/ExCom/59/51) could support the options in paragraphs 27(b) to 27(d) by providing a related comparison.

29. The Executive Committee might therefore wish to reflect on what is considered to be a baseline for the quality of refrigeration and air-conditioning equipment, to allow the assessment of eligible funding for these cases.

Export to non-A5

30. The enterprise produces a wide range of equipment; a number of the types produced are delivered without refrigerant charge, i.e. do not lead to consumption in the manufacturing plant. Of this equipment, a large amount is exported, some of it to non-Article 5 countries. In these cases there is no HCFC consumption associated with this equipment in Jordan, since the charge is consumed in the importing country. The Executive Committee has, in document UNEP/OzL.Pro/ExCom/15/45, declared that for beneficiaries that export part of their production to non-Article 5 countries there shall be a reduction equivalent to the percentage of total production represented by such exports.

31. It remains unclear, though, on which basis this quantification occurs. In case of more or less uniform equipment like such as refrigerators, this question is largely irrelevant, since calculation of the export share in relation to number of units, ODS content or value would yield similar results. For products that cover a wide range of equipment, a per-unit approach appears the least suitable, under-representing large and over-representing small units. A calculation on the basis of ODS content might be appropriate, but can not take into account the share of non-charged units sold, which will be produced on the same converted manufacturing facilities. A calculation on the basis of the value, i.e. the relative turnover, however, would require the company to provide sensitive commercial information. The Secretariat believes that given these considerations, using the ODS content might be the most appropriate solution; however, this is not yet covered by a decision of the Executive Committee and might need clarification. UNIDO has informed the Secretariat that it also views the calculation based on the ODS content as the most suitable procedure.

Cost for conversion of component manufacturing versus incremental operating cost

32. Petra Engineering manufactures heat exchangers, one of the main components of the air-conditioning equipment, on the same premises as the equipment itself. The project before the Committee covers both, the conversion of the air-conditioning equipment as well as the conversion of some of its components, namely heat exchangers; which conceivably might be sourced from independent manufacturers. The project proposal requests incremental capital costs (ICC) for the conversion of the heat exchanger production, and there is no request for IOC for heat exchangers. This leads to the question what part of the conversion will be considered as IOC, and what part will form the ICC.

33. A similar issue has already been discussed by the Executive Committee in the past; i.e. whether to fund IOC for compressors or to fund the conversion of the compressor manufacturers. The Executive Committee had taken the related decision 26/36 in order to avoid double funding. This double funding might have been caused by payment of both IOCs for compressors and the conversion cost for compressor manufacturers. The decision of that meeting differentiated between countries which had both component manufacturers and equipment manufacturers – where equipment manufacturers would not receive IOCs if component manufacturers received conversion funding – and countries which had only equipment manufactures, where IOCs would be paid. Underlying assumptions of that decision appear to have been a limited export of compressors from Article 5 countries, and assumed sourcing of components from non-Article 5 countries. However, in the eleven years since that meeting, the global exchange of goods has increased dramatically, and it is no longer possible to avoid double funding on the basis of national borders. In addition, one can assume that the predominant share of component manufacturing for air-conditioning equipment is today located in Article 5 countries.

34. The Executive Committee might therefore consider whether it wishes to revisit the existing guidelines for funding of incremental operating cost for compressors. If the guidelines would be revisited, the Committee might consider to what extent any decision should be applicable to key components of an air conditioning unit other than the compressor if a conversion of the manufacturing

would be necessary; and whether to decide to either pay IOC for these components or, alternatively, fund the incremental cost of the conversion of the related manufacturing facilities.

Procedural issues / HPMP issues

Priority for HCFC-22 phase-out

35. Based on the 2008 consumption, Jordan would need to reduce its HCFC consumption by about 6.0 ODP tonnes to achieve compliance with the 2013 and 2015 consumption targets. The 8.1 ODP tonnes to be phased out through this project would make it very likely that Jordan can achieve compliance with these HCFC targets through this project alone; consequently, the possible funding for an HPMP might be minimal. However, the latest consumption data for HCFC-141b suggests that even if only a third of the consumption of HCFC-141b would be phased out, full compliance would be achieved in 2013 and 2015.

36. The Secretariat pointed out that the phase-out efforts of Jordan, to be delineated in an HPMP, do not necessarily need to feature an air-conditioning project at this point in time. Alternatively, the country might concentrate mainly on measures in the foam sector, plus good practices in the servicing of refrigeration and air-conditioning equipment in order to stabilise and reduce the consumption. Such activities would avoid the premature introduction of technology for the refrigeration sector which might soon be obsolete. The Secretariat also pointed to the wording of decision XIX/6 of the 19th Meeting of the Parties, suggesting phasing-out first those HCFCs with higher ozone-depleting potential. Finally, the Secretariat highlighted the importance of providing to the Executive Committee a sound explanation as to why this given choice of technology was made. UNIDO advised that the consumption in the foam sector is distributed among a high number of small and medium-sized enterprises, and expressed doubt that sustainable reductions could be achieved by 2015 in a sector as difficult as the foam sector in terms of its structure.

Other issues presently under discussion

37. The Secretariat perceived an increase in capacity of the foaming equipment and has asked UNIDO for additional information. It was also noted that equipment for and training of service technicians was included, as well as "awareness promotion of the new technology". The Secretariat advised that these are potentially eligible under the HPMP to be submitted, but not as part of a demonstration project.

38. The Secretariat has requested a considerable amount of technical information from UNIDO and has so far received in excess of 500 pages of documentation. The large amount of documentation required relates partially to the overly complex situation at present regarding the date of installation of production capacity, for which the company must provide a complex history for each manufacturing line covered by the conversion. Secondly, the calculation of incremental operating costs and the question of what upgrade, if any, is requested as part of those costs is very data intensive, given the 60 different models affected by the conversion. Similarly, to determine the need and eligibility of the heat exchanger conversion, considerable data is necessary for several models of heat exchanger manufactured there.

39. The exchanges with UNIDO to establish a common basis for the determination of the eligible funding are ongoing as of writing of this document. The related discussion is partially dependent on some issues already in front to the Committee, such as the determination of incremental operating costs as well as the cut-off date. In addition, a number of other issues were identified, and were being presented in this document.

40. The Secretariat will advise the Executive Committee of any significant progress achieved in the discussions.

RECOMMENDATION

41. Pending.
