



**United Nations
Environment
Programme**

Distr.
GENERAL

UNEP/OzL.Pro/ExCom/81/32
1 June 2018

ORIGINAL: ENGLISH

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

PROJECT PROPOSALS: ECUADOR

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

Foam

- Phase-out of HCFC-141b contained in imported pre-blended polyols in the polyurethane foam sector UNIDO

Refrigeration

- Conversion of the manufacturing of domestic and commercial refrigerators from HFC-134a and R-404A to isobutane (R-600a) and propane (R-290) at Ecasa UNIDO
- Conversion of the manufacturing of commercial refrigerators from HFC-134a to isobutane (R-600a) and propane (R-290) at Induglob UNIDO

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

Ecuador

PROJECT TITLE(S)

BILATERAL/IMPLEMENTING AGENCY

(a) Phase-out of HCFC-141b contained in imported pre-blended polyols in the polyurethane foam sector	UNIDO
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NATIONAL COORDINATING AGENCY

Ministerio de la Industria y la Productividad

LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT

A: ARTICLE-7 DATA (ODP TONNES, 2017, AS OF APRIL 2018)

HCFCs	18.13
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B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, 2017, AS OF APRIL 2018)

HCFC-22	15.89
HCFC-141b	2.17
HCFC-142b	0.02
HCFC-123	0.03
HCFC-124	0.01
HCFC-141b contained in imported pre-blended polyols	12.99

HCFC consumption remaining eligible for funding (ODP tonnes)

20.97

CURRENT YEAR BUSINESS PLAN ALLOCATIONS

Funding (US \$)

Phase-out (ODP tonnes)

147,513

5.71

PROJECT:

ODS used at enterprise (ODP tonnes):	16.20
ODS to be phased out (ODP tonnes):	15.34
ODS to be phased in (ODP tonnes):	0.00
Project duration (months):	24
Initial amount requested (US \$):	507,871
Final project costs (US \$):	
Incremental capital costs:	558,460
Contingency (10 %):	49,000
Incremental operating costs:	31,376
Total project costs:	638,836
Local ownership (%):	100
Export component (%):	0
Requested grant (US \$):	431,719
Cost-effectiveness (US \$/kg):	*9.79
	Threshold: 9.79
Implementing agency support costs (US \$):	30,220
Total cost of project to the Multilateral Fund (US \$):	461,939
Status of counterpart funding (Y/N):	Y
Project monitoring milestones included (Y/N):	Y

*The cost-effectiveness including all eligible and non-eligible consumption phased out is US \$3.10/kg.

SECRETARIAT'S RECOMMENDATION

For individual consideration

PROJECT DESCRIPTION

1. On behalf of the Government of Ecuador, UNIDO has submitted an investment umbrella project to phase out the use of HCFC-141b contained in imported pre-blended polyols in the manufacturing of polyurethane (PU) foam in the remaining enterprises, at a cost of US \$507,871, plus agency support costs of US \$35,550.

Background

2. At the 65th meeting, the Executive Committee approved stage I of the HCFC phase-out management plan (HPMP) for Ecuador,¹ including an investment project for the phase-out of 136.00 metric tonnes (mt) (14.96 ODP tonnes) of HCFC-141b contained in imported pre-blended polyols used by the largest domestic refrigeration enterprise (Indurama) in the manufacturing of PU foam panels.

3. At the time of the approval of stage I of the HPMP, there were several small- and medium-sized PU foam enterprises, which consumed all together 51.88 mt (5.71 ODP tonnes) of HCFC-141b contained in imported pre-blended polyols, representing the remaining consumption eligible for funding. Given that at that time there were no proven, cost-effective, and commercially available technologies with low global-warming potential (GWP) in Ecuador, it was agreed that the Government could submit during the implementation of stage I, a proposal for the conversion of the remaining eligible PU foam enterprises, at an estimated cost of up to US \$507,871, using the cost-effectiveness threshold for foams as reference, once such technologies became available.²

HCFC consumption in the foam sector in Ecuador

4. The consumption of HCFC-141b contained in imported pre-blended polyols in Ecuador during the past five years is presented in Table 1. A major decrease in consumption in 2013 was due to the phase-out associated with the conversion of Indurama. However, the consumption increased between 2014 and 2016 due to growth in the construction and the demand for PU insulation applications. The decrease in 2017 was due to economic slowdown.

Table 1. Consumption of HCFC-141b contained in imported pre-blended polyols in Ecuador

Consumption	Average 2007–2009	2013	2014	2015	2016	2017	Average 2015–2017
Metric tonnes	187.88	95.64	140.73	142.56	181.07	118.09	147.24
ODP tonnes	20.67	10.52	15.48	15.68	19.92	12.99	16.20

5. The polyols are imported by two systems distributors (30 per cent of the total) and ten PU foam manufacturers. One of the systems distributors started to import cyclopentane pre-blended polyols from Pumex in Mexico, and another enterprise (Enviroplastic) is the representative of a systems house able to supply HFO-1233zd in the region.

Enterprise background, phase-out activities and associated costs

6. The seven largest small and medium-sized enterprises (SMEs) producing foam are: Ecasa, Infri, Kubiec, Mafrico, Marco Mora Duque, Rooftec and Vertron; they account for more than 90 per cent of the consumption of HCFC-141b contained in pre-blended polyols. The list of 11 enterprises included for conversion in the project, their applications and the technology selected for conversion is presented in Table 2.

¹ UNEP/OzL.Pro/ExCom/65/31

² UNEP/OzL.Pro/ExCom/65/31 and Appendix 8-A of the Agreement between the Government of Ecuador and the Executive Committee for stage I of the HPMP.

Table 2. Remaining PU foam enterprises eligible for funding in Ecuador

Enterprise	Foam dispenser installation	Application	HCFC-141b (mt)	Technology selected
Cepolfi	n/a	Integral skin	0.00	Water
Chova del Ecuador	n/a	Roof insulation	0.10	To be determined
Ecasa	1996	Refrigerators	6.60	Pre-blended hydrocarbon (HC)
Elasto	Prior to 2007	Integral skin/flexible	0.10	Water
Fibroacero	n/a	Refrigeration	0.10	To be determined
Infri	2007	Panels, spray foam	4.40	Pre-blended HCs
Kubiec	2006/2014	Panels	54.60	Pre-blended HCs
Mafrico	2000/2016	Panels	51.60	HFO-1233zd
Marco Mora Duque	2005	Panels	2.60	Pre-blended HCs, water
Rooftec	Unknown*	Roof insulation	10.90	Pre-blended HCs
Verton	1986/2005	Panels	6.90	Pre-blended HCs, water
Other SMEs**	n/a	Panels/integral skin/ shoe sole/spray foam	~9.54	Pre-blended HCs, water
Total			147.24	

*The enterprise started manufacturing in 2004; equipment was installed before 2007 but the exact date is not available.

