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EXECUTIVE COMMITTEE OF  
THE MULTILATERAL FUND FOR THE  
IMPLEMENTATION OF THE MONTREAL PROTOCOL  
Eighty-first Meeting  
Montreal, 18-22 June 2018

**PROJECT PROPOSAL: MEXICO**

This document consists of the comments and recommendations of the Secretariat on the following project proposals:

Phase-out

- HCFC phase-out management plan (stage II, third tranche) UNIDO/UNEP/  
Germany/Italy/Spain

Refrigeration

- Conversion of commercial refrigeration manufacturing in two facilities from the use of HFC-134a and R-404A as the refrigerants to isobutane (R-600a) and propane (R-290) at Imbera UNIDO
- Conversion of domestic refrigeration manufacturing facility from HFC-134a to isobutane (R-600a) as a refrigerant and conversion of compressor manufacturing facility from HFC-134a-based compressors to isobutane-based compressors at Mabe Mexico S.A. de C.V. (Mabe-Mexico) UNDP/Canada

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

**Mexico**

(I) PROJECT TITLE	AGENCY	MEETING APPROVED	CONTROL MEASURE
HCFC phase-out plan (stage II)	Germany, Italy, Spain, UNEP, UNIDO (lead)	73 <sup>rd</sup>	67.5% in 2022

<b>(II) LATEST ARTICLE-7 DATA (Annex C Group I)</b>	Year: 2017	414.22 (ODP tonnes)
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(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)								Year: 2017	
Chemical	Aerosol	Foam	Fire fighting	Refrigeration		Solvent	Process agent	Lab use	Total sector consumption
				Manufacturing	Servicing				
HCFC-22				13.04	245.14				258.18
HCFC-123					0.50				0.50
HCFC-124					0.22				0.22
HCFC-141b		22.00		124.43					146.43
HCFC-142b		8.89							8.89

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	1,148.8	Starting point for sustained aggregate reductions:	1,214.8
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	950.9	Remaining:	263.9

(V) BUSINESS PLAN		2018	2019	2020	After 2020	Total
UNIDO	ODS phase-out (ODP tonnes)	99.75	0	75.17	21.01	195.93
	Funding (US \$)	2,289,499	0	1,725,215	482,142	4,496,856
UNEP	ODS phase-out (ODP tonnes)	0	0	1.86	0	1.86
	Funding (US \$)	0	0	45,200	0	45,200
Spain	ODS phase-out (ODP tonnes)	49.88	0	0	0	49.88
	Funding (US \$)	1,192,731	0	0	0	1,192,731

(VI) PROJECT DATA			2014	2015	2016	2018	2020	2022	Total
Montreal Protocol consumption limits			1,148.80	1,033.92	1,033.92	1,033.92	746.72	746.72	n/a
Maximum allowable consumption (ODP tonnes)			1,148.80	1,033.92	1,033.92	746.72	574.40	373.36	n/a
Agreed funding (US \$)	UNIDO	Project costs	2,404,412	0	1,165,509	2,139,719	1,612,350	450,600	7,772,590
		Support costs	168,309	0	81,586	149,780	112,865	31,542	544,082
	Germany	Project costs	325,000	0	325,000	0	0	0	650,000
		Support costs	40,750	0	40,750	0	0	0	81,500
	Italy	Project costs	458,191	0	0	0	0	0	458,191
		Support costs	59,565	0	0	0	0	0	59,565
	Spain	Project costs	0		1,056,991	1,070,000	0	0	2,126,991
		Support costs	0		121,238	122,731	0	0	243,969
	UNEP	Project costs	0	0	40,000	0	40,000	0	80,000
		Support costs	0	0	5,200	0	5,200	0	10,400
Funds approved by ExCom (US \$)	Project costs	3,187,603	0	2,587,500				5,775,103	
	Support costs	268,624	0	248,774				517,398	
Total funds requested for approval at this meeting (US \$)	Project costs				3,209,719			3,209,719	
	Support costs				272,511			272,511	

<b>Secretariat's recommendation:</b>	For blanket approval
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## PROJECT DESCRIPTION

1. On behalf of the Government of Mexico, UNIDO, as the lead implementing agency, has submitted a request for funding for the third tranche of stage II of the HCFC phase-out management plan (HPMP), at a total cost of US \$3,482,230, consisting of US \$2,139,719, plus agency support costs of US \$149,780 for UNIDO, and US \$1,070,000, plus agency support costs of US \$122,731 for the Government of Spain.<sup>1</sup> The submission includes a progress report on the implementation of the second tranche, the verification report on HCFC consumption in 2016 and 2017, and the tranche implementation plan for 2018 to 2020.

### Report on HCFC consumption

2. The Government of Mexico has reported consumption of 414.22 ODP tonnes of HCFCs in 2017, which is 64 per cent below the HCFC baseline for compliance. The 2013–2017 HCFC consumption is shown in Table 1.

**Table 1. HCFC consumption in Mexico (2013–2017 Article-7 data)**

HCFC	2013	2014	2015	2016	2017	Baseline
<b>Metric tonnes (mt)</b>						
HCFC-22	4,695.21	4,933.17	4,468.17	4,635.72	4,694.12	8,505.1
HCFC-123	20.90	29.00	48.57	11.78	24.86	73.1
HCFC-124	-62.17	21.10	25.76	-8.14	10.03	8.0
HCFC-141b	4,802.50	4,096.89	3,661.47	2,324.41	1,331.16	6,123.9
HCFC-142b	89.00	166.00	158.78	137.67	136.82	89.2
<b>Total (mt)</b>	<b>9,545.44</b>	<b>9,246.16</b>	<b>8,362.75</b>	<b>7,101.45</b>	<b>6,196.99</b>	<b>14,799.3</b>
<b>ODP tonnes</b>						
HCFC-22	258.24	271.32	245.75	254.96	258.18	467.8
HCFC-123	0.42	0.58	0.97	0.24	0.50	1.4
HCFC-124	-1.37	0.46	0.57	-0.18	0.22	0.2
HCFC-141b	528.27	450.66	402.76	255.69	146.43	673.6
HCFC-142b	5.79	10.79	10.32	8.95	8.89	5.8
<b>Total (ODP tonnes)</b>	<b>791.35</b>	<b>733.82</b>	<b>660.37</b>	<b>519.66</b>	<b>414.22</b>	<b>1,148.8</b>

3. The decrease in HCFC consumption was mainly due to the completion of projects in the polyurethane foam, domestic refrigeration, commercial refrigeration and aerosol/solvent sectors, and significant advances in the technicians' training programme, which started with the first tranche of stage I of the HPMP approved at the 64<sup>th</sup> meeting (July 2011).

### *Country programme (CP) implementation report*

4. The HCFC sector consumption data reported by the Government of Mexico in its 2017 CP implementation report is consistent with the data reported under Article 7 of the Montreal Protocol.

### *Verification report*

5. The verification report has confirmed that the Government is implementing a comprehensive licensing and quota system for HCFC imports and exports that ensures compliance with the Montreal Protocol and the Agreement with the Executive Committee. The verification exercise has also confirmed that the HCFC consumption reported by the Government of Mexico for 2016 and 2017 is consistent with the information provided by the import and export enterprises and official customs administration reports.

<sup>1</sup>As per the letter of 18 April 2018 from the Ministry of Environment of Mexico to UNIDO.

Progress report on the implementation of the second tranche of the HPMP*Legal framework*

6. The Government of Mexico has continued applying the HCFC licensing and quota system and adjusting it to ensure better control of imports of HCFC pure and contained in blends.

7. In addition, the standard on energy efficiency in free discharge, non-ducted split air conditioners (NOM-023-2017) has been updated, increasing efficiency limits by an average of 11 per cent, which is above the performance of HCFC-22-based air conditioners. Therefore, HCFC-22-based equipment would not be allowed to be imported. The proposal was finalized in December 2017 and is due to be published in June 2018.

*Aerosol manufacturing sector*

8. All the eight aerosol manufacturing enterprises included in stage II have completed their conversion to HCFC-free technologies, with the phase-out of 384.28 metric tonnes (mt) of HCFC-22 and 383.96 mt of HCFC-141b as summarized in Table 2.

**Table 2. Status of conversion of aerosol-manufacturing enterprises**

Enterprise	Substance	HCFC consumption (mt)		Alternatives adopted
		HCFC-22	HCFC-141b	
Aerosoles Internacionales	HCFC-22 HCFC-141b	35.80	12.75	- Perchlorethylene/HFC-134a - HFC-152a
Alben	HCFC-22	10.27	0.00	HFC-152a
Dimmex	HCFC-22	60.34	0.00	HFC-152a
Envatec	HCFC-22 HCFC-141b	70.10	14.00	- Perchlorethylene/HFC-134a - HFC-152a
Quimica Jerez	HCFC-22 HCFC-141b	29.90	22.00	- Perchlorethylene/HFC-134a - HFC-152a
Quimica Marcat	HCFC-22 HCFC-141b	90.80	79.35	- Perchlorethylene/HFC-134a - HFC-152a - Hydrocarbons
Tecnosol*	HCFC-22 HCFC-141b	68.30	49.25	- HFC-134a - HFC-152a - HFC-365mfc/HFC-227ea
Quimobasicos	HCFC-22 HCFC-141b	18.75	206.61	HFO-1233zd/Nitrogen
<b>Total</b>		<b>384.28</b>	<b>383.96</b>	

\*Tecnosol is using less than two mt per year of HFC-365mfc/HFC-227ea blend in some applications due to corrosion issues.

*Conversion of non-eligible enterprises in other manufacturing sectors*

9. At the 73<sup>rd</sup> meeting (when stage II was approved), enterprises non-eligible for funding due to foreign ownership were consuming 272.10 ODP tonnes of HCFC-141b/HCFC-22. So far, 88 ODP tonnes have been phased out by Whirlpool and Metecno through conversion to non-HCFC-based technologies, and all other non-eligible enterprises have also converted to alternative technologies. The remaining consumption in Metecno and Whirlpool will be phased out in 2020.

*Refrigeration servicing sector*

10. The following activities have been completed: the training of 36 customs officers in the identification of refrigerants and HCFC-141b in pre-blended polyols; the procurement of equipment for two new reclamation centres, including reclaiming units for multiple refrigerants (i.e., CFC-12, HCFC-22, HFC-134a and R-410A), refrigerant cylinder filling systems, laboratory equipment, and a cylinder cleaning

system; distribution of 170 tool kits to service technicians (in addition to 200 distributed under stage I); and the selection of four additional training centres (in addition to the 11 already included in the programme) to expand the coverage of the refrigeration training activities.

11. Training for technicians in good servicing practices continued to be provided at the 11 training centres. Additional training at the four new centres and the development of additional chapters for the technicians' manual will be implemented when a cooperation agreement between the Ministries of Environment and Education is signed in June 2018.

