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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Ninety-ninth Meeting
Montreal, 7–11 December 2026
Item 9(d) of the provisional agenda[1]

PROJECT PROPOSALS: INDIA

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

Phase-out		
• HCFC phase-out management plan (stage III, third tranche)	UNDP, UNEP and Government of Germany	Individual consideration
Refrigeration (HFC)		
• Conversion from HFC-134a and R-407C to R-290 in the manufacturing of commercial refrigeration appliances at Birla Aircon	UNDP	Individual consideration
Energy efficiency		
• Pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration on the use of HFO-1233zd(E) and HFO-1234ze(E) as refrigerants in water-cooled centrifugal and screw chillers	UNDP	Individual consideration

[1] UNEP/OzL.Pro/ExCom/99/1

Pre-session documents of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol are without prejudice to any decision that the Executive Committee might take following issuance of the document.

• Pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration on the use of transcritical CO_2 high-temperature industrial heat pump	UNDP	Individual consideration
• Pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Pilot project to demonstrate the use of transcritical CO_2 and sub-critical CO_2-NH_3 cascade cooling systems in commercial and industrial refrigeration applications	UNDP	Individual consideration

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS

India

PROJECT TITLE	AGENCY	MEETING APPROVED	CONTROL MEASURE
HCFC phase-out plan (stage III)	UNDP (lead), UNEP, Germany	91st	100% phase-out by 2030

ARTICLE 7 DATA (Annex C, Group I)	Year: 2025	45.51 ODP tonnes

COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)							Year: 2025
Substance	Aerosol	Foam	Firefighting	Refrigeration		Solvent	Total sector consumption
				Manufacturing	Servicing		
HCFC-22					74.61		74.61
HCFC-123					0.84		0.84

CONSUMPTION DATA (ODP tonnes)			
2009–2010 baseline:	1,608.2	Starting point for sustained aggregate reductions:	1,691.25
CONSUMPTION ELIGIBLE FOR FUNDING			
Already approved:	1,691.25	Remaining:	0.00

ENDORSED BUSINESS PLAN		2026	2027	2028	Total
UNDP	ODS phase-out (ODP tonnes)	61.40	0.00	0.00	61.40
	Funding (US $)	2,849,726	0	0	2,849,726
UNEP	ODS phase-out (ODP tonnes)	26.95	0.00	0.00	26.95
	Funding (US $)	1,300,864	0	0	1,300,864
Germany	ODS phase-out (ODP tonnes)	55.26	0.00	0.00	55.26
	Funding (US $)	2,663,992	0	0	2,663,992

(VI) PROJECT DATA			2022	2023	2024	2025	2026*	2027-2028	2029	2030	Total*
Montreal Protocol consumption limits (ODP tonnes)			1,045.33	1,045.33	1,045.33	522.67	522.67	522.67	522.67	0.00	n/a
Maximum allowable consumption (ODP tonnes)			698.82	643.28	643.28	75.85	75.85	75.85	75.85	0.00	n/a
Funding agreed in principle (US $)	UNDP	Project costs	6,166,500	0	5,495,933	0	5,060,182	0	509,332	0	17,231,947
		Support costs	431,655	0	384,715	0	354,213	0	35,653	0	1,206,236
	UNEP	Project costs	668,215	0	1,011,000	0	1,168,825	0	521,960	0	3,370,000
		Support costs	75,486	0	114,210	0	132,039	0	58,965	0	380,700
	Germany	Project costs	1,700,643	0	2,140,772	0	0	0	714,270	0	4,555,685
		Support costs	189,517	0	238,564	0	0	0	83,044	0	511,125
Funds approved by ExCom (US $)		Project costs	8,535,358	0	8,647,705	0					17,183,063
		Support costs	696,658	0	737,489	0					1,434,147
Total funds recommended for approval at this meeting (US $)		Project costs	0	0	0	0	6,229,007				6,229,007
		Support costs	0	0	0	0	486,252				486,252

***** Funding reflects the proposed revision to transfer funding for the Government of Germany under the third tranche to UNDP. Text to be included in the updated Agreement is contained in annex I.