**Includes: Acimco, Dipacmanta, Ecuapoliuretanos, Enviroplastic, Esprom, Fabrec, Gasepol (formerly Tecnistamp), Imptek del Ecuador, Inducalsa, La Fortaleza, Milenium, Milplast, Novacero and other SMEs not identified.

7. The reasons for the selection of the alternative technologies are the following:

- (a) Pre-blended HCs are used in Mexico and have been tested in Ecuador with good results; they do not require costly pre-mixing or large storage tanks, saving on capital costs; and systems are sufficiently stable for commercial use if the applicable safety measures are taken (e.g. shelf life has to be checked for each different formulation);
- (b) HFO-1233zd is non-flammable and has negligible GWP; it does not require equipment modifications and shows better isolation properties in the foam; it can also be decreased in the formulation, with water, to reduce the high operating cost that stems from its price. The disadvantages are availability, cost, and limited experience in its use; and
- (c) Water-based technology has low GWP, is not flammable and can be used in some applications where thermal conductivity is not a key factor, noting that it also requires an increase in foam density.

Incremental costs

8. The incremental capital costs (ICCs) for the conversion to pre-blended HC include: the retrofit of foam dispensers (US \$15,000 to US \$30,000 per enterprise); drum storage, including safety-related items (US \$6,000 to US \$12,000 per enterprise); plant safety measures, including ventilation, gas sensors, a fire-protection system, antistatic floors and civil works (US \$32,000 per enterprise); trials and tests (US \$5,000), and project management (US \$1,000 to US \$2,000 per enterprise). The conversion to HFO and water-blown technologies includes: the retrofit of foam dispensers (US \$15,000 to US \$30,000 per enterprise); formulation development (between US \$5,000 and US \$20,000); and trials and tests (US \$5,000). Contingencies have been calculated at 10 per cent of the capital costs.

9. A technical assistance component has been included at a total cost of US \$33,000 and is focused on assisting the SMEs in introducing pre-blended HCs in several applications, including spray foam, or water for other applications where insulation properties are not critical.

10. Incremental operating costs (IOCs) have been requested only for one enterprise (Mafrico) which is being converted to HFO, and have been calculated on the basis of the difference between the blowing agents formulations. No IOCs are being requested for the other enterprises.

11. The total incremental costs of the conversion of the PU foam sector amount to US \$746,605, as originally submitted. In line with decisions 61/47 and 63/15, a total of US \$507,871 is being requested at a cost-effectiveness of US \$9.79/kg, as shown in Table 3. The project will be implemented in 24 months.

Table 3. Incremental costs of the conversion of the PU foam sector in Ecuador

Enterprise	Consumption (mt)		ICC (US \$)	IOC (US \$)	Total cost (US \$)
	Total	Eligible*			
Cepolfi	0.00	0.00	28,600	-	28,600
Chova del Ecuador	0.10	0.10	23,100	-	23,100
Ecasa	6.60	6.60	66,000	-	66,000
Elasto	0.10	0.10	28,600	-	28,600
Fibroacero	0.10	0.10	64,900	-	64,900
Infri	4.40	4.40	66,000	-	66,000
Kubiec	54.60	13.65	72,600	-	72,600
Mafrico	51.60	19.61	57,200	89,905	147,105
Marco Mora Duque	2.60	2.60	66,000	-	66,000
Rooftec	10.90	4.36	66,000	-	66,000
Verton	6.90	6.90	84,700	-	84,700
Technical assistance to SMEs	~9.54	7.50	33,000	-	33,000
Total costs	147.24	65.92	656,700	89,905	746,605
Funds requested					507,871
Eligible consumption		51.88			9.79

*Manufacturing capacity established before the cut-off date of 21 September 2007

12. In accordance with decision 61/47(c)(iv), the Government of Ecuador commits to banning imports of HCFC-141b contained in imported pre-blended polyols once the project has been completed, and no later than 1 January 2020.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

Enterprise eligibility

13. The Secretariat reviewed the project proposal in the light of decisions 61/47(c) and 63/15. The eligibility of the enterprises included in the project was assessed, taking into consideration the indicative list of enterprises established prior to 21 September 2007 that used HCFC-141b contained in pre-blended polyols, and relevant decisions of the Multilateral Fund. The results of the assessment are summarized below:

- (a) *Enterprises not included in the indicative list:* The following four enterprises were not contained in the indicative list: Marco Mora Duque (2.6 mt), Chova del Ecuador (0.1 mt), Fibroacero (0.1 mt) and Dipac (0.0 mt). UNIDO explained that except Fibroacero, the three other enterprises were established before 2007 and were still manufacturing foams, but their consumption was intermittent. These three enterprises had been included under "other enterprises," which groups together a number of SMEs. On this basis, Fibroacero was removed from the project;
- (b) *Enterprises in the indicative list that are not consuming HCFC-141b:* The current consumption of seven of the enterprises in the indicative list, is zero. UNIDO explained that the market has substantially changed since the 2007-2009 period (the reference years for the indicative list); some enterprises have reduced their consumption, and others have increased it. While these enterprises do not receive funding for conversion, all the SMEs that have been identified as using or having recently used HCFC-141b will be contacted

and invited to participate at workshops demonstrating new alternatives under the technical assistance component of the project; and

- (c) *Second-stage conversions:*³ The enterprise Ecasa converted to HCFC-141b with Multilateral Fund assistance. As funds are requested for conversion of the same line, the enterprise does not comply with the condition for full funding in decision 60/44;⁴ accordingly it was agreed that funding would be for trials, installation and training only. Mafrico also converted to HCFC-141b with Multilateral Fund assistance; however, the funds being requested under the present project proposal are for another manufacturing line installed in 2000. Finally, Elasto converted to methylene chloride with Multilateral Fund assistance; its capacity is therefore not eligible for funding for the phase-out of HCFC-141b.

Issues related to the selected technologies

14. In line with decisions 74/20(a) and 77/35(a)(v), UNIDO has provided information on how and when an adequate supply of pre-blended HCs and HFO-1233zd and associated components (e.g. additives) will be made commercially available to Ecuador. For the enterprises that have selected pre-blended HCs, the technology is already present on the local market, and tests have been made with positive results, particularly in Ecasa; the alternative is patented by Pumex Mexico and will be represented in Ecuador by Quimica Suiza, which already has the infrastructure required to handle HC products.

15. The supplier of HFO-1233zd is a systems house located in Panama; its representative in Ecuador (Enviroplastic) has confirmed that a permanent supply will be guaranteed in the event that there is demand for its product. Given that only one enterprise (Mafrico) is converting to this technology, it has been agreed that, if, during the implementation of the project, the enterprise decides also to convert to pre-blended HCs, the additional capital cost will be covered by the enterprise itself and the IOCs would be returned to the Multilateral Fund.

16. The Secretariat expressed a major concern about the proposal to use pre-blended HCs in spray foam applications, as HCs are not recommended for this application on account of their flammability. Given that fact, some countries have implemented demonstration projects to test other technologies (e.g. HFO reduced with water); other countries have postponed the conversion of the spray foam sector to future stages of the HPMP when an alternative that is economically feasible and non-flammable is more likely to be available. Furthermore, the Technology and Economic Assessment Panel (TEAP) reports do not recommend the use of this flammable technology in spray foam.⁵ In addition, the independent technical expert that reviewed the project for UNIDO also stated that he had no experience in the use of HCs in spray foam.