12. The procurement of 20 R-290-based split air-conditioning (AC) systems to be used as trial units in the hydrocarbon (HC) demonstration project was delayed due to difficulties in importing the equipment experienced by the Government of Germany office in Mexico. It was decided that the procurement and delivery would be done from Germany, directly with the Mexican Ministry of Foreign Affairs and the Mexican Agency of International Cooperation. The implementation plan was adjusted accordingly, with the units to be delivered by October 2018, and the safety test and field monitoring of the trials to take place between October 2018 and April 2019. In addition, the 1,000 AC units planned by the financial incentive programme will be distributed to end-users between January and June 2019.

*Project implementation and monitoring unit (PMU)*

13. The PMU is continuously monitoring the approved phase-out projects; holding coordination meetings with industry stakeholders to agree on the reduction of import quotas in line with the phase-out schedule proposed in the HPMP; producing public-awareness materials, such as videos on the aerosol sector and a video on all stage II activities; and monitoring of HCFC production including the preparation of verification reports for 2016 and 2017.

Level of fund disbursement

14. As of March 2018, of the US \$5,775,103 approved so far, US \$4,335,997 had been disbursed (US \$3,243,067 for UNIDO, US \$40,000 for UNEP, US \$196,606 for the Government of Germany, US \$156,324 for the Government of Italy and US \$700,000 for the Government of Spain), as shown in Table 3. The balance of US \$1,439,106 will be disbursed in 2018 and 2019.

**Table 3. Financial report of stage II of the HPMP for Mexico (US \$)**

Agency	First tranche		Second tranche		Total approved	
	Approved	Disbursed	Approved	Disbursed	Approved	Disbursed
UNIDO	2,404,412	2,307,950	1,165,509	935,117	3,569,921	3,243,067
UNEP	0	0	40,000	40,000	40,000	40,000
Government of Germany	325,000	196,606	325,000	0	650,000	196,606
Government of Italy	458,191	156,324	0	0	458,191	156,324
Government of Spain	0	0	1,056,991	700,000	1,056,991	700,000
<b>Total</b>	<b>3,187,603</b>	<b>2,660,880</b>	<b>2,587,500</b>	<b>1,675,117</b>	<b>5,775,103</b>	<b>4,335,997</b>
<b>Disbursement rate (%)</b>	<b>83</b>		<b>65</b>		<b>75</b>	

Implementation plan for the third tranche of stage II of the HPMP

15. The following activities will be implemented between July 2018 and June 2020:

- (a) Purchase of equipment for the four new training centers to provide training on good practices including proper systems flushing; distribution of 50 flushing units and 120 kits to properly clean refrigeration circuits using non-HCFC alternatives for the trained technicians; and training of additional 1,000 new technicians on good practices, including adequate system flushing, in the 14 existing training centers (UNIDO) (US \$635,990);

- (b) Installation and commissioning of the reclamation equipment purchased during the second tranche; initiation of reclamation operations by the two new centers; additional training and procurement of tools and cylinders as required (Italy) (funds from previous tranches);
- (c) Continuation of the ongoing HC demonstration project with the delivery of the 20 test trial units and the 1,000 AC units; demonstration of the safe installation, use and maintenance of these HC-based systems; two train-the-trainer workshops on the safe use of HCs; development of regulations and standards related to the use of HCs as refrigerants, including labelling standards for equipment; and distribution of awareness materials (Government of Germany) (funds from previous tranches);
- (d) Continuation of the technician training programme on good servicing practices, including in the newly established training centres; distribution of equipment (to be determined according to needs) to the four new centres providing refrigeration training; development of an updated training manual in good refrigeration practices (2,000 copies) which will address issues related to handling of various alternatives with special considerations, such as high pressure, flammability, and blends (UNIDO/Spain) (US \$2,251,229); and
- (e) Monitoring of all activities, including: coordination among stakeholders; verification of ODS consumption and production; development of guidelines for importers and exporters on trade procedures and reporting requirements; and dissemination of the results of the activities under the HPMP in the aerosol and refrigeration servicing sectors (UNIDO) (US \$322,500).

## SECRETARIAT'S COMMENTS AND RECOMMENDATION

### COMMENTS

16. The Secretariat noted that, as per the Agreement between the Government of Mexico and the Executive Committee, the third tranche of stage II of the HPMP is only due at the 82<sup>nd</sup> meeting. The Secretariat has reviewed it and produced a recommendation based on the level of progress and of disbursement achieved. The early submission of the tranche request does not affect funding planning as it is within the same business plan year.

#### Progress report on the implementation of the second tranche of the HPMP

##### *Aerosol manufacturing sector*

17. The Secretariat notes the successful conversion of all the aerosol enterprises funded under stage II, resulting in the complete phase-out of 63.37 ODP tonnes of HCFCs, the depletion of all their HCFC inventories, and their commitment not to purchase HCFCs. These enterprises have converted to the technologies originally planned; two of the enterprises that were using HFC-134a on an interim basis instead of HFC-152a (the approved technology), are no longer producing with HFC-134a.

18. In 2017, one enterprise, Tecnosol, consumed on an interim basis two mt (of its total consumption of 117.3 mt) of the blend of HFC-365mfc (93 per cent) and HFC-227ea (7 per cent) for very specific automotive applications where perchloroethylene cannot be used as it is corrosive, and only non-flammable substances can be used. UNIDO explained that the use of this blend is on an interim basis, it is for testing with special customers and is intermittent due to its high price. Tecnosol is currently developing other alternatives for this application with the assistance from UNIDO. In line with decision 74/20(a)(ii), UNIDO will report to the Executive Committee on the status of use of the interim technology at each meeting until

the technology originally selected, or another technology with a low global-warming potential (GWP), has been introduced.

19. Laboratory tests with HFO-1233zd were planned for some of the aerosol/solvent applications where HFCs are being used. However, they could not be undertaken during the second tranche as the substance was not commercially available, and import prices were too high to make it economically viable. During the second tranche, the conversion of Quimobasicos (from HCFC-22 and HCFC-141b to HFO-1233zd) was completed earlier than planned as the enterprise (a producer of HCFCs) was able to import HFO-1233zd in the amount required for the conversion and at a reasonable price. The Secretariat asked whether samples of HFC-1233zd could be obtained through Quimobasicos to finalize the ongoing laboratory tests on alternatives. UNIDO informed that the price of HFO-1233zd offered to Quimobasicos is not the same as that proposed to other enterprises and its commercial agreement does not allow deviation of material. However, taking into consideration the small amounts needed, UNIDO agreed to explore this possibility with Quimobasicos. If samples of HFO-1233zd can be procured, the laboratory tests could be completed by the end of 2018.

#### *Refrigeration servicing sector*

20. In relation to the HC demonstration project for end-users, which includes the procurement of HC-based AC units, the Government of Germany informed that 20 public and private institutions have already been selected to test the first 20 units. The selected sites will sign a Memorandum of Understanding, and will be responsible for the proper operation and maintenance of the equipment, of buying maintenance tools and of delivering the necessary data. Their contribution will be mostly in-kind. For the additional 1,000 AC units included in the project, the end-users will cover around 70 per cent of the price and will be responsible for the proper operation and maintenance of the equipment, of buying maintenance tools and of delivering the necessary data for the monitoring.

21. Regarding the sustainability of refrigerant recovery and reclaiming activities, UNIDO has explained that exclusive reclaiming operations are not a sustainable business and, therefore, the reclaiming enterprises also offer environmentally appropriate collection and management services for refrigeration and air-conditioning (RAC) equipment. Up to 70 per cent of their income is from the sales of recoverable materials (e.g., copper, iron, and plastics), and the remaining 30 per cent is from the sales of reclaimed refrigerant. Large reclaiming centres are able to handle large quantities of appliances from commercial RAC enterprises, even covering the cost of collection of the appliance and transport to the centre, while medium-sized reclaiming centres are more dependant on subsidies from a Government energy-efficiency programme. The destruction of unwanted refrigerant has so far been covered through the ODS disposal pilot implemented; however, as this project is completed, this may become an issue as destruction costs must be covered by the refrigeration technicians.

22. On the subject of the introduction of low-GWP alternative refrigerants and their affordability in the commercial and domestic refrigeration sectors, UNIDO indicated that the penetration of such refrigerants could happen relatively quickly, but there is no technical capacity in the market for the servicing of the new appliances. They are, therefore, being introduced only where enterprises are able to conduct the servicing in their own shops. This constitutes a barrier to the adoption of these low-GWP alternatives, which could be addressed, among others, with training on handling low-GWP alternatives and associated equipment.

#### Conclusion

23. The Secretariat notes that Mexico continues to be in compliance with the Montreal Protocol and with its Agreements of stage I and stage II of the HPMP. Sufficient level of implementation of the second tranche of the HPMP has been achieved, including the conversion of all the eight aerosol/solvent enterprises, phasing out 384.28 mt of HCFC-22 and 383.96 mt of HCFC-141b. Activities in the refrigeration servicing sector are also continuing to be implemented, with some delays in adding new

training centres and undertaking the HC demonstration project. UNIDO has reported that the issues that have caused the delays are being resolved and activities in these two areas will resume shortly.

**RECOMMENDATION**

24. The Fund Secretariat recommends that the Executive Committee:

- (a) Takes note of the progress report on the implementation of the second tranche of stage II of the HCFC phase-out management plan (HPMP) for Mexico;
- (b) Notes that one enterprise in the aerosol sector, conversion of which was approved on the basis of the use of an alternative with low global-warming potential (GWP), is temporarily using approximately two metric tonnes of HFC-365mfc and HFC-227ea in one cleaning application, owing to corrosiveness issues; and
- (c) Requests UNIDO to continue assisting the Government of Mexico in identifying a low-GWP alternative for the application mentioned in sub-paragraph (b) during the implementation of the HPMP; and to report to the Executive Committee on the status of use of the interim technology at each meeting, until the technology originally selected or another technology with a low-GWP has been fully introduced.