Secretariat's recommendation:	Individual consideration

PROJECT DESCRIPTION

1. On behalf of the Government of India, UNDP as the lead implementing agency has submitted a request for funding for the third tranche of stage III of the HCFC phase-out management plan (HPMP), at a total cost of US $6,715,259, consisting of US $5,060,182, plus agency support costs of US $354,213, for UNDP and US $1,168,825, plus agency support costs of US $132,039, for UNEP.[2] The submission includes a progress report on the implementation of the second tranche, the verification report on HCFC consumption for 2024 and 2025, and the tranche implementation plan for 2027 to 2029.

Report on HCFC consumption

2. The Government of India reported a consumption of 45.51 ODP tonnes of HCFCs in 2025, which is 97 per cent below the country's HCFC baseline for compliance. The 2021–2025 HCFC consumption is shown in table 1.

Table 1. HCFC consumption in 2021–2025 in India (Article 7 data)

HCFC	2021	2022	2023	2024	2025	Baseline
Metric tonnes (mt)						
HCFC-22	4,278.99	6,220.55	5,819.05	8,413.22	1,356.56	10,944.7
HCFC-123	47.19	173.38	84.38	37.69	41.95	176.5
HCFC-142b	0.00	0.00	0.00	-240.66	-80.86	1,903.0
HCFC-225*	-254.49	-44.26	10.09	315.95	-351.81	0.0
Total (mt)	**4,071.69**	**6,349.67**	**5,913.51**	**8,526.20**	**965.39****	**21,504.4*****
ODP tonnes						
HCFC-22	235.34	342.13	320.05	462.73	74.61	602.0
HCFC-123	0.94	3.47	1.69	0.75	0.84	3.5
HCFC-142b	0.00	0.00	0.00	-15.64	-5.26	123.7
HCFC-225*	-17.81	-3.10	0.71	22.12	-24.63	0.0
Total (ODP tonnes)	**218.47**	**342.50**	**322.44**	**469.95**	**45.51****	**1,608.2*****

* India produced HCFC-225 in 2018, 2019, and 2022 to 2024 for feedstock uses. Exports of HCFC-225 in 2021, 2022, 2024, and 2025 were for feedstock and were produced partly in prior years.
** Including exports of a customs mix of HCFC-241, HCFC-242, HCFC-243, and HCFC-244 produced in 2025 for feedstock uses that resulted in calculated consumption of -0.45 mt (-0.054 ODP tonnes) due to an inadvertent typographical error.
*** Baseline includes 611.8 mt (13.5 ODP tonnes) of HCFC-124 and 7,868.4 mt (865.5 ODP tonnes) of HCFC-141b that had been consumed during the baseline years and has not been reported in recent years.

3. HCFC consumption decreased in 2020 and 2021 due to the COVID-19 pandemic, followed by an increase in 2022 along with the economic recovery, and a decrease in 2023 owing to the transition to alternatives, mainly by enterprises not eligible for assistance under stage III of the HPMP. Consumption increased in 2024, mainly due to consumption in the servicing sector and possible stockpiling of HCFC-22 in advance of the 2025 compliance obligation. In 2025, consumption decreased due to the reduction of the HCFC-22 production quota for controlled uses and the manufacturing consumption dropping to zero in line with the ban on the manufacture of HCFC-based refrigeration and air-conditioning (RAC) equipment that entered into force on 1 January 2025.