17. In this regard, UNIDO explained that pre-blended HCs have been used by Pumex in Mexico for some years already; some tests have also been made in Ecasa and other small producers, with reported success. However, after further consultations, UNIDO agreed that the conversion of 7.78 mt of HCFC-141b

³ Project ECU/FOA/09/INV/10 included Ecasa and Mafrico. Project ECU/FOA/26/INV/24 included Elasto.

⁴ Decision 60/44(b)(i) and (ii): (b)(i) Full funding of eligible incremental costs of second-stage conversion projects will be considered in those cases where an Article 5 Party clearly demonstrates in its HPMP that such projects are necessary to comply with the Montreal Protocol HCFC targets up to and including the 35 per cent reduction step by 1 January 2020 and/or are the most cost-effective projects measured in ODP tonnes that the Party concerned can undertake in the manufacturing sector in order to comply with these targets; (b)(ii) Funding for all other second-stage conversion projects not covered under paragraph (b)(i) above will be limited to funding for installation, trials, and training associated with those projects.

⁵ The 2014 FTOC Assessment Report indicates that: "for PU spray foam the major challenge relates to the safe processing of these systems under in-situ conditions within a building. The potential for the accumulation of blowing agent in 'pockets' creates the risk of fire or explosion if flammable materials are used. Therefore, HCs have broadly been ruled out for these applications."

in spray foam will be postponed to stage II of the HPMP, representing the remaining eligible consumption for funding.

Incremental costs

18. On the basis of the eligibility analysis of the enterprises included in the umbrella project, four individual conversions will be removed. Specifically, it has been agreed that the requests for funding for Elasto (US \$28,600) and Fibroacero (US \$64,900) will be removed, as they were found to be ineligible; and given their very low level of consumption, the enterprises Cepolfi (US \$28,600) and Chova del Ecuador (US \$23,100) have been integrated into the technical assistance component rather than treated as individual conversions. In addition, the request for funding for Ecasa (second-stage conversion) will be reduced from US \$66,000 to US \$44,000 to include only installation of equipment (mostly safety items to be procured by the enterprise), trials and training.

19. Given that the tests and trials of pre-blended HCs were an underfunded element in the original request, and that the technology is relatively new in the country and is not yet being commercially used, part of the funding associated with the above enterprises has been used to increase the amount of funding requested for the five individual conversions. This will allow more enterprises to be included. The cost of trials, testing and training for the individual conversions has been agreed at between US \$15,000 and US \$30,000, depending on the production level of the enterprise. For the remaining ICC items, the Secretariat notes that the cost levels requested are already comparable to, and in some cases lower than, other proposals made to convert to cyclopentane. As a result, no major adjustments have been made to the unitary cost levels. The cost of retrofitting foam dispensers has been maintained as submitted (US \$15,000 to US \$30,000 per enterprise), the cost of the drum storage area has been set at US \$10,000 for each enterprise and the cost of safety system in the plant is US \$30,000. The project management costs (US \$1,000 to US \$2,000 per enterprise) have been removed.

20. It has also been agreed that technical assistance would be provided with support from the two main distributors of polyols in the country, following the model applied with systems houses. In the case of Ecuador, however, given the low level of consumption by SMEs and the limits on the funding available, funds would be only for the development of formulations (US \$24,400) and trials, testing and training for end-users (US \$50,000). No equipment costs are included in this component.

21. The IOCs for Mafrico have also been adjusted to US \$1.60/kg, as per the cost guidelines for stage I of HPMPs (decision 60/44(f)(v)), and have been calculated on the basis of the eligible portion of the consumption only (19.61 mt).

22. On the basis of the above, the total cost of the project amounts to US \$638,836, to phase out 65.72 mt of HCFC-141b contained in imported pre-blended polyols, with a cost-effectiveness of US \$9.72/kg. Taking into consideration that the consumption eligible for funding is 44.10 mt (51.88 mt in line with decision 61/47 and 63/15, minus a deduction of 7.78 mt used in the spray foam to be phased out during stage II of the HPMP), the maximum level of funding is US \$431,719. The funds requested by enterprises and technical assistance were adjusted accordingly, as shown in Table 4.

Table 4. Agreed incremental costs for the conversion of PU foam enterprises in Ecuador

Enterprise	Consumption (mt)	Cost (US \$)			
		ICC	IOC	Total	Requested*
Ecasa	6.60	44,000	-	44,000	32,000
Infri	4.40	86,152	-	86,152	62,000
Kubiec	13.65	110,000	-	110,000	70,000
Mafrico	19.61	66,000	31,376	97,376	82,719
Marco Mora Duque	2.60	50,908	-	50,908	37,000
Rooftec	4.36	77,000	-	77,000	56,000
Verton	6.90	99,000	-	99,000	72,000

Enterprise	Consumption (mt)	Cost (US \$)			
		ICC	IOC	Total	Requested*
Technical assistance to SMEs	7.60	74,400	-	74,400	20,000
Total	65.72	607,460	31,376	638,836	431,719
Eligible consumption					44.10
Cost-effectiveness					9.79

*Funds by enterprise have been adjusted to the maximum of 44.10 mt that can be requested in a proportional way to allow proper implementation, with a lower level for the technical assistance for SMEs, considering that in stage II additional funding could be requested to address up to 7.78 mt used in spray foam.

23. In addition to the 65.72 mt of HCFC-141b contained in imported pre-blended polyols eligible for funding, as shown in Table 4, these enterprises are also consuming 81.52 mt not eligible for funding. This consumption (with exception of the 7.78 mt used in spray foam) will also be phased out during stage I. The cost-effectiveness, including all the tonnage being phased out in stage I, is US \$3.10/kg.

24. Given the level of funding available for the individual conversions, it was agreed with UNIDO that there will be flexibility in the allocation of funds for the procurement of equipment, on the understanding that if an enterprise stops using HCFC-141b, the funds allocated to that enterprise will be returned to the Multilateral Fund.

25. Consistent with decision 63/15(d), the project proposal includes a commitment from the Government of Ecuador to put in place, by the time the last foam manufacturing plant has been converted to a non-HCFC technology, regulations or policies banning the import and/or the use of HCFC-141b in pre-blended polyol systems. Given that the spray foam enterprises will only convert in stage II, the deadline for establishing the ban on imports and use of HCFC-141b pre-blended polyols systems has been moved from 1 January 2020 to 1 January 2022 when the spray foam enterprises will have been converted. In the meantime, the Government commits to establishing a ban on the import of HCFC-141b contained in imported pre-blended polyols for any use other than spray foam as of 1 January 2020. The import of HCFC-141b contained in imported pre-blended polyols for spray foam will be subject to a quota of a maximum of 7.78 mt until the complete ban enters into force on 1 January 2022.