25. The Fund Secretariat further recommends blanket approval of the third tranche of stage II of the HPMP for Mexico, and the corresponding 2018–2020 tranche implementation plan, at the levels of funding shown in the table below:

	<b>Project title</b>	<b>Project funding (US \$)</b>	<b>Support costs (US \$)</b>	<b>Implementing agency</b>
(a)	HCFC phase-out management plan (stage II, third tranche)	2,139,719	149,780	UNIDO
(b)	HCFC phase-out management plan (stage II, third tranche)	1,070,000	122,731	Government of Spain



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

**Mexico**

**PROJECT TITLE(S)**

**BILATERAL/IMPLEMENTING AGENCY**

(a) Conversion of commercial refrigeration manufacturing in two facilities from the use of HFC-134a and R-404A as the refrigerants to isobutane (R-600a) and propane (R-290) at Imbera	UNIDO
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<b>NATIONAL COORDINATING AGENCY</b>	National Ozone Unit/SEMARNAT
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**LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN THE PROJECT**

**A: ARTICLE-7 DATA (METRIC TONNES (MT), 2017)**

HFCs	n/a
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**B: COUNTRY PROGRAMME SECTORAL DATA (MT, 2017))**

HFCs	n/a
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<b>HFC consumption remaining eligible for funding (ODP tonnes)</b>	n/a
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<b>CURRENT YEAR BUSINESS PLAN ALLOCATIONS</b>		<b>Funding (US \$)</b>	<b>Phase-out (ODP tonnes)</b>
	(a)	365,109	44.70

<b>Particulars</b>	<b>Units</b>	<b>HFC-134a</b>	<b>R-404A</b>
HFC used at enterprise:	mt	51.73	4.31
	mt CO <sub>2</sub> -eq	73,974	16,904
HFC to be phased out through this project:	mt	51.73	4.31
	mt CO <sub>2</sub> -eq	73,974	16,904
HFC/alternatives to be phased in:		<b>R-600a and R-290</b>	
	mt	28.3	
	mt CO <sub>2</sub> -eq	84.9	
Project duration (months):		24	
Initial amount requested (US \$):		1,270,766	
Final project costs (US \$):			
Incremental capital costs:		1,016,378	
Contingency (10 %):		Included in ICC	
Incremental operating costs:		40,000	
Total project cost:		1,056,378	
Local ownership (%):		100	
Export component (%):		14	
Requested grant (US \$):		1,018,123	
Cost-effectiveness:		US \$/kg	13.24
		US \$/mt CO <sub>2</sub> -eq	8.17
Implementing agency support costs (US \$):		71,268	
Total cost of project to Multilateral Fund (US \$):		1,089,391	
Counterpart funding (Y/N):		Y	
Project monitoring milestones included (Y/N):		Y	

<b>SECRETARIAT'S RECOMMENDATION</b>	For individual consideration
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## PROJECT DESCRIPTION

26. On behalf of the Government of Mexico, UNIDO has submitted a project proposal to convert the manufacturing of commercial refrigerators at Imbera from HFC-134a and R-404A to propane (R-290) and isobutane (R-600a), at a total cost of US \$1,323,715, as originally submitted, and associated funding request from the Multilateral Fund of US \$1,270,766, plus agency support costs of US \$88,954.

### HFC consumption and sector background

27. In 2015, 17,286.66 mt of HFCs were consumed in the refrigeration and air-conditioning (RAC) sector in Mexico. The sectoral distribution of this consumption is contained in Table 1 of document UNEP/OzL.Pro/ExCom/80/45, attached to the present document. The total consumption of HFC-134a and R-404A in all commercial, industrial and transport refrigeration subsectors (including servicing) stood at 412.87 mt and 729.24 mt, respectively. Of this amount, 157.60 mt of HFC-134a and 41.24 mt of R-404A were consumed by stand-alone commercial refrigeration appliance manufacturers as presented in Table 1.

**Table 1. HFC consumption in 2015 by manufacturers of stand-alone commercial refrigerators and freezers in Mexico**

<b>Enterprise</b>	<b>HFC-134a (mt)</b>	<b>R-404A (mt)</b>
Bohn*	n/a	15.00
Criotec	21.62	n/a
Hussman*	n/a	20.50
Imbera Plant 1	42.80	1.11
Imbera Plant 2 (Fersa)	5.80	1.59
Metalfrio	39.15	1.80
Metalplus	12.08	n/a
Ojeda	30.70	1.00
Other small enterprises	5.45	0.24
<b>Total</b>	<b>157.60</b>	<b>41.24</b>

\*Non-Article-5-owned enterprise

28. The largest consumer of HFC-134a in the commercial refrigerator sector is Imbera. The majority of R-404A in the sector is consumed by two non-Article-5-owned enterprises (Bohn and Hussman), followed by Imbera. It is estimated that the associated HFC consumption in servicing of this type of equipment is 35 per cent of the amount used in manufacturing.

### Enterprise background

29. Imbera is the largest manufacturer of commercial refrigeration appliances in Mexico and is 100 per cent Mexican-owned. Imbera is interested in converting to HC-based technology because of the demand for environmentally friendly, high-efficiency coolers among both multinational and domestic beverage enterprises. Imbera has two plants.

#### *Plant 1*

30. Formerly known as Vendo de Mexico S.A., this plant manufactures more than 250 models of self-contained vertical and horizontal refrigerated displays for beverage cooling, in eight assembly lines operating five days a week in three shifts. The eight lines share five charging areas. The baseline equipment includes five charging units for HFCs, three units for CO<sub>2</sub> and three units for hydrocarbons (HCs). The production capacity is 98 units/hour, and in 2017 the plant produced 35,000 appliances per month. Plant 1 exports an average of 16 per cent of its production to non-Article 5 countries.

31. In 1997, plant 1 received Multilateral Fund assistance to replace 7.80 mt of CFC-11 with HCFC-141b and 8.7 mt of CFC-12 with HFC-134a.<sup>2</sup> Since the completion of the project in December 1998, HFC-134a and R-404A have been used to charge their products. Around 2012, Imbera started to introduce CO<sub>2</sub> technology in several manufacturing lines in plant 1 to replace its HFC-based manufacturing, but it has been noted that the CO<sub>2</sub>-based product has a larger failure rate (up to 7 per cent), its energy consumption is similar to that of the HFC-based product, and the service needs and costs of repair are high. Around 2014, the enterprise also started to manufacture some products using R-290 and R-600a. The average refrigerant charge of products in plant 1 is 303 g for HFC-134a-based equipment and 342 g for R-404-based equipment. The equipment using R-290, R-600a and CO<sub>2</sub> has an average charge of 92 g, 26 g and 300 g, respectively.

#### *Plant 2*

32. Formerly known as Fersa, this plant was established in 1970. It manufactures stainless steel refrigerators, modular refrigeration chambers, stainless steel freezers, vertical display coolers and freezers, deli merchandise display cabinets, meat cases and cold tables, in six assembly lines that operate five days a week in one shift each. The six lines share three charging stations, including three dual-use (HFC-134a/R-404A) charging machines. The production capacity is 14 units/hour, and in 2017 it produced an average of 1,830 appliances per month. Plant 2 exports seven per cent of its production to non-Article 5 countries.

33. In 1997, plant 2 received Multilateral Fund assistance<sup>3</sup> to replace 10.6 mt of CFC-11 with HCFC-141b and 4.5 mt of CFC-12 with HFC-134a at a cost of US \$228,165, plus agency support costs. Since completion of project in December 1999, HFC-134a and R-404A have been used to charge the products. The average refrigerant charges of HFC-134a- and R-404A-based equipment are 375 g and 619 g, respectively.

34. Tables 2 and 3 present an overview of the production of commercial refrigerators at the two plants.

**Table 2. Manufacturing of commercial refrigerators at Plant 1 (2014–2017)**

Year	HFC-134a	R-404A	R-290	R-744 (CO <sub>2</sub> )	R-600a	HFC-134a+R-404A
<b>Production (units)</b>						
2014	200,003	3,119	58,160	47,869	913	203,122
2015	150,380	3,659	61,265	105,748	1,052	154,039
2016	99,013	4,755	141,919	176,196	2,217	103,768
2017	130,475	6,113	227,708	67,315	3,250	136,588
<b>Average (2014-2016)*</b>	149,799	3,844	87,115	109,938	1,394	153,643
<b>Consumption (kg)</b>						
2014	60,294	1,149	6,575	14,140	22.825	61,443
2015	42,783	1,112	5,417	30,716	26.30	43,895
2016	32,113	1,685	10,859	55,455	64.79	33,799
2017	41,372	2,295	18,017	20,763	107.29	43,667
<b>Average (2014-2016)*</b>	<b>45,063</b>	<b>1,315</b>	<b>7,617</b>	<b>33,437</b>	<b>38</b>	<b>46,379</b>
Losses (3%)	1,352	39	229	1,003	1	1,391
<b>Average total</b>	<b>46,415</b>	<b>1,355</b>	<b>7,846</b>	<b>34,440</b>	<b>39</b>	<b>47,770</b>

\*During the discussions the reference consumption for the project was changed from the 2014-2016 average to the year 2017.

<sup>2</sup> Project MEX/REF/23/INV/74 at a cost of US \$248,524. In 2011, the Multilateral Fund also provided US \$200,000 to replace 21 mt of HCFC-141b with cyclopentane in foam panels (MEX/PHA/64/INV/159). Both projects have been completed.

<sup>3</sup> Project MEX/REF/23/INV/68 at a cost of US \$228,165. In 2011, the Multilateral Fund also provided US \$651,848 to replace 66.6 mt of HCFC-141b with cyclopentane in foam panels (MEX/PHA/64/INV/157). Both projects have been completed.

**Table 3. Manufacturing of commercial refrigerators at Plant 2 (2015–2017)**

<b>Production (units)</b>	<b>HFC-134a</b>	<b>R-404A</b>	<b>Total</b>
2015	16,899	2,884	19,783
2016	19,038	2,949	21,987
2017	18,748	2,480	21,228
<b>Average</b>	<b>18,228</b>	<b>2,771</b>	<b>20,999</b>
<b>Consumption (kg)</b>			
2015	5,542	1,595	7,137
2016	6,165	1,603	7,768
2017	8,852	1,888	10,740
<b>Average</b>	<b>6,853</b>	<b>1,695</b>	<b>8,548</b>
Losses (3%)	205.59	50.86	256.45
<b>Average total</b>	<b>7,059</b>	<b>1,746</b>	<b>8,805</b>

Project description

35. Imbera aims to convert two manufacturing lines in plant 1 and one in plant 2 with the assistance from the Multilateral Fund. The conversion of the remaining lines will be funded by Imbera. The conversion process in both plants is similar.

36. The currently available replacements for HFC-based capacity are HCs (R-290 and R-600a), HFOs and their blends. R-290 and R-600a have been selected as they: have zero ODP and very low global-warming potential (GWP); are proven, commercially available, internationally accepted and long-term alternatives for Imbera-type products; allow the use of mineral oil; have relatively low corrosiveness; enhance overall technical reliability; and reduce operating noise.

37. In addition, there are no significant technical and safety-related barriers to transition to R-290 and R-600a as their charge in commercial refrigerator appliances is relatively low (50 g to 120 g); the cooling circuit, including the compressor, is hermetically sealed, and the refrigerant is charged under well-controlled conditions at the manufacturing facilities.

38. Given the flammability of R-290 and R-600a, changes are required in the manufacturing process, in the refrigerant storage and supply, and in the products. The conversion of both plants contains four main components for which funds are being requested:

- (a) Product development, including: redesign of 55 platforms; pilot production of five prototypes in each platform; certification of HC appliances; and field trials and marketing (US \$130,625); and
- (b) Replacement of manufacturing equipment:
  - (i) Modifications to the refrigerant charging areas, including introduction of: seven charging stations suited to R-290 and R-600a (four of them self-funded), along with safety control systems (four of them self-funded) and antistatic floors for each charging area (all of them self-funded); seven ultrasonic welding machines (five self-funded); twelve post-charge leak detectors (eight self-funded); nine helium leak-detection systems (four self-funded); six HC recovery units (three self-funded); and five refrigerant booster pumps (three self-funded) (US \$737,000);
  - (ii) Modifications to the supply and storage of refrigerants in each plant, including: explosion-proof lights and transfer pipes; refrigerant supply system for five bottles; pneumatic transfer pumps with controls and accessories; safety control system; and an antistatic floor for the storage area (US \$80,000);

- (iii) Adaptations to the common infrastructure in each plant, including: emergency diesel generators; fire extinguisher sprinkler systems; a ventilation and safety system for the test rooms; and 10 handheld HC leak detectors (US \$160,000); and
- (iv) Contingencies and other services, including: delivery and installation, training and safety certification (US \$196,090).

#### Project costs and co-financing

39. The incremental capital costs (ICCs), as originally submitted, including contingencies, were US \$1,303,715, as shown in Table 4.

**Table 4: ICCs of the conversion of commercial refrigerators at Imbera**

Item	Units required	Unit cost	Total cost	Co-financing	Funds requested
<b>Refrigerant charging area</b>			US \$		
Assembly-line modification	7	5,000	35,000	35,000	-
Charging machine for R-600a	7	48,000	336,000	192,000	144,000
Safety (control system, ventilation, antistatic floor)	7	60,000	420,000	255,000	165,000
Leak detection (R600a/R290)	12	15,000	180,000	120,000	60,000
Ultrasonic welding machine	7	30,000	210,000	150,000	60,000
Refrigerant booster pump, pneumatic	5	8,000	40,000	24,000	16,000
HC recovery machine	6	4,000	24,000	12,000	12,000
Helium detection system	9	55,000	495,000	220,000	275,000
Handheld HC leak detectors	10	500	5,000	-	5,000
<b>Refrigerant storage and supply</b>					
Refrigerant storage area, including building, explosion-proof lights, transfer pipes	2	10,000	20,000	10,000	10,000
Refrigerant supply system for 5 bottles, 2 pneumatic transfer pumps with controls and accessories	2	15,000	30,000		30,000
Safety (control system, ventilation and antistatic floor)	2	30,000	60,000	20,000	40,000
<b>Common infrastructure</b>					
Emergency diesel generator	2	25,000	50,000	25,000	25,000
Fire extinguisher sprinkler system for storage and 5 charging areas	2	35,000	70,000	35,000	35,000
Ventilation and safety system for test room	15	10,000	150,000	50,000	100,000
<b>Total equipment cost</b>			<b>2,125,000</b>	<b>1,148,000</b>	<b>977,000</b>
Contingency (10% of equipment costs)			212,500	114,800	97,700
Installation and delivery (7% of equipment costs)			148,750	80,360	68,390
Training	2	5,000	5,000	5,000	-
Safety certification by TÜV Süd	2	15,000	30,000	-	30,000
<b>Grand total equipment</b>			<b>2,521,250</b>	<b>1,348,160</b>	<b>1,173,090</b>
<b>Product development</b>					
Product design and trials			302,500	226,875	75,625
Certification of HC appliances	55	4,000	220,000	165,000	55,000
Field trials, marketing	1	20,000	20,000	20,000	-
<b>Subtotal</b>			<b>542,500</b>	<b>411,875</b>	<b>130,625</b>
<b>TOTAL ICC</b>			<b>3,063,750</b>	<b>1,760,035</b>	<b>1,303,715</b>

40. The incremental operating costs (IOCs), which include costs related to changes in the compressor, capillary tube, electrical components and refrigerant, were estimated at US \$12.80/unit. The IOCs calculated in plant 1 for a two-year period are US \$1,223,048, as shown in Table 5.

**Table 5. IOCs for commercial refrigerator manufacturing at Imbera**

Item	Cost with HFC-134a	Cost with R-290	Cost difference
	US \$		
Compressor	49.85	55.92	6.07
Filter	2.57	2.57	0.00
Capillary tube	5.62	6.90	1.28
Other electrical components	45.69	51.54	5.85
Refrigerant	1.91	1.51	-0.40
<b>Total IOC per unit</b>	<b>105.64</b>	<b>118.44</b>	<b>12.80</b>
Average annual production			47,770
Total IOCs per year			<b>611,524</b>
<b>IOCs for 2 years</b>			<b>1,223,048</b>

41. Following the same methodology, IOCs for plant 2 were estimated at US \$223,681. The total IOCs for both plants are estimated at US \$1,446,729 and will be covered by Imbera. The total cost of the project for the Multilateral Fund, as originally proposed, is presented in Table 6.

**Table 6. Total cost of the Multilateral Fund project as submitted**

Item	Cost (US \$)
ICCs	1,303,715
IOCs	0
International consultant	20,000
Total cost	1,323,715
Deduction for exports to non-Article 5 countries (14% minus 10%)	-52,949
<b>Grand total cost</b>	<b>1,270,766</b>
HFC phase-out (kg)	56,575
Cost-effectiveness (US \$/kg)	22.46

42. As submitted, the counterpart contribution from Imbera is US \$3,206,764, comprising US \$1,760,035 for the ICCs and US \$1,446,729 for the IOCs. The cost-effectiveness of the project is US \$80.08/kg. Once the counterpart funding by Imbera and the portion of exports to non-Article 5 countries<sup>4</sup> have been deducted, the cost-effectiveness of the conversion would become US \$22.46/kg for the Multilateral Fund. The project will be implemented over a period of 24 months.

43. The project will eliminate annual consumption of 53.47 mt (76,462 mt CO<sub>2</sub>-eq) of HFC-134a and 3.10 mt (12,158 mt CO<sub>2</sub>-eq) of R-404A. The energy efficiency of the commercial refrigerators is estimated to improve by about eight per cent through modifications to the components and improved design.

## SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

### COMMENTS

#### *Eligibility*

44. The Secretariat has reviewed the project proposal on the basis of the current policies and decisions of the Executive Committee, similar approved conversion projects for CFC and HFC phase-out and approved projects to phase-out ODS with flammable alternatives.

<sup>4</sup> 4 per cent (14 per cent minus 10 per cent as per UNEP/OzL.Pro/ExCom/15/45 (paras. 146, 147)), "where exports to non-Article 5 countries exceed 10 per cent of production but do not exceed 70 per cent, there shall be a reduction equivalent to the percentage of total production represented by such exports less 10 per cent."

45. The project for Imbera has been submitted in line with decisions 78/3(g) and 79/45. It includes an official letter from the Government of Mexico with the commitment required in decision 78/3(g). In line with decision 79/45, the endorsement letter from the Government: indicates that it will make every effort to ratify the Kigali Amendment, as soon as possible; confirms that it is aware that, if this project is approved by the Executive Committee, no further funding will be available until the instrument of ratification of the Kigali Amendment has been received by the depositary at the United Nations Headquarters in New York; and acknowledges that, in the event that this project is approved, any reduction in HFC consumption will be deducted from any starting point that may be agreed in the future.

46. The Secretariat notes that plants 1 and 2 of Imbera received funding from the Multilateral Fund in 1997 to convert from CFC-11 as a blowing agent and CFC-12 as a refrigerant to HCFC-141b and HFC-134a, respectively. As such, the Secretariat considers that these conversions fall under paragraph 18(b) of decision XXVIII/2.

*Maturity of the technology, replicability and sustainability of the project*

47. The Secretariat requested clarification of whether the production of R-290 and R-600a-based refrigerators by Imbera would be sustainable, noting the high level of IOCs estimated, and the fact that 69 per cent of the production of HFC-134a-based commercial refrigerators and more than 90 per cent of the production of R-404A-based units have still to be converted in Mexico, and that the Government of Mexico was not in a position at this point to implement a ban or consider policy measures to help ensure the market uptake of the converted equipment. UNIDO explained that the main customers of Imbera products are beverage retailers, including large multinationals with strong environmental policies that are influencing technology trends towards low-GWP alternatives. In addition, client markets are developing climate-change-related policies that are causing an increase in the demand for HC-based products. In reviewing this information the Secretariat has also noted that the number of HC-based refrigerators produced in plant 1 of Imbera grew from 58,160 to 227,708 between 2014 and 2017, while the production of HFC-based units decreased from 203,122 to 136,588 during the same period (Table 2). The Secretariat considers this trend, and the demand from Imbera's clients for low-GWP-based equipment, as meaningful arguments for the sustainability of the conversion.

48. UNIDO reiterated the strong commitment of the Government and Imbera to implement this project. The Secretariat notes that the enterprise has already made considerable investments to be able to manufacture HC-based equipment, reflecting the enterprise's commitment to the conversion. The results of the project are expected to encourage adoption of energy-efficient R-290- and R-600a-based equipment by the markets in Mexico and in the region. There are at least four other locally-owned commercial-refrigeration manufacturing enterprises in the country and others in the region that could, potentially, adopt this technology.

49. With regard to the lines and equipment currently used for CO<sub>2</sub>-based products, UNIDO has explained that they will be converted to HCs if the project is approved. Otherwise, there is the possibility to return to HFC-134a, on at least two lines, until financial resources are found.

50. Given the extensive experience of Imbera in HC-based manufacturing, it is expected that the project will be implemented within the two-year time frame established by decision 78/3(g). In addition, UNIDO has confirmed that, with the approval of this project, the enterprise commits to total phase-out of HFC-134a and R-404A.

*Proposed costs*

51. The cost calculation was initially presented in an integrated manner, including both plants and the portions covered by Imbera and by the Multilateral Fund. In order to obtain a good understanding of the incremental costs of converting specific manufacturing lines, the Secretariat and UNIDO, in their discussions, focused exclusively on the lines for which funding was requested, and separated plant 1 from

plant 2. The Secretariat also noted that plant 1 already manufactured HC-based equipment and therefore already had the necessary equipment in its baseline (e.g., the enterprise has three R-290 charging machines, four helium leak detection and recovery systems, etc.). As such, the Secretariat considers that equipment as part of the existing baseline rather than as new, counter-part funding. UNIDO clarified that the three R-290 charging machines were used on lines 4 and 7 (which share a charging machine), line 6, and line 8. Therefore, the necessary investments were made for four lines to be capable of manufacturing HC-based equipment.

52. The Secretariat and UNIDO discussed areas of rationalization, taking into consideration, especially for plant 1, already existing HC-based commercial refrigerator units and the associated safety infrastructure. The following changes to the cost of the proposal were agreed:

- (a) The unit costs of some of the elements in the charging area were adjusted, taking as reference those in other plants with comparable capacity (i.e., the HC leak detectors, ultrasonic welding machines, helium leak detection and recovery, ventilation and safety systems) from US \$720,000 to US \$607,900. In relation to the charge of the units produced, it was agreed to remove the HC recovery units and to use a more cost-effective method to evacuate the refrigerant from the testing areas (adjustment from US \$12,000 to US \$6,000);
- (b) The cost of the refrigerant storage and supply was adjusted in both plants from US \$80,000 to US \$57,500, and the cost of some of the common infrastructure elements in plant 1 (i.e., the emergency diesel generators, fire extinguishers, ventilation and safety systems for test rooms and leak detectors) was adjusted from US \$129,000 to US \$41,000. It was also agreed that the use of sprinklers would be limited to the storage area given the potential for water damage to machinery in the charging area, where other protective measures (e.g., sensors combined with handheld fire extinguishers) would be used (adjustment from US \$35,000 to US \$10,000); and
- (c) The cost of product design and trials was also rationalized, given the existence of already developed HC products and that many products are based on common patterns. In the case of plant 1, it was agreed to reduce the costs associated with the redesign, prototyping and certification of the product from US \$74,375 to US \$40,000, and include them as part of the IOCs.