Revision of the Agreement

26. In order to reflect the approval of the PU foam projects, the Updated Agreement between the Government of Ecuador and the Executive Committee for stage I of its HPMP has been revised to reflect the changes in Appendix 2-A (the funds approved and the remaining eligible consumption) and to revise paragraph 16 to indicate that the Revised updated Agreement for stage I supersedes the one reached at the 70th meeting, as contained in Annex I to the present document. The full Revised updated Agreement will be appended to the Final report of the 81st meeting.

Impact on the climate

27. The conversion of the PU foam manufacturing enterprises in Ecuador would avoid the emission into the atmosphere of 46,585 tonnes of CO₂ equivalent per year, as shown in Table 5.

Table 5. Impact on the climate of the PU foam projects

Substance	GWP	Tonnes/year	CO ₂ -eq (tonnes/year)
Before conversion			
HCFC-141b	725	65.72	47,647
After conversion			
HFO-1233zd, cyclopentane, water	~20	39.43	789
Impact			(46,858)

RECOMMENDATION

28. The Executive Committee may wish to consider:
- (a) Approving the project proposal for the phase-out of HCFC-141b contained in imported pre-blended polyols in the foam sector, excluding spray foam, in Ecuador, in the amount of US \$431,719, plus agency support costs of US \$30,220 for UNIDO;
 - (b) Deducting 4.85 ODP tonnes of HCFCs from the remaining HCFC consumption eligible for funding;
 - (c) Noting:
 - (i) The commitment of the Government of Ecuador not to issue any import quota for HCFC-141b contained in pre-blended polyols starting 1 January 2020, except for a maximum of 0.86 ODP tonnes (7.78 mt) for spray foam for the years 2020 and 2021;
 - (ii) That the updated Agreement between the Government of Ecuador and the Executive Committee for stage I of its HPMP has been revised to reflect the changes in Appendix 2-A (the funds approved and the remaining eligible consumption) and to revise paragraph 16 to indicate that the Revised updated Agreement for stage I supersedes that reached at the 70th meeting, as contained in Annex I to the present document; and
 - (iii) That the Government of Ecuador will submit as part of stage II a project proposal for the phase-out of HCFC-141b contained in imported pre-blended polyols for spray foam.

Annex I

TEXT TO BE INCLUDED IN THE UPDATED AGREEMENT BETWEEN THE GOVERNMENT OF ECUADOR AND THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE REDUCTION IN CONSUMPTION OF HYDROCHLOROFLUOROCARBONS
(Relevant changes are in bold font for ease of reference)

16. This updated Agreement supersedes the updated Agreement reached between the Government of Ecuador and the Executive Committee at the 70th meeting of the Executive Committee.

APPENDIX 2-A: THE TARGETS, AND FUNDING

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
1.1	Montreal Protocol reduction schedule of Annex C, Group I substances (ODP tonnes)	n/a	n/a	23.49	23.49	21.14	21.14	21.14	21.14	21.14	15.27	n/a
1.2	Maximum allowable total consumption of Annex C Group I substances (ODP tonnes)	n/a	n/a	23.49	23.49	21.14	21.14	21.14	21.14	21.14	15.27	n/a
2.1	Lead IA UNIDO agreed funding(US \$)	1,531,940	0	86,500	0	0	86,500	0	*518,219	0	55,000	2,278,159
2.2	Support costs for Lead IA(US \$)	114,896	0	6,488	0	0	6,487	0	*36,707	0	4,125	168,703
2.3	Cooperating IA UNEP agreed funding (US \$)	30,000	0	20,000	0	0	30,000	0	25,000	0	10,000	115,000
2.4	Support costs for Cooperating IA (US \$)	3,900	0	2,600	0	0	3,900	0	3,250	0	1,300	14,950
3.1	Total agreed funding (US \$)	1,561,940	0	106,500	0	0	116,500	0	543,219	0	65,000	2,393,159
3.2	Total support cost	118,796	0	9,088	0	0	10,387	0	39,957	0	5,425	183,653
3.3	Total agreed costs (US \$)	1,680,736	0	115,588	0	0	126,887	0	583,176	0	70,425	2,576,812
4.1.1	Total phase-out of HCFC-22 agreed to be achieved under this agreement (ODP tonnes)											7.36
4.1.2	Phase-out of HCFC-22 to be achieved in previously approved projects (ODP tonnes)											n/a
4.1.3	Remaining eligible consumption for HCFC-22 (ODP tonnes)											13.66
4.2.1	Total phase-out of HCFC-141b agreed to be achieved under this agreement (ODP tonnes)											0.86
4.2.2	Phase-out of HCFC-141b to be achieved in previously approved projects (ODP tonnes)											n/a
4.2.3	Remaining eligible consumption for HCFC-141b (ODP tonnes)											0.00
4.3.1	Total phase-out of HCFC-123 agreed to be achieved under this agreement (ODP tonnes)											0.00
4.3.2	Phase-out of HCFC-123 to be achieved in previously approved projects (ODP tonnes)											n/a
4.3.3	Remaining eligible consumption for HCFC-123 (ODP tonnes)											0.18
4.4.1	Total phase-out of HCFC-142b agreed to be achieved under this agreement (ODP tonnes)											0.00
4.4.2	Phase-out of HCFC-142b to be achieved in previously approved projects (ODP tonnes)											n/a
4.4.3	Remaining eligible consumption for HCFC-142b (ODP tonnes)											1.20
4.5.1	Total phase-out of HCFC-124 agreed to be achieved under this agreement (ODP tonnes)											0.00
4.5.2	Phase-out of HCFC-124 to be achieved in previously approved projects (ODP tonnes)											n/a
4.5.3	Remaining eligible consumption for HCFC-124 (ODP tonnes)											0.22
4.6.1	Total phase-out of HCFC-141b in pre-blended polyols agreed to be achieved under this agreement (ODP tonnes)											19.81
4.6.2	Phase-out of HCFC-141b in pre-blended polyols to be achieved in previously approved projects (ODP tonnes)											n/a
4.6.3	Remaining eligible consumption for HCFC-141b in pre-blended polyols (ODP tonnes)											0.86

*Funding for UNIDO includes the fourth tranche request at US \$86,500, plus agency support cost of US \$6,487, and the foam project at US \$413,719, plus agency support cost of US \$30,220.