53. Noting that market acceptance of HC-based equipment would be strongly influenced by the presence of technicians capable of servicing it, it was agreed to add funding associated with technician training. This funding is separated from the ICCs and will be discounted at US \$ 4.80/kg. The tonnage associated to the servicing funding will also be deducted from any future starting point.

54. As IOCs are not being requested, their calculation was not discussed in detail. The Secretariat, however, noted that the difference in the cost between the HFC-134a and the R-600a compressors should be no higher than US \$1.00/unit rather than US \$5.00/unit as estimated, given the existence of R-600a compressor on the market.

55. Notwithstanding that IOCs were not requested, UNIDO confirmed that, in line with decision 78/3(g), the project will collect and include in the final report data on ICCs and IOCs, and that, in line with decision 22/38 and subsequent decisions of the Executive Committee, equipment to be replaced by the project will, as part of the project, be destroyed or rendered unusable.

56. The revised costs of the conversion of the commercial refrigeration manufacturing lines in plants 1 and 2 are shown in Table 7.



**Table 7. Proposed and revised costs for conversion of commercial refrigeration manufacturing at Imbera**

ITEM	Proposed cost (US \$)		Agreed cost (US \$)	
	Plant 1	Plant 2	Plant 1	Plant 2
<b>Charging area</b>				
Charging machine for HC	96,000	48,000	96,000	40,000
Safety control system and ventilation for charging area	110,000	55,000	100,000	25,000
HC leak detector (HLD 6000) plus calibration unit	30,000	30,000		15,000
Ultrasonic welding machine	60,000	-	50,000	
Refrigerant booster pump, pneumatic	16,000	-	14,400	
HC evacuation system	8,000	4,000	4,000	2,000
Helium leak detection system	220,000	55,000	212,500	55,000
<b>Refrigerant storage and supply</b>				
Refrigerant storage area (ex-proof lights, transfer pipes)	10,000	-	-	25,000
Refrigerant supply system for 5 bottles	15,000	15,000	32,500	
Safety ventilation for storage area	15,000	25,000	-	
<b>Common infrastructure</b>				
Emergency diesel generator	25,000	-	10,000	
Fire extinguisher sprinkler system	35,000	-	10,000	
Ventilation and safety system for test room	100,000	-	30,000	
Handheld HC leak detectors for storage area and labs	4,000	1,000	1,000	1,000
<b>Total equipment cost</b>	<b>744,000</b>	<b>233,000</b>	<b>560,400</b>	<b>163,000</b>
Contingency on investment cost 10%	74,400	23,300	56,040	16,300
<b>Other items</b>				
Installation (4%)	29,760	9,320	22,416	6,520
Training	-	-		
International expert	10,000	10,000	10,000	10,000
Delivery (3%)	22,320	6,990	16,812	4,890
Safety certification by TÜV Süd	15,000	15,000	15,000	15,000
<b>Subtotal</b>	<b>77,080</b>	<b>41,310</b>	<b>64,228</b>	<b>36,410</b>
<b>Grand total equipment</b>	<b>895,480</b>	<b>297,610</b>	<b>680,668</b>	<b>215,710</b>
<b>Product development</b>				
Redesign, prototyping, trials and test per model	34,375	41,250	-	20,000
Certification of hydrocarbon appliances	40,000	15,000	-	
<b>Subtotal</b>	<b>74,375</b>	<b>56,250</b>	<b>-</b>	
<b>Total ICC</b>	<b>969,855</b>	<b>353,860</b>	<b>680,668</b>	<b>235,710</b>
IOC	-	-	40,000	-
<b>Total incremental cost before adjustments</b>	<b>969,855</b>	<b>353,860</b>	<b>720,668</b>	<b>235,710</b>
Adjustment for exports to non-Article 5 countries	38,794	14,154	28,827	9,428
<b>Total incremental costs adjusted</b>	<b>931,061</b>	<b>339,706</b>	<b>691,841</b>	<b>226,282</b>
HFC-134a consumption (mt)	46.41	7.06	42.61	9.12
R-404A consumption (mt)	1.35	1.75	2.36	1.94
<b>Total HFC consumption to be phased out(*)</b>	<b>47.77</b>	<b>8.80</b>	<b>44.98</b>	<b>11.06</b>
Cost effectiveness per plant (US \$/kg)	19.49	38.58	15.38	20.46
Cost-effectiveness per plant (US \$/mt CO <sub>2</sub> -eq mt)	12.99	20.05	9.85	10.95
<b>Total cost</b>		<b>1,270,766</b>		<b>918,123</b>
Cost effectiveness both plants (US \$/kg)		22.46		14.60
Cost-effectiveness both plants (US \$/mt CO <sub>2</sub> -eq mt)		12.36		8.52
Servicing component				100,000
HFC associated to servicing (discounted at US \$4.80/kg)				20.83
<b>Total project cost requested to the Multilateral Fund</b>				<b>1,018,123</b>
Cost effectiveness including servicing (US \$/kg)				13.24
Cost effectiveness including servicing (US \$/mt CO <sub>2</sub> -eq mt)				8.17

\*The project was originally prepared on the basis of the average consumption of HFC for the years 2014–2016 for plant 1 (47.77 mt) and the years 2015–2017 for plant 2 (8.80 mt). During the review process, UNIDO indicated that the reference year for HFC consumption to be phased out by the project should be changed to 2017. Accordingly, the HFC consumption associated with the project changed to 44.98 mt for plant 1 and 11.06 mt for plant 2.

57. The agreed incremental costs for the conversion of commercial refrigeration manufacturing at Imbera amount to US \$918,123, to phase out a total of 56.04 mt (90,878 mt CO<sub>2</sub>-eq) of HFC-134a and of R-404A (51.73 mt (73,974 mt CO<sub>2</sub>-eq) and 4.31 mt (16,904 mt CO<sub>2</sub>-eq), respectively), at a cost-effectiveness of US \$16.38/kg. Including the servicing component, the total cost is US \$1,018,123 at a cost-effectiveness of US \$13.24/kg.

58. The Secretariat notes that the purpose of implementing projects under decision 78/3(g) is to gain experience in the ICCs and IOCs that might be associated with phasing down HFCs. On the basis of the information available at the time of review, the Secretariat considers that the agreed costs are its best estimates of the overall incremental costs of conversion; these estimates, however, might change as more information becomes available and according to the specific characteristics of the enterprises. The Secretariat, therefore, considers that approval of the project at the levels proposed above would not constitute a precedent.

### **2018-2020 business plan**

59. This project is included in the 2018-2020 business plan of the Multilateral Fund at a value of US \$273,168 for plant 1 and US \$91,941 for plant 2, to phase out 33.6 mt and 11.1 mt of HFC, respectively. The Secretariat notes that after the adjustments to the cost, the proposal is US \$724,282 above the value included in the business plan.

### **RECOMMENDATION**

60. The Executive Committee may wish to consider:

- (a) The project proposal for the conversion of commercial refrigeration manufacturing in two facilities from the use of HFC-134a and R-404A as the refrigerants to isobutane (R-600a) and propane (R-290) at Imbera, in the context of its discussion on HFC stand-alone project submitted to the 81<sup>st</sup> meeting in line with decision 78/3(g), as described in the document on the Overview of issues identified during project review (UNEP/OzL.Pro/ExCom/81/14);
- (b) Whether or not to approve the project indicated in sub-paragraph (a) above in the amount of US \$1,018,123, plus agency support cost of US \$71,268 for UNIDO, on the understanding, if the project were to be approved:
  - (i) That [, noting that the Government of Mexico has already submitted a request for enabling activities,] no further funding would be available until the instrument of ratification by the Government of Mexico had been received by the depositary at the Headquarters of the United Nations in New York;
  - (ii) That 76.87 mt (124,657 mt CO<sub>2</sub>-eq) of HFC-134a and R-404A would be deducted from the starting point for sustained aggregate reduction in HFC once it had been established;
  - (iii) That the project would be completed within 24 months of the transfer of funds to UNIDO, and a comprehensive completion report with detailed information on the eligible incremental capital costs, incremental operating costs, any possible savings incurred during the conversion and relevant factors that facilitated implementation, would be submitted within six months of project completion; and
  - (iv) That any remaining funds would be returned to the Multilateral Fund no later than one year after the date of project completion.

## PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

## MEXICO

## PROJECT TITLE(S)

## BILATERAL/IMPLEMENTING AGENCY

(a) Conversion of domestic refrigeration manufacturing facility from HFC-134a to isobutane (R-600a) as a refrigerant and conversion of compressor manufacturing facility from HFC-134a-based compressors to isobutane-based compressors at Mabe Mexico S.A. de C.V. (Mabe Mexico)	Government of Canada/ UNDP
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NATIONAL CO-ORDINATING AGENCY	National Ozone Unit/SEMARNAT
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## LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT

## A: ARTICLE-7 DATA (METRIC TONNES (MT), 2017)

HFCs	mt	n/a
	CO <sub>2</sub> -eq.	n/a

## B: COUNTRY PROGRAMME SECTORAL DATA (MT, 2017)

HFCs	mt	n/a
	CO <sub>2</sub> -eq.	n/a

HFC consumption remaining eligible for funding (ODP tonnes)	n/a
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CURRENT YEAR BUSINESS PLAN ALLOCATIONS		Funding US \$	Phase-out ODP tonnes
	(a)	250,157	0

PROJECT TITLE	Mabe Mexico			
	Domestic refrigerator		Compressor	
HFC-134a used at enterprise	mt	198.00	mt	0
	mt CO <sub>2</sub> -eq.	283,140	mt CO <sub>2</sub> -eq.	0
HFC-134a to be phased out through this project:	mt	198.00	mt	0
	mt CO <sub>2</sub> -eq.	283,140	mt CO <sub>2</sub> -eq.	0
Alternative to be phased in through this project: R-600a	mt	99.00	mt	0
	mt CO <sub>2</sub> -eq.	297	mt CO <sub>2</sub> -eq.	0
Project duration (months):		24		24
Initial amount requested (US \$):		4,500,000		
Final project costs (US \$):				
Incremental capital cost:		1,159,988		1,366,167
Contingency (10%):		108,499		133,617
Incremental operating cost:		1,401,931		n/a
Total project cost:		2,670,418		1,499,784
Local ownership (%):		100		100
Export component (%):		79.35		0
Requested grant (US \$)*:		1,618,866		1,499,784
Cost-effectiveness (US \$/kg and US \$/CO <sub>2</sub> -eq.)	US \$/kg	8.18	US \$/kg	n/a
	US \$/mt CO <sub>2</sub> -eq.	5.72	US \$/mt CO <sub>2</sub> -eq.	n/a
Implementing agency support cost (US \$):		72,371		104,985
Bilateral agency support cost (US \$)		74,349		n/a
Total cost of project to Multilateral Fund (US \$):		1,765,586		1,604,769
Status of counterpart funding (Y/N):		Y		Y
Project monitoring milestones included (Y/N):		N		N

\*After adjustment of US \$500,000 from a separate bilateral agreement of Government of Canada with UNDP.