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT
Ecuador
PROJECT TITLES
BILATERAL/IMPLEMENTING AGENCY

(a)	Conversion of the manufacturing of domestic and commercial refrigerators from HFC-134a and R-404A to isobutane (R-600a) and propane (R-290) at Ecasa	UNIDO
(b)	Conversion of the manufacturing of commercial refrigerators from HFC-134a to isobutane (R-600a) and propane (R-290) at Induglob	UNIDO

NATIONAL COORDINATING AGENCY	Ministry of Industries and Productivity of Ecuador
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LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN 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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HFC consumption remaining eligible for funding (mt)	n/a
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CURRENT YEAR BUSINESS PLAN ALLOCATIONS		Funding US \$	Phase-out mt
	(a) Ecasa	71,710	8.80
	(b) Induglob	0	0

Particular	Units	(a) Ecasa		(b) Induglob
		HFC-134a	R-404A	HFC-134a
HFC used at enterprise:	mt	2.32	3.52	19.80
	mt CO ₂ -eq	3,317.60	13,805.44	28,314
HFC to be phased out through this project:	mt	2.32	3.52	19.80
	mt CO ₂ -eq	3,317.60	13,805.44	28,314
HFC/alternatives to be phased in:	Units	R-600a	R-290	R-600a and R-290
	mt	1.16	1.76	9.00
	mt CO ₂ -eq	3.48	5.28	27.00
Project duration (months):			24	24
Initial amount requested (US \$):			235,190	319,370
Final project costs (US \$):				
Incremental capital costs:			184,800	205,100
Contingency (10 %):			14,680	15,560
Incremental operating costs:			*n/a	*n/a
Total project cost:			199,480	220,660
Local ownership (%):			100	100
Export component (%):			0	0
Requested grant (US \$):			199,480	220,660
Cost-effectiveness:	US \$/kg		34.16	11.14
	US \$/mt CO ₂ -eq		11.65	7.79
Implementing agency support costs (US \$):			17,953	19,859
Total cost of project to Multilateral Fund (US \$):			217,433	240,519
Counterpart funding (Y/N):			Y	Y
Project monitoring milestones included (Y/N):			Y	Y

*Not available as a detailed review of the IOC did not take place

SECRETARIAT'S RECOMMENDATION	For individual consideration
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PROJECT DESCRIPTION

29. On behalf of the Government of Ecuador, UNIDO has submitted the following two project proposals for the phase-out of HFCs in line with decision 78/3(g):

- (a) Conversion of the manufacturing of domestic and commercial refrigerators⁶ at Ecasa from HFC-134a and R-404A to isobutane (R-600a) and propane (R-290), at a total cost of US \$235,190, plus agency support costs of US \$21,167; and
- (b) Conversion of the manufacturing of commercial refrigerators at Induglob from HFC-134a to isobutane (R-600a) and propane (R-290), at a total cost of US \$319,370, plus agency support costs of US \$22,356. UNIDO submitted this project proposal without receiving preparation funding from the Multilateral Fund.

30. The two project proposals relate to the two largest refrigeration manufacturing enterprises in Ecuador, accounting for over 99 per cent of the total HFC consumption in this sector. The pre-requisites for the submission of the two project proposals, as well as the background information on the consumption in the country and in the sector, are applicable to both enterprises. In order to facilitate the review of the proposals by the Executive Committee and avoid duplicating the same information in each proposal, the present document consists of the following sections:

- Section 1: Pre-requisite for the submission of the project proposals, including matters related to eligibility, maturity of the technology, replicability and sustainability
- Section 2: Background, providing an overview on the total consumption of HFCs and in the refrigeration manufacturing sector in Ecuador
- Section 3: Project proposal for conversion at Ecasa, providing an overview of the enterprise, describing the manufacturing process, the changes proposed for the conversion to non-HFC refrigerants and associated incremental costs; Secretariat's comments and recommendation
- Section 4: Project proposal for conversion at Induglob (content similar to Ecasa)

Section 1: Pre-requisite for submission of the project proposals

31. The Secretariat has reviewed the two project proposals 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.

Eligibility

32. The project proposals for the conversions of Ecasa and Inglob have been submitted in line with decisions 78/3(g) and 79/45. The proposals include official letters from the Government of Ecuador (one for each enterprise) stating that the Government will make every effort to ratify the Kigali Amendment, as soon as possible; confirming that it is aware that, if the 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 acknowledging that, in

⁶ For the purpose of the present document, commercial refrigerators refer to stand-alone appliances used in the commercial refrigeration sector, which contain HFC refrigerant charges below 500 grams.

the event that the project is approved, any reduction in HFC consumption will be deducted from any starting point that may be agreed in the future.

Maturity of the technology, replicability and sustainability

33. In providing information to demonstrate the sustainability of the two project proposals, UNIDO explained that the Government of Ecuador is working on the development of regulatory measures to protect and support national production once the two enterprises have been converted. This includes one technical regulation (RTE-035) intended to classify and label equipment according to their refrigerant and energy consumption to prevent safety and health risks, and another regulation (RTE-009) that will restrict access to equipment containing HCFC or HFC as the refrigerant. It is also expected that the conversion of the two enterprises will improve national and regional competitiveness, as existing multilateral trade agreements allow the entry of such products into the country without tariffs.

34. UNIDO has confirmed that HC-based products are already on the market, and there is no limitation or barrier to the introduction of the domestic and commercial refrigerators converted to HC-based refrigerants into the market, since all units produced will have a refrigerant charge lower than 150 g. Furthermore, Ecuador has a national regulation for HC operations that includes transportation considerations (standard NTE-2266). HC pre-blended polyols are also starting to be used in the manufacturing of PU foam.

35. UNIDO has indicated that the results of the conversions associated with the two project proposals are expected to encourage adoption of energy-efficient R-290- and R-600a-based equipment by smaller commercial-refrigeration manufacturing enterprises in the region and in other regions.

36. UNIDO has confirmed that, with the approval of the two project proposals, the enterprises commit to total phase-out of HFC-134a and R-404A.

Section 2: Background

HFC consumption

37. Based on the data reported under the surveys on ODS alternatives submitted to the 78th meeting, a total of 813.1 mt of HFCs (pure and in blends) were imported in 2015 into Ecuador. The main HFCs were HFC-134a (461.9 mt representing 56.8 per cent of the total consumption), R-404A (113.5 mt representing 14.0 per cent), R-410A (103.1 mt representing 12.7 per cent), and R-507A (85.6 mt, representing 10.5 per cent). The remaining consumption (49.0 mt representing 6.0 per cent) included one pure HFC (HFC-152a) and six blends of HFCs.

38. The project proposals contained detailed information on the total consumption in Ecuador of the two HFCs used by the two enterprises, namely HFC-134a and R-404A (which represented approximately 71.0 per cent of the total consumption in 2015). In 2017, 897.15 mt of HFCs were imported into Ecuador, including 509.51 mt of HFC-134a (57.0 per cent) and 108.43 mt of R-404A (12.0 per cent). Table 1 presents the imports of HFC-134a and R-404A between 2012 and 2017 as presented in the proposal.

Table 1. Imports of HFC-134a and R-404A in Ecuador (2012–2017) (mt)

Substance	2012	2013	2014	2015	2016	2017
HFC-134a	265.19	351.08	484.35	521.37	485.81	509.51
R-404A	43.33	81.00	116.31	120.95	107.33	108.43
Total	308.52	432.08	600.66	642.32	593.14	617.94

39. In 2017, the total consumption of HFC-134 and R-404A in the domestic and commercial refrigerator manufacturing sector was estimated at 21.81 mt and 3.52 mt, respectively. Practically all the

consumption is by two enterprises, Ecasa and Induglob, with 0.10 mt of HFC-134a used by a few small and medium size enterprises (SMEs) providing technical assistance and assembly of small refrigeration equipment, as shown in Table 2.