SECRETARIAT'S RECOMMENDATION	For individual consideration
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## Note from the Secretariat

### Background

61. On behalf of the Government of Mexico, UNDP submitted to the 80<sup>th</sup> meeting a project proposal to convert the manufacturing of domestic refrigerators at Mabe Mexico from HFC-134a to isobutane (R-600a) as a refrigerant and conversion of a compressor manufacturing facility from compressors using HFC-134a to isobutane,<sup>5</sup> pursuant to decision 78/3(g). At the 80<sup>th</sup> meeting, the Executive Committee deferred consideration of the project to the 81<sup>st</sup> meeting.

62. On behalf of the Government of Mexico, UNDP resubmitted the project proposal that was submitted to the 80<sup>th</sup> meeting, which is attached to the present note from the Secretariat.

#### Additional information since the 80<sup>th</sup> meeting

63. In resubmitting the project proposal, UNDP provided updated information on the HCFC-134a consumption at the enterprise in 2017 as shown in Table 1. Based on the current consumption, the phase-out of HFC-134a associated with the project has increased from 170.19 metric tonnes (mt) (243,372 CO<sub>2</sub>-eq) to 198 mt (283,410 CO<sub>2</sub>-eq).

**Table 1. Consumption of HFC-134a at Mabe Mexico (2014-2017)**

Year	Consumption	
	Mt	mt CO <sub>2</sub> -eq
2014	133.96	191,563
2015	158.07	226,040
2016	170.19	243,372
2017	198.00	283,140
Average 2015-2017	175.42	250,851

64. UNDP also indicated that the Government of Canada has agreed to provide support to the project through a bilateral contribution of US \$584,988, and through a bilateral agreement with UNDP (outside the Multilateral Fund) for an additional US \$500,000.

65. The Secretariat reassessed the eligible incremental costs for the project based on the application of the decision of the Executive Committee on cost adjustments due to export of manufactured products to non-Article 5 countries.<sup>6</sup> The project proposal submitted to the 80<sup>th</sup> meeting was adjusted based on the total amount of products exported (i.e., 30.65 per cent) instead of the level allowable under the decision of the Executive Committee (i.e., 20.65 percent).<sup>7</sup>

<sup>5</sup> UNEP/OzL.Pro/ExCom/80/45

<sup>6</sup> As stated in paragraph 146 of UNEP/OzL.Pro/ExCom/15/45, the Executive Committee endorsed the following guidelines to apply them in projects which benefit enterprises that export part of their production to non-Article 5 countries: where exports to non-Article 5 countries correspond to or are less than 10 per cent of total production, the total incremental costs shall be covered; where exports to non-Article 5 countries exceed 10 per cent of production but do not exceed 70 per cent, there shall be a reduction equivalent to the percentage of total production represented by such exports less 10 per cent; where exports to non-Article 5 countries exceed 70 per cent of production, the project shall not be eligible; the average over the three years prior to submission of the project shall be used to determine production and exports to non-Article 5 countries; and projects where the exports to non-Article 5 countries are in the form of agricultural or fisheries products shall be eligible for total incremental costs.

<sup>7</sup> The CE value agreed at the 80<sup>th</sup> meeting would be US \$12.45/kg, if the eligible funding were assessed after adjustment for 20.65 per cent export to non-Article 5 countries.

66. Table 2 presents the agreed eligible incremental costs of the conversion at Mabe Mexico, taking into consideration the increased consumption of HFC-134a to be phased out (i.e., 198.00 mt instead of 170.19 mt), the adjustments due to the export component to non-Article 5 countries, and the additional contribution by the Government of Canada of US \$500,000 for the conversion of the refrigeration manufacturing line outside the Multilateral Fund.

**Table 2: Revised eligible incremental costs for the conversion at Mabe Mexico (US \$)**

Particulars	Agreed at the 80 <sup>th</sup> meeting	Revised at the 81 <sup>st</sup> meeting
<b>Refrigerator manufacturing line</b>		
Product design, testing and certification	-	-
Refrigerant charging and supply system	260,000	260,000
Assembly line modifications	562,988	562,988
Safety systems	262,000	262,000
<b>Subtotal</b>	<b>1,084,988</b>	<b>1,084,988</b>
Contingency (10%)	108,499	108,499
Technical assistance and safety audit	60,000	60,000
Training	15,000	15,000
<b>Total capital cost</b>	<b>1,268,487</b>	<b>1,268,487</b>
Incremental operating costs	1,401,931	1,401,931
<b>Total cost before adjustment for exports to non-Article 5 countries</b>	<b>2,670,418</b>	<b>2,670,418</b>
Adjustment for exports to non-Article 5 countries	(818,594)	(551,552)
Counterpart funding from Canada outside the Multilateral Fund		(500,000)
<b>Total incremental costs</b>	<b>1,851,824</b>	<b>1,618,866</b>
<b>HFC-134a consumption (mt)</b>	<b>170.19</b>	<b>190.00</b>
<b>CE (US \$/kg)</b>	<b>10.88</b>	<b>8.52</b>
<b>Compressor manufacturing</b>		
Costs of plant equipment modification	1,086,167	1,086,167
Product redesign and prototype development	-	-
Product testing and quality control	250,000	250,000
Subtotal	1,336,167	1,336,167
Contingency (10%)	133,617	133,617
Technical assistance	30,000	30,000
<b>Total</b>	<b>1,499,784</b>	<b>1,499,784</b>
<b>Grand total (domestic and compressor manufacturing)</b>	<b>3,351,608</b>	<b>3,118,650</b>

### Secretariat's comments

67. As indicated in paragraphs 25, 37 and 42 of the project proposal submitted to the 80<sup>th</sup> meeting, some of the enterprises already had in their baseline, equipment required for the conversion to R-600a. On this basis, the Secretariat sought further information on the status of the conversion at the enterprise. UNDP clarified that the enterprise has not issued any purchase order for new equipment included in project proposal submitted to the 80<sup>th</sup> meeting; UNDP also advised that there is no significant change in exports to non-Article 5 countries from the enterprise.

68. On the changes in the project funding structure, UNDP advised that after the 80<sup>th</sup> meeting, UNDP in consultation with the Governments of Mexico and Canada had agreed on funding support from the Government of Canada (i.e., US \$584,988) to finance a part of the ICCs relating to refrigerant charging and supply system, assembly line modifications and safety systems. The additional US \$500,000 outside the Multilateral Fund, would be used to finance additional items related to the refrigerator manufacturing component.

69. UNDP confirmed, in line with decision 22/38 and subsequent decisions of the Executive Committee, that equipment to be replaced by the project would be destroyed or rendered unusable as part of the project.

## Recommendation

70. The Executive Committee may wish to consider:

- (a) The project proposal for the conversion of domestic refrigeration manufacturing facility from HFC-134a to isobutane (R-600a) as a refrigerant and conversion of compressor manufacturing facility from HFC-134a-based compressors to isobutane-based compressors at Mabe Mexico in the context of its discussion on HFC stand-alone project submitted to the 81<sup>st</sup> meeting in line with decision 78/3(g), as described in the document on the Overview of issues identified during project review (UNEP/OzL.Pro/ExCom/81/14);
  - (b) Whether or not to approve the project proposal indicated in sub-paragraph (a) above in the amount of US \$3,370,355, consisting of US \$2,533,662, plus agency support costs of US \$177,356 for UNDP and, US \$584,988, plus agency support costs of US \$74,349 for the Government of Canada, on the understanding, if the project were to be approved:
    - (i) That no further funding would be available until the instrument of ratification by the Government of Mexico had been received by the depositary at the Headquarters of the United Nations in New York, except funding request relating to enabling activities that is submitted for consideration in the current meeting;
    - (ii) That 198 mt (283,140 mt CO<sub>2</sub>-eq) of HFC-134a would be deducted from the starting point for sustained aggregate reduction in HFC once it has been established;
    - (iii) That the project would be completed within 24 months of the transfer of funds to UNDP, and a comprehensive completion report with detailed information on the eligible incremental capital costs, incremental operating costs, any possible savings incurred during the conversion and relevant factors that facilitated implementation, would be submitted within six months of the project completion; and
    - (iv) That any remaining funds will be returned to the Multilateral Fund no later than one year after the date of project completion.
-



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EXECUTIVE COMMITTEE OF  
THE MULTILATERAL FUND FOR THE  
IMPLEMENTATION OF THE MONTREAL PROTOCOL  
Eightieth Meeting  
Montreal, 13-17 November 2017

**PROJECT PROPOSAL: MEXICO**

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

Refrigeration

- Conversion of domestic refrigeration manufacturing facility from HFC-134a to isobutane (R-600a) as a refrigerant and conversion of compressor manufacturing facility from HFC-134a-based compressors to isobutane-based compressors at Mabe Mexico S.A. de C.V. (Mabe-Mexico)

UNDP

## PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

## MEXICO

## PROJECT TITLE(S)

## BILATERAL/IMPLEMENTING AGENCY

(a) Conversion from HFC-134a to isobutane in the manufacture of domestic refrigerators at Mabe Mexico	UNDP
(b) Conversion of compressor manufacturing facility from HFC-134a-based compressors to isobutane-based compressors at Mabe-Mexico	UNDP

NATIONAL CO-ORDINATING AGENCY	National Ozone Unit/SEMARNAT
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## LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT

## A: ARTICLE-7 DATA (ODP TONNES, [INSERT YEAR], AS OF [INSERT MONTH AND YEAR])

HFCs	*
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## B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, [INSERT YEAR], AS OF [INSERT MONTH AND YEAR])

HFCs	*
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HFC consumption remaining eligible for funding (ODP tonnes)	n/a
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CURRENT YEAR BUSINESS PLAN ALLOCATIONS		Funding US \$	Phase-out ODP tonnes
	(a)		0

PROJECT TITLE:	Mabe-Mexico	
Project component	Domestic refrigerator component	Compressor component
HFC-134a used at enterprise (mt):	170.19	n/a
HFC-134a to be phased out (mt):	170.19	n/a
HFC-134a to be phased in (mt CO <sub>2</sub> equivalent):	22,320	n/a
Project duration (months):	24	24
Initial amount requested (US \$):	4,500,000	
Final project costs (US \$):		
Incremental capital cost:	1,159,988	1,366,167
Contingency (10 %):	108,499	133,617
Incremental operating cost:	1,401,931	n/a
Total project cost:	2,775,940	1,499,784
Local ownership (%):	100	100
Export component (%):	69.35	0
Requested grant (US \$):	1,851,824	1,499,784
Cost-effectiveness (US \$/kg):	10.88	n/a
Implementing agency support cost (US \$):	129,628	104,985
Total cost of project to Multilateral Fund (US \$):	1,981,452	1,604,769
Status of counterpart funding (Y/N):	Y	Y
Project monitoring milestones included (Y/N):	Y	Y

SECRETARIAT'S RECOMMENDATION	For individual consideration
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\*A total of 17,286.66 mt of HFC (including 8,164.20 mt of HFC-134a) was estimated in 2015 (source: ODS survey).



## PROJECT DESCRIPTION

1. On behalf of the Government of Mexico, UNDP has submitted a project proposal to convert the manufacturing of domestic refrigerators and compressors at Mabe Mexico, S.A. de C.V. (Mabe- Mexico), from HFC-134a to isobutane (R-600a), at a total cost of US \$17,094,016, as originally submitted and associated funding request from the Multilateral Fund of US \$4,500,000, plus agency support costs of US \$315,000.

### Project objective

2. The project will eliminate the annual consumption of 170.19 mt (243,371 CO<sub>2</sub> tonnes) of HFC-134a at six lines manufacturing domestic refrigerators at Mabe-Mexico; and will convert production of compressors that work with HFC-134a as refrigerant to R-600a. The energy efficiency of the domestic refrigerators is estimated to improve by about 16 per cent through modifications of the components and in line with requirements under National Official Standards (NOM-15).

### HFC consumption and sector background

3. In 2015, 17,286.66 mt of HFCs were consumed in the refrigeration and air-conditioning (RAC) sector in Mexico. Table 1 presents the sector distribution of consumption of HFCs.

**Table 1. HFC consumption in the RAC sector in 2015 (mt)\***

Sectors	HFC-134a	R-404A	R-407C	R-410A	R-413A	Others	Total
<b>Refrigeration</b>							
Manufacturing	1,310.29	413.14			469.26	90.75	2,283.44
Servicing	1,480.34	316.10			175.99	92.25	2,064.68
<b>Air-conditioning</b>							
AC manufacturing	327.78		69.29	6,667.02			7,064.10
Mobile AC	4,589.25						4,589.25
AC servicing	166.09		82.62	316.92		5.61	571.23
Chiller Manufacturing	265.00			349.73			614.73
Chiller servicing	25.45		4.70	69.08			99.23
<b>Total</b>	<b>8,164.20</b>	<b>729.24</b>	<b>156.61</b>	<b>7,402.76</b>	<b>645.25</b>	<b>188.60</b>	<b>17,286.66</b>
<b>% consumption in mt</b>	<b>47.2</b>	<b>4.2</b>	<b>0.9</b>	<b>42.8</b>	<b>3.7</b>	<b>1.1</b>	<b>100.0</b>
<b>% consumption in CO<sub>2</sub>-equivalent</b>	<b>25.3</b>	<b>8.9</b>	<b>0.9</b>	<b>47.9</b>	<b>4.1</b>	<b>13.0</b>	<b>100.0</b>

\*As reported in the survey of ODS alternatives.

### Domestic refrigerator market

4. There are three domestic refrigerator manufacturing enterprises that cater to about 63 per cent of the market in Mexico. The capacity of the equipment ranges from 210 litres to 520 litres. Table 2 provides total domestic market refrigerator production and sales in Mexico.

**Table 2. Market of domestic refrigerators in Mexico (in units)**

Particulars	2010	2011	2012	2013	2014	2015	2016
Production	7,009,900	7,220,197	7,436,803	7,659,907	7,889,704	8,126,395	8,410,819
Import	597,376	615,297	633,756	652,769	672,352	692,523	716,761
Export	5,976,733	6,156,035	6,340,716	6,530,938	6,726,866	6,928,672	7,171,176
<b>Total domestic sales</b>	<b>1,630,543</b>	<b>1,679,460</b>	<b>1,729,843</b>	<b>1,781,738</b>	<b>1,835,190</b>	<b>1,890,246</b>	<b>1,956,404</b>
<b>R-600a based units</b>							
Production			293,833	302,648	615,166	499,000	513,960

Particulars	2010	2011	2012	2013	2014	2015	2016
Import							
Export			293,833	302,648	499,000	499,000	513,960

5. In 2016, about 8.41 million domestic refrigerators were manufactured in Mexico; 85.2 per cent of this production were exported and 716,761 refrigerators were imported. Of the total production for domestic sales, approximately 79.2 per cent are HFC-134a-based and 20.8 per cent are R-600a-based. Details of number of manufacturers producing R-600a based domestic refrigerators is not available.

#### Enterprise background

6. Mabe-Mexico is one of the largest producers of domestic refrigerators<sup>8</sup> and has Mexican and Chinese ownership.

7. At the 15<sup>th</sup> meeting, Mabe-Mexico received funding to convert its two domestic refrigerator manufacturing lines (i.e., from CFC-12 to HFC-134a and from CFC-11 to HCFC-141b). At the same meeting, Mabe-Mexico received funding for conversion of their domestic refrigerator CFC-12 compressor manufacturing facility to manufacture HFC-134a-based compressors. These projects were completed in September 1997.

8. At the 59<sup>th</sup> meeting, Mabe-Mexico received additional assistance to convert its manufacturing capacity from HCFC-141b used in insulation foam to cyclopentane. The project has completed resulting in the phase-out of 354 mt (38.94 ODP tonnes) of HCFC-141b and 306 mt (16.83 ODP tonnes) of HCFC-22.

#### HFC consumption by the enterprise

9. Mabe-Mexico produces six models of domestic refrigerators using HFC-134a at its six production lines which are located in the same facility and have similar layout and installed capacity. Of the six production lines, two lines have capacity to produce R-600a-based domestic refrigerators. The compressor manufacturing facility is also located in the same location.

10. Table 3 presents the 2014-2016 production of HFC-134a-based domestic refrigerators at Mabe Mexico.

**Table 3. Capacity and sales of Mabe-Mexico refrigerators**

Year	Production (units)		
	HCFC-134a (mt)	Total	Export to non-Article 5 countries
2014	133.96	1,189,892	391,772
2015	158.07	1,405,817	435,792
2016	170.19	1,507,453	462,097
<b>Average consumption</b>	<b>154.07</b>		
<b>Average consumption (CO<sub>2</sub> tonnes)</b>	<b>220,320</b>		

#### Selection of alternative technology

11. R-600a was selected as the alternative technology as it has an energy efficiency advantage over HFC-134a, and has zero ODP and very low-global warming potential (GWP). Further, this technology is

<sup>8</sup> The enterprise has production and commercial operations in Argentina, Brazil, Canada, Central America, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, and Venezuela (Bolivarian Republic of).

currently in use in Mexico with adequate supply of refrigerant gas and components. The markets in Latin American are moving towards R-600a domestic refrigerators.

### Project description

#### *Domestic refrigerator manufacturing*

12. Given the flammability of R-600a, changes are required in the production process mainly at the four out of six manufacturing lines, in the end-products, and modifications in material flow operations to work with HC-based refrigerants. The project contains three components for which funds are requested:

- (a) Modifications to the storage and supply of refrigerant, including explosion proof pumping and pipeline system to download, store and distribute the refrigerant at the plant; a storage tank; a safety system (i.e., leak detectors, fire-fighting equipment, shut-off valves and flux and pressure sensors, water sprinkler, smoke detectors); equipment installation and civil works (i.e., construction of pump and transfer rooms); and relevant certifications (US \$592,923);
- (b) Production line modifications including introduction of helium leak detection equipment; four refrigerant charging stations suitable for R-600a and retrofitting of one existing charging station; three ultrasonic sealing of the refrigeration system; five post-charge leak detectors; safety system and certification based on local standards in the manufacturing process and repair zone; civil works; costs of modification of tools, and material handling facilities (US \$1,471,396); and
- (c) Modifications to the laboratory for development and testing; modifications to the electrical controls of the HC-based fridges to ensure safe operation; installation and start-up of all the new equipment modifications and engineering component changes; and electronic components of manufacturing facilities including electronic cards and harness (US \$897,566).

### Project costs and co-financing

13. The incremental capital costs (ICC), as originally submitted and including contingencies, were at US \$3,258,074 as shown in Table 4.

**Table 4: Costs for the conversion of domestic refrigerators to R-600a in Mabe-Mexico**

Description	Cost (US\$)	%
Supply system R-600a (tank + facilities + pump room)	370,783	11.4
Safety systems R-600a (tank + facilities)	222,140	6.8
Charging equipment, tube sealed and leakage detection in process areas	480,282	14.7
Safety systems and charging and leakage area facilities	311,461	9.6
Helium leakage detection systems for evaporator and high side	399,460	12.3
Charging area room (flame-free and electrical components)	90,962	2.8
Working station enabling (assembly and cabinet)	189,231	5.8
Modification of liners die cutters and foam moulds	34,570	1.1
Secondary facilities (air, nitrogen and electricity) node network	139,972	4.3
Material flow (containers and backup cars)	178,011	5.5
Die cutters for back recess and lid (back up electronic card)	260,000	8.0
Electronic cards (equipment and devices)	186,000	5.7
Harness (routing board)	99,013	3.0
<b>Sub-total</b>	<b>2,961,885</b>	<b>90.9</b>
Contingencies (10 %)	296,189	9.1
<b>Total</b>	<b>3,258,074</b>	<b>100.0</b>

14. As the baseline equipment varied for each line, the requested funding for some of the lines were lower than the other lines; for example, one line had refrigerant charging equipment, HC leak detection equipment and helium leak detector and as a result funding was not required for these equipment items. Further, some of the equipment items appear to relate to material flow modifications and engineering tools that may be not be incremental for the conversion project.

15. Incremental operating costs (IOC) which includes costs related to change in refrigerant and energy efficiency improvement was estimated at US \$3.82 per unit on an average excluding compressors for conversion of refrigerant to R-600a, and US \$2.54 per unit on an average for energy efficiency component. Funding requested for total IOC for one year is US \$7,744,980, as shown in Table 5.

**Table 5. IOC for domestic refrigerator manufacturing in Mabe-Mexico**

Models	R-600a (US \$)	Energy efficiency (US \$)	Total (US \$)
One door (A210)	46,428	30,952	77,380
No Frost (230 L to 300 L)	1,973,400	1,315,600	3,289,000
No Frost 360 L	777,240	518,160	1,295,400
No Frost (400 L to 520 L)	853,440	568,960	1,422,400
BF Pangea	435,960	290,640	726,600
SXS	560,520	373,680	934,200
<b>Total</b>	<b>4,646,988</b>	<b>3,097,992</b>	<b>7,744,980</b>

#### *Compressor manufacturing*

16. Mabe-Mexico also has compressor manufacturing facilities with a total capacity of 1.5 million compressors per annum producing two different categories of compressors namely CQ (30 to 100 watts) and CB (90 to 140 watts).

17. The conversion of compressor manufacturing involves retrofitting manufacturing lines, quality-testing equipment, tooling for new parts, product development and modification in testing facilities including calorimeter, at a total estimated cost of the product is US \$6,090,962 as shown in Table 6.