Table 2. HFC-134a and R-404A use in domestic and commercial refrigerators (2017) (mt)

Enterprise	HFC-134a	R-404A
Ecasa	2.32	3.52
Induglob	19.39	0.00
Others (Fibroacero, Mafrico, Megafrio, Refricerm, and other SMEs)	0.10	n/a
Total	21.81	3.52

Section 3: Project proposal for conversion at Ecasa

Enterprise background

40. Ecasa, a locally-owned enterprise, received Multilateral Fund assistance⁷ to replace CFC-12 with HFC-134a at the 26th meeting (November 1998). Since the completion of the project in November 2001, HFC-134a has been used as a refrigerant to charge their products. As such, the Secretariat considers that this conversion falls under paragraph 18(b) of decision XXVIII/2.

41. Ecasa manufactures 18 models of self-contained domestic refrigeration, vertical and horizontal coolers, which operate with different temperature ranges, in three manufacturing lines operating for one eight-hour shift per day. In 2017 the enterprise produced 14,518 units using HFC-134a and 12,283 units using R-404A. Table 3 presents the 2015–2017 production of HFC-based domestic and commercial refrigerators at Ecasa.

Table 3. Manufacturing of domestic and commercial refrigerators at Ecasa (2015–2017)

Production (units/year)	HFC-134a	R-404A	Total
2015	12,225	9,957	22,182
2016	13,752	11,619	25,371
2017	14,518	12,283	26,801
Average	13,498	11,286	24,785
Consumption (kg/year)			
2015	1.96	2.84	4.80
2016	2.20	3.33	5.53
2017	2.32	3.52	5.85
Average	2.16	3.23	5.39

Project description

42. Ecasa aims to convert the manufacturing line with the highest production ratio with assistance from the Multilateral Fund. Through implementation of the project, the enterprise will integrate the production of the other two lines in the converted line.

43. 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, and internationally accepted; require the use of 40 per cent less refrigerant; use mineral oil; have low corrosiveness; enhance overall technical reliability and performance; and reduce operating noise. In addition, the enterprise has experience in manufacturing panels with pre-blended HCs.

44. 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 contains two main components for which funds are being requested:

- (a) Product redesign for the new refrigerant and pilot production of 10 products (US \$12,000);
- (b) Replacement of manufacturing equipment, including adaptation of the assembly line; introduction of one refrigerant charging station suited to R-290 and R-600a, along with a refrigerant booster pump; safety control systems, ventilation and an antistatic floor; one ultrasonic welding machine; one post-charge leak detector and one helium leak-detection system; one HC recovery unit and four handheld leak detectors for product leak tests;

⁷ Project ECU/REF/26/INV/26. Ecasa also received assistance to convert its foam panels from CFC-11 to water based technology (later changed to HCFC-141b) at the 9th meeting (March 1993) (ECU/FOA/09/INV/10).

contingencies; safety certification, training and installation (US \$223,190).

Project costs

45. The incremental capital costs (ICCs), as originally submitted, stood at US \$235,190 as shown in Table 4.

Table 4. ICCs for the conversion of domestic and commercial refrigerators manufacturing at Ecasa

Item	Units	Unit cost (US \$)	Total cost (US \$)
1. General product redesign			
Platform redesign	10	1,200	12,000
Total product design and trials			12,000
2. Production equipment			
Adaptation of assembly line	1	5,000	5,000
Charging machine for R-600a/R-290, explosion-proof	1	55,000	55,000
Safety control system for the charging area			
Refrigerant booster pump, pneumatic			
Safety ventilation	1	12,000	12,000
HC leak detector, plus calibration unit	1	15,000	15,000
Ultrasonic welding machine	1	30,000	30,000
Antistatic floor	1	3,800	3,800
HC recovery machine, explosion-proof	1	3,500	3,500
Helium charging unit	1	20,000	20,000
Helium recovery/recycling unit	1	20,000	20,000
Helium leak detector, plus calibration	1	15,000	15,000
Handheld HC leak detectors	4	400	1,600
Refrigerant storage area, including safety items	0	0	0
Subtotal equipment costs			180,900
Contingency (10% of investment costs)			19,290
Safety certification by TÜV Süd	1	15,000	15,000
Training and installation	1	8,000	8,000
Total ICC			235,190

46. The incremental operating costs (IOCs), which include costs related to changes in the compressor, capillary tube, electrical components and refrigerant, were estimated at US \$12.11 per unit converted from HFC-134a to R-600a and US \$12.00 per unit converted from R-404A to R-290. The IOCs calculated for a 12-month period are US \$323,301, as shown in Table 5. No funding for IOCs is being requested to the Multilateral Fund.

Table 5. IOCs for domestic and commercial refrigerators manufacturing at Ecasa (US \$)

Item	HFC-134a to R-600a			R-404A to R-290		
	Baseline	New	Difference	Baseline	New	Difference
Compressor	50.55	55.90	5.35	60.85	65.90	5.05
Filter	2.50	2.50	-	2.50	2.75	0.25
Capillary tube	5.00	6.50	1.50	5.00	6.50	1.50
Other electrical components	45.50	51.50	6.00	55.50	61.75	6.25
Refrigerant	1.73	0.99	(0.74)	2.98	2.05	(0.94)
Total	105.28	117.39	12.11	126.83	138.95	12.00
Units per year	14,518			12,283		
IOC per type of product	175,871			147,430		
Total IOCs				*323,301		

*IOCs had been initially calculated at US \$37,055 using the average production by model (1,320 units using HFC-134a and 1,755 units using R-404A), but it was later corrected at US \$323,301 to cover the entire production (14,518 units using HFC-134a and 12,283 units using R-404A).

47. A summary of the total project cost, as submitted, is given in Table 6.

Table 6. Total project cost and total cost requested for the conversion of domestic and commercial refrigerators manufacturing at Ecasa

Item	Costs (US \$)
ICCs	235,190
IOCs	0
Total cost requested	235,190

48. The overall cost-effectiveness of the project is US \$40.27/kg based on the funds requested from the Multilateral Fund. The project will be implemented over a period of 24 months.

49. The project will eliminate annual consumption of 2.32 mt (3,317.60 CO₂-eq mt) of HFC-134a and 3.52 mt (13,805.44 CO₂-eq mt) of R-404A. The energy efficiency of the refrigerators is estimated to improve by about 10 per cent through the modifications to the components.

Secretariat's comments

Proposed costs

50. Upon discussion with UNIDO of the elements included in the project, the following adjustments were made and agreed: a reduction in the cost of the charging unit, including safety elements, from US \$55,000 to US \$40,000, given the level of production required; a reduction in the cost of the helium management system from US \$55,000 to US \$38,000, in line with other proposals; and a reduction in the number of handheld leak detectors from four to two on the basis of the needs of the line. It was also agreed to include US \$5,000 for the adaptation of the refrigerant storage and supply area as it is required but had not been included in the proposal, and to increase the cost of redesign and trial of products from US \$1,200 to US \$1,500 per product, in line with the other proposal in Ecuador by Induglob.

51. 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 based compressor on the market.

52. Nevertheless, UNIDO has confirmed that, in line with decision 78/3(g), the project will collect, and include in the final report, data on the ICCs and IOCs incurred, 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.

53. The revised costs of the conversion of the domestic and commercial refrigerators manufacturing line in Ecasa are shown in Table 7.

Table 7. Proposed and revised costs the conversion of domestic and commercial refrigerators manufacturing at Ecasa

Item	Proposed (US \$)	Revised (US \$)
1. General product redesign		
Platform redesign	12,000	15,000
Total product design and trials	12,000	15,000
2. Production equipment		
Adaptation assembly line	5,000	5,000
Charging machine for R-600a/R-290, explosion-proof	55,000	40,000
Safety control system for the charging area		
Refrigerant booster pump, pneumatic		
Safety ventilation	12,000	12,000

Item	Proposed (US \$)	Revised (US \$)
HC leak detector, plus calibration unit	15,000	15,000
Ultrasonic welding machine	30,000	25,000
Antistatic floor	3,800	3,800
HC recovery machine, explosion-proof	3,500	2,000
Helium charging unit	20,000	38,000
Helium recovery/recycling unit	20,000	
Helium leak detector, plus calibration	15,000	
Handheld HC leak detectors	1,600	1,000
Refrigerant storage area, including safety items	0	5,000
Subtotal equipment costs	180,900	146,800
Contingency (10% of investment costs)	19,290	14,680
Safety certification by TÜV Süd	15,000	15,000
Training and installation	8,000	8,000
Total ICC	235,190	199,480
IOCs	323,301	n/a*
Total incremental cost	558,491	199,480
Total funds requested	235,190	199,480
HFC consumption per year	5.84	5.84
Cost-effectiveness (US \$/kg)	40.27	34.16
Cost-effectiveness (US \$/mt CO ₂ -eq)	13.73	11.65

*Not available as a detailed review of the IOC did not take place

54. The proposed incremental costs for the conversion of domestic and commercial refrigerators at Ecasa amount to US \$199,480, to phase out a total of 5.84 mt (17,123.04 CO₂-eq mt) of HFC-134a and R-404A (2.32 mt (3,317.60 mt CO₂-eq) and 3.52 mt (13,805.44 mt CO₂ eq), respectively), with a cost-effectiveness of US \$34.16/kg. The Secretariat noted that although funding was not requested for IOCs, the cost-effectiveness of the proposal is higher than that of larger manufacturing enterprises.

55. 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 enterprise. The Secretariat, therefore, considers that approval of the project at the levels proposed above would not constitute a precedent.

2018–2020 business plan

56. This project is included in the 2018–2020 business plan of the Multilateral Fund at a value of US \$71,710, including agency support costs, to phase out 8.80 mt of HFC. The Secretariat notes that after the adjustments to the costs, the proposal is US \$141,733 more than what has been included into the business plan.

Recommendation

57. The Executive Committee may wish to consider

- (a) The project proposal for the conversion of domestic and commercial refrigerator manufacturing at Ecasa from the use of HFC-134a and R-404A as the refrigerants to propane (R-290) and isobutane (R-600a), in the context of its discussion on HFC stand-alone project submitted to the 81st 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 \$199,480, plus agency support costs of US \$17,953 for UNIDO, 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 Ecuador had been received by the depositary at the Headquarters of the United Nations in New York;
 - (ii) That 5.84 mt (17,123.04 CO₂-eq mt) of HFC-134 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.

Section 4: Project proposal for conversion at Induglob

Enterprise background

58. Induglob, a locally-owned enterprise (formerly as Indurama), received Multilateral Fund assistance to replace CFC-12 with HFC-134a at the 26th meeting (November 1998).⁸ Since the completion of the project in September 2002, HFC-134a has been used as a refrigerant to charge their products. As such, the Secretariat considers that this conversion falls under paragraph 18(b) of decision XXVIII/2.

59. Induglob manufactures self-contained domestic refrigeration and vertical and horizontal coolers, which operate with different temperature ranges, in two manufacturing lines, with two charging units, operating for one ten-hour shift per day. In 2017, the enterprise produced 146,976 units using 19.80 mt of HFC-134a (an average charge of 135 g of refrigerant per unit). The average production is 16,000 units per month. Table 8 presents the 2015–2017 production of HFC-based domestic and commercial refrigerators at Induglob.

Table 8. Manufacturing of domestic and commercial refrigerators at Induglob (2015–2017)

Year	Refrigerator units produced			HFC-134a consumed (mt)
	Domestic	Commercial	Total	
2015	168,629	37,899	206,528	25.70
2016	118,514	36,325	154,839	20.10
2017	105,645	41,331	146,976	19.80

Project description

60. Induglob is already converting one of its two manufacturing lines to R-600a; at present, this conversion is 50 per cent executed. Consequently, the present proposal is only requesting funds for the conversion of one line manufacturing commercial refrigerators.

61. 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, and internationally accepted; require the use of 40 per cent less refrigerant; use mineral oil; have low corrosiveness; enhance overall technical reliability and performance; and reduce operating noise. In addition, the enterprise has experience in manufacturing panels with pre-blended HCs.

62. 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 contains two main components for which funds are being requested:

- (a) Product redesign for the new refrigerant and pilot production of 26 products (US \$39,000);
- (b) Replacement of manufacturing equipment, including adaptation of the assembly line; introduction of one refrigerant charging station suited to R-290, along with a refrigerant booster pump, safety control systems, ventilation and an antistatic floor; one ultrasonic welding machine; one helium leak-detection system; one HC recovery unit and four handheld leak detectors for product leak tests; contingencies; safety certification; training; and installation (US \$295,370).

⁸ ECU/REF/26/INV/25. Induglob also received assistance to convert its foam panels from CFC-11 to water-based technology (later changed to HCFC-141b) at the 9th meeting (ECU/FOA/09/INV/10) and to convert from HCFC-141b to cyclopentane at the 65th meeting (ECU/PHA/65/INV/55).