**Table 6: Costs for conversion to R-600a compressors at Mabe-Mexico**

Description	Cost (US \$)	%
<b>Retrofit of existing manufacturing lines</b>	<b>3,552,844</b>	<b>58.3</b>
Monoblock line	628,672	
Crankshaft line	864,369	
Connecting rod line	237,125	
Valve plate line	415,394	
Piston line	270,935	
Assembly line	479,183	
Rotor line	33,131	
Stator line	624,035	
<b>Quality test equipment</b>	<b>460,576</b>	<b>7.6</b>
<b>New parts tooling</b>	<b>445,684</b>	<b>7.3</b>
<b>Prototypes and tools</b>	<b>77,482</b>	<b>1.3</b>
<b>Product development</b>	<b>567,884</b>	<b>9.3</b>
<b>Calorimeters</b>	<b>432,768</b>	<b>7.1</b>
<b>Subtotal</b>	<b>5,537,238</b>	<b>90.9</b>
<b>Contingencies (10%)</b>	<b>553,724</b>	<b>9.1</b>
<b>Total</b>	<b>6,090,962</b>	<b>100.0</b>

18. The project also includes co-financing. UNDP has indicated that they have assured grants under Kigali Cooling Efficiency Program (KCEP) amounting to US \$400,000, which is available once the project

is prepared with completely assured funding. Additional co-financing amounting to US \$8,564,008 would be provided by Mabe-Mexico.

19. The summary of the total project funding including adjustments for exports to non- Article 5 countries and co-financing, is given Table 7.

**Table 7. Total project funding request for Mabe-Mexico (as submitted)**

<b>Component</b>	<b>Costs in US \$</b>
Incremental cost for refrigerator manufacturing	11,003,054
Incremental cost for compressor manufacturing	6,090,962
<b>Total</b>	<b>17,094,016</b>
Adjustment for export to non-Article 5 countries for refrigerator manufacturing (33 per cent)	(3,631,008)
<b>Adjusted incremental costs</b>	<b>13,463,008</b>
Co-financing from KCEP	(400,000)
Co-financing from enterprise and other sources	(8,563,008)
<b>Requested funding</b>	<b>4,500,000</b>

20. The cost-effectiveness of the project for the conversion of the refrigerator manufacturing lines (excluding the compressor lines) is US \$64.65/kg. The project will be implemented over a period of 24 months.

## SECRETARIAT'S COMMENTS AND RECOMMENDATION

### COMMENTS

#### *Eligibility*

21. The Secretariat reviewed the project proposal based on the current policies and decisions of the Multilateral Fund, similar approved conversion projects for CFC phase-out (i.e., conversion of refrigerant component from CFC-12 to R-600a involving product and manufacturing process redesign, conversion of compressor manufacturing plants from ODS to flammable alternatives) and approved projects to phase-out ODS with flammable alternatives.

22. The project for Mabe-Mexico has been submitted in line with decisions 78/3(g) and 79/45. It included an official letter from the Government with the commitment required in decision 78/3(g). In line with decision 79/45, the endorsement letter from the Government of Mexico indicates it would make every effort to ratify the Kigali Amendment, as soon as possible, confirmed that it is aware that no further funding would be available until the instrument of ratification of the Kigali Amendment had been received by the depositary at the United Nations Headquarters in New York, if this project would be approved by the Executive Committee; and acknowledged that in case this project is approved, any HFC reduced would be deducted from its starting point (which may be agreed in the future). The Secretariat also notes with appreciation that this proposal was submitted without preparation funding.

23. UNDP explained that Mabe-Mexico and the Government are strongly committed to implement this project; this is reflected in the significant levels of co-financing that the enterprise proposes to invest for implementing this project; the enterprise also intends to use this conversion project for achieving energy efficiency standards in the country. The results of the project are expected to encourage adoption of energy efficient R-600a-based equipment in the markets in Mexico and in the region.

#### *Regulatory framework*

24. The Secretariat requested clarifications on how sustainability of production of R-600a-based refrigerators would be achieved noting that R-600a-based refrigerators are just being introduced in the

market and have a share of 6.2 per cent in the total production in the country. UNDP explained that the Government has implemented nine standards that relate to energy efficiency and safety for production and sales of R-600a-based domestic refrigerators; further, Mabe-Mexico has decided to adopt R-600a technology to comply with the national energy efficiency regulations which would require refrigerators to increase their energy efficiency on average of 16 per cent; this will also help the enterprise sell in other markets which are implementing higher energy efficiency standards for refrigerators. The Secretariat also noted that the R-600a-based refrigerator production has increased since 2012.

#### *Proposed costs*

25. The Secretariat requested clarification on the need and costs for charging equipment, helium leak detectors, ultrasonic welding machine, HC leak detector, HC recovery machine, and other equipment that were for distribution of components, quality control and information technology support, noting that some of these costs do not appear to be incremental for the proposed conversion project. The Secretariat also asked clarifications on what components of the project would be co-financed by the enterprise.

26. UNDP explained that the requested modifications were necessary to implement the conversion project noting that the enterprise has already undertaken initial steps such as product design modifications and conversion of some of the refrigerator assembly lines. UNDP agreed to adjust costs required for refrigerant charging equipment, ultrasonic welding machines in the production lines, helium leak detection equipment, some of the costs relating to storage and gas supply systems, and costs relating to safety equipment. Additional costs for technical assistance and safety audit and training amounting to US \$75,000 were included in the incremental capital costs. UNDP also explained that the enterprise has not specifically identified individual components that would be co-financed but would be providing additional finance beyond the agreed costs for implementing the conversion project.

27. The Secretariat also requested clarification on the methodology followed for calculating the IOC (i.e., how the energy efficiency component and refrigerant conversion components were separately identified) and noted that IOC was higher than the costs of similar projects submitted to the 80<sup>th</sup> meeting. UNDP provided details of IOC calculations for individual models and explained that a proportion of the total incremental costs was applied to refrigerant conversion (60 per cent) and energy efficiency component (40 per cent). Based on discussions and inputs on comparable projects with similar refrigerator conversion requirements from the region, UNDP agreed to rationalise the IOC from US \$6.36 to US \$0.93 per unit on an average. Incremental costs for compressor was also removed as the project includes conversion of compressor manufacturing facility in the enterprise.

28. The agreed costs of the conversion of the domestic refrigerator manufacturing lines are shown in Table 8.

**Table 8. Agreed costs for conversion of domestic refrigerator manufacturing at Mabe-Mexico**

Particulars	Proposed cost (US \$)	Agreed cost (US \$)
<b>Refrigerator manufacturing</b>		
Product design, testing and certification	-	-
Refrigerant charging and supply system	370,783	260,000
Assembly line modifications	1,966,539	562,988
Safety systems	624,563	262,000
<b>Subtotal</b>	<b>2,961,885</b>	<b>1,084,988</b>
Contingency (10%)	296,189	108,499
Technical assistance and safety audit	0	60,000
Training	0	15,000
<b>Total capital cost</b>	<b>3,258,074</b>	<b>1,268,487</b>
Incremental operating costs	7,744,980	1,401,931
<b>Total cost before adjustment for exports to non-Article 5 countries</b>	<b>11,003,054</b>	<b>2,670,418</b>
Adjustment for exports to non-Article 5 countries*	(3,631,008)	(818,594)

Particulars	Proposed cost (US \$)	Agreed cost (US \$)
<b>Total incremental costs</b>	<b>7,372,046</b>	<b>1,851,824</b>
<b>HFC-134a consumption (mt)</b>	<b>170.19</b>	<b>170.19</b>
<b>CE (US \$/kg)</b>	<b>43.32</b>	<b>10.88</b>

\*Exports to non-Article 5 countries amount is 30.65 per cent of total production.

#### *Conversion project for compressors*

29. The Secretariat has limited experience in projects related to the conversion of compressor manufacturing from HFC-134a to isobutane for domestic refrigerators; however, it reviewed this project in light of the demonstration projects approved for compressor conversion to HC refrigerant in air-conditioning and discussions relating to compressor conversion project for Bangladesh submitted to the 80<sup>th</sup> meeting<sup>9</sup>, noting similarities between these projects.

30. The proposed conversion is for producing fixed-speed isobutane-based compressors. UNDP explained that the choice of fixed-speed compressor model was to provide a cost advantage. The conversion of the compressor to variable speed design would be undertaken based on market demand for such equipment at a future date.

31. The Secretariat requested clarification on the costs associated with changes in the manufacturing facility, and the costs associated with product redesign noting that the enterprise has already developed product designs, testing facilities and technical assistance costs.

32. Further to discussion with UNDP, it was agreed to adjust the costs for plant equipment modification from US \$3,998,528 to US \$1,086,167; costs of testing from US \$893,344 to US \$250,000, and allocate US \$30,000 for technical assistance. The agreed costs for conversion of the compressor manufacturing facility are shown in Table 9.

**Table 9. Agreed costs for conversion of compressor manufacturing at Mabe-Mexico**

Particulars	Proposed cost (US \$)	Agreed cost (US \$)
Costs of plant equipment modification	3,998,528	1,086,167*
Product redesign and prototype development	645,366	-
Product testing and quality control	893,344	250,000
<b>Subtotal</b>	<b>5,537,238</b>	<b>1,336,167</b>
Contingency (10%)	553,724	133,617
Technical assistance		30,000
<b>Total</b>	<b>6,090,962</b>	<b>1,499,784</b>

\*Including delivery and installation costs.

#### **Agreed level of funding**

33. Based on the above review, the proposed incremental costs for conversion for the refrigerator manufacturing component of Mabe-Mexico amounts to US \$3,351,607 to phase out 170.19 mt (308,044 CO<sub>2</sub> tonnes) of HFC-134a as shown in Table 10. UNDP informed that additional funding required for conversion will be co-financed by the enterprise and/or obtained from other funding sources.

<sup>9</sup> UNEP/OzL.Pro/ExCom/80/32.

**Table 10. Agreed incremental costs for conversion of refrigerator and compressor manufacturing at Mabe-Mexico**

Particulars	HFC-134a phase-out (mt)	Cost (US \$)	Cost-effectiveness (US \$/kg)
Refrigerator manufacturing	170.19	1,851,824	10.88
Compressor manufacturing	-	1,499,784	n/a
<b>Total</b>	<b>170.19</b>	<b>3,351,608</b>	<b>n/a</b>

34. The Secretariat notes that the purpose of implementing projects under decision 78/3(g) is to gain experience in the ICCs and IOCs that might be associated with phasing down HFCs. Based on available information at the time of review, the Secretariat considers that the agreed costs are its best estimates of the overall incremental costs of conversion; these estimates might change as more information becomes available, and according to the specific characteristics of the enterprises. The Secretariat, therefore, considers that the agreed costs above would not constitute a precedent.

35. The enterprise has committed that it will stop using HFC-134a in producing domestic refrigerators upon project completion by December 2019.

### **2017-2019 Business plan**

36. This project does not fall under the regular business plans submitted to the Secretariat and presented to the Executive Committee as it falls under the purview of decision 78/3(g).

### **RECOMMENDATION**

37. The Executive Committee may wish to consider the project for conversion of domestic refrigeration manufacturing facility from HFC-134a to isobutane (R-600a) as a refrigerant and conversion of compressor manufacturing facility from HFC-134a-based compressors to isobutane-based compressors at Mabe Mexico S.A. de C.V. in the context of its discussion of the proposals for HFC-related projects described in the document on Overview of issues identified during project review (UNEP/OzL.Pro/ExCom/80/22).