Project costs

63. The incremental capital costs (ICCs), as originally submitted, stood at US \$334,370 as shown in Table 9.

Table 9. ICC for the conversion of domestic and commercial refrigerators manufacturing at Induglob

Item	Units	Unit cost (US \$)	Total cost (US \$)
1. General product redesign			
Platform redesign	26	1,500	39,000
Total product design and trials			
2. Production equipment			
Adaptation of assembly line	1	8,000	8,000
Charging machine for R-290, explosion-proof	1	48,000	48,000
Safety control system for the charging area	1	38,000	38,000
Refrigerant booster pump, pneumatic	1	8,000	8,000
Safety ventilation	1	15,000	15,000
HC leak detector, plus calibration unit	0	-	-
Ultrasonic welding machine	1	30,000	30,000
Antistatic floor	1	3,800	3,800
HC recovery machine, explosion-proof	1	3,500	3,500
Helium charging unit	1	20,000	20,000
Helium recovery/recycling unit	1	20,000	20,000
Helium leak detector, plus calibration	1	15,000	15,000
Handheld HC leak detectors	4	400	1,600
Refrigerant storage area, including safety items	1	26,800	26,800
Subtotal equipment costs			237,700
Contingency (10% of investment costs)			27,670
Safety certification by TÜV Süd	1	15,000	15,000
Training and installation	1	15,000	15,000
Total equipment costs			295,370
Total ICCs			334,370

64. The incremental operating costs (IOCs), which include costs related to changes in the compressor, capillary tube, electrical components and refrigerant, were estimated at US \$19.46 per unit converted from HFC-134a to R-290. The IOCs calculated for a 12-month period are US \$804,301, as shown in Table 10. No funding for IOCs is being requested from the Multilateral Fund.

Table 10. IOCs for domestic and commercial refrigerator manufacturing in Induglob

Item	IOCs for conversion of HFC-134a-based products to R-290 (US \$)		
	Baseline product	New product	Difference
Compressor	50.55	59.00	8.45
Filter	2.50	2.75	0.25
Capillary tube	5.00	6.50	1.50
Electrical components	45.50	55.50	10.00
Refrigerant	1.73	0.99	(0.74)
Total	105.28	124.74	19.46
Units per year line funded			41,331
Total IOCs			*804,301

*IOCs had been initially calculated at US \$30,448 using the average production by model (1,590 units), but it was later corrected to US \$804,301 to cover the entire production (41,331 units).

65. A summary of the total project cost, as submitted, is given in Table 11.

Table 11. Total project cost and total cost requested for the conversion of domestic and commercial refrigerators manufacturing at Induglob

Item	Costs in US \$
ICCs	334,370
IOCs	0
Total cost requested	319,370
HFC phase-out by funded line (mt)	7.99
Cost-effectiveness (US \$/kg)	39.94
Cost-effectiveness (US \$/mt CO ₂ -eq)	27.93

66. The overall cost-effectiveness of the project is US \$39.94/kg based on the funds requested from the Multilateral Fund. The project will be implemented over a period of 24 months.

67. The project will eliminate annual consumption of 19.80 mt (28,314 CO₂-eq mt) of HFC-134a. The energy efficiency of the refrigerators is estimated to improve by about 10 per cent through the modifications to the components.

Secretariat's comments

Proposed costs

68. Upon discussion with UNIDO of the elements included in the project, the following adjustments were made and agreed: a reduction in the cost of product design and trials from US \$39,000 to US \$22,500, given that different products are based on common patterns; the removal of a new charging machine as the existing one can already operate with flammable refrigerants (instead US \$7,000 were agreed to undertake needed repairs to the unit to operate safely with R-290); a reduction in the cost of the helium management system from US \$55,000 to US \$38,000 in line with other proposals; a reduction in the number of handheld leak detectors from four to two, based on the needs of the line; and minor adjustments to the safety systems costs as shown in Table 12.

69. As IOCs are not being requested, their calculation was not discussed in detail. The Secretariat, however, noted that the costs of R-290-based compressors are expected to be comparable with HFC-134a-based compressors once economies-of-scale are achieved in their production.

70. Nevertheless, UNIDO has confirmed that, in line with decision 78/3(g), the project will collect, and include in the final report, data on the ICCs and IOCs incurred, 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.

71. The revised costs of the conversion of the commercial refrigeration manufacturing line in Induglob are shown in Table 12.

Table 12. Proposed and revised costs of the conversion of domestic and commercial refrigerators manufacturing at Induglob

Item	Proposed costs (US \$)	Revised costs (US \$)
1. General product redesign		
Platform redesign	39,000	22,500
Total product design and trials	39,000	22,500
2. Production equipment		
Adaptation assembly line	8,000	5,000
Charging machine for R-600a/R-290, explosion-proof	48,000	7,000
Safety control system for the charging area	38,000	30,000
Refrigerant booster pump, pneumatic	8,000	8,000

Item	Proposed costs (US \$)	Revised costs (US \$)
Safety ventilation	15,000	12,000
Ultrasonic welding machine	30,000	25,000
Antistatic floor	3,800	3,800
HC recovery machine, explosion-proof	3,500	2,000
Helium charging unit	20,000	38,000
Helium recovery/recycling unit	20,000	
Helium leak detector, plus calibration	15,000	
Handheld HC leak detectors	1,600	1,000
Refrigerant storage area, including safety items	26,800	23,800
Subtotal equipment costs	237,700	155,600
Contingency (10% of investment costs)	27,670	15,560
Safety certification by TÜV Süd	15,000	15,000
Training and installation	15,000	12,000
Total ICCs	334,370	220,660
IOCs	804,301	n/a*
Total incremental cost	1,138,671	220,660
Total funds requested	319,370	220,660
HFC consumption per year in line to be funded (mt)	7.99	7.99
Cost-effectiveness (US \$/kg)	39.95	27.58
Cost-effectiveness (US \$/mt CO ₂ -eq)	27.93	19.30
HFC consumption per year entire plant (funded and non-funded lines (mt)	19.80	19.80
Cost-effectiveness including the self-funded line (US \$/kg)	16.13	11.14
Cost-effectiveness including the self-funded line(US \$/mt CO ₂ -eq)	11.28	7.79

*Not available as a detailed review of the IOC did not take place

72. The proposed incremental costs for the conversion of commercial refrigerators at Induglob amount to US \$220,660, to phase out a total of 7.99 mt (11,432 mt CO₂-eq) of HFC-134a, with a cost-effectiveness of US \$27.58/kg (or US \$19.30/mt CO₂-eq). Including the HFC-134a consumption of the other line, whose conversion is currently self-funded by Induglob (19.80 mt in total for both lines), the cost-effectiveness for the enterprise is US \$11.14/kg (or US \$7.79/mt CO₂-eq).

73. 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

74. This project is included in the 2018–2020 business plan of the Multilateral Fund at a value of US \$148,015, including agency support costs, to phase out 18.2 mt of HFC. The Secretariat notes that after the adjustments to the costs, the proposal is US \$72,645 more than what has been included into the business plan.

Recommendation

75. The Executive Committee may wish to consider:

- (a) The project proposal for the conversion of commercial refrigerators manufacturing at Induglob from the use of HFC-134a as the refrigerant to propane (R-290) and isobutane (R-600a), in the context of its discussion on HFC stand-alone project submitted to the

81st meeting in line with decision 78/3(g) and decision 79/45, 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 \$220,660, plus agency support costs of US \$19,859 for UNIDO, 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 Ecuador had been received by the depositary at the Headquarters of the United Nations in New York;
 - (ii) That 19.80 mt (28,3144 CO₂-eq mt) of HFC-134a 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.
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