4. Consumption of HCFC-141b was phased out in 2020, in line with the ban in effect since 1 January 2020. Controlled uses of HCFC-142b, which had been used in the manufacture of extruded polystyrene foam, were phased out in 2017; the country also imports and exports HCFC-142b for feedstock

[2] As per the letter of 14 September 2026 from the Ministry of Environment, Forest and Climate Change (MoEFCC) of India to UNDP. As further described in paragraphs 30 and 31 of the present document, the funds requested for UNDP include the transfer of US $2,396,887, plus support cost from the Government of Germany, as requested by the Government of India.

uses. HCFC-123 is imported and used in servicing fire-protection equipment and chillers; the manufacture of HCFC-123-based fire-fighting equipment has been banned since 1 January 2025, and no HCFC-123 consumption was reported in the firefighting sector in 2025. The fluctuations in HCFC-123 consumption are due to market conditions and the fact that imports from one year can supply needs for more than one year.

5. India produced HCFC-241, HCFC-242, HCFC-243, and HCFC-244 in 2024 and 2025 as part of a custom mix (CustMix-374); 2024 was the first year the country produced those HCFCs, all of which are exported for feedstock use.

Country programme implementation report

6. The HCFC consumption data for HCFC-22 and HCFC-123 provided by the Government of India in its country programme (CP) implementation report for 2025 is consistent with the data reported under Article 7 of the Montreal Protocol. The CP implementation report did not include exports of HCFC-225 and of HCFC-142b; both those substances were exported for feedstock use.

Verification report

7. The verification report confirmed that the Government was implementing a licensing and quota system for HCFC imports and exports and that the total consumption of HCFC-22 and HCFC-123 reported under Article 7 of the Montreal Protocol for 2024 and 2025 was correct (as shown in table 1 above). The verification concluded that HCFC consumption in 2024 and 2025 was below the maximum allowable consumption in the Agreement and that India is in compliance with the accelerated HCFC phase-out schedule of the Montreal Protocol for those years.

8. As in the previous verification, the production, import, and export of HCFC-225 for feedstock uses were not included in the scope of the verification, nor was the production of HCFC-241, HCFC-242, HCFC-243, and HCFC-244, which the country started producing in 2024 and which are exported for feedstock uses as part of a custom mix (CustMix-374). The report verified imports of HCFC-142b for feedstock uses; however, exports of HCFC-142b for feedstock were not verified.

Status of implementation of stage II of the HCFC phase-out management plan

9. Stage II of the HPMP was completed on 1 December 2024. The project completion report was submitted on 27 April 2026.

Progress report on the implementation of the second tranche of stage III of the HCFC phase-out management plan

Legal framework

10. The country has in place an operational HCFC licensing and quota system. The import of HCFC-based air conditioners has been prohibited since 1 July 2015, and the ban on the manufacture of HCFC-based air conditioners and RAC products and equipment entered into force on 1 January 2025. The country ratified the Kigali Amendment in September 2021; India established an HFC licensing system in 2022 and will implement an HFC quota system from 1 January 2028.

Air-conditioning manufacturing sector (UNDP)

11. Of the 16 eligible air-conditioning (AC) manufacturing enterprises (13 in the residential AC sector and three in the light commercial AC sector, with a consumption of 222.92 mt of HCFC-22), 12 enterprises have signed Memoranda of Agreement (MoAs) and completed their conversion to HFC-32, phasing out 188.85 mt of HCFC-22, as confirmed by third-party verification. The remaining four enterprises (34.08 mt), including one large enterprise (29.43 mt) that also manufactures commercial refrigeration equipment,

declined to participate owing to concerns over the market acceptability and commercial feasibility of the proposed alternative, and transitioned to other technologies, including high-global-warming-potential (GWP) HFCs, with their own resources; their phase-out of HCFC-22, achieved through the manufacturing ban, was verified on site by an independent third party. The funding associated with these four enterprises, amounting to US $652,621, will be returned to the Multilateral Fund.

Commercial refrigeration manufacturing sector (UNDP)

12. Of the 48 commercial refrigeration and process chiller manufacturing enterprises (163.19 mt of HCFC-22) verified as eligible, 38 have signed MoAs, of which 37 have completed their conversion to R-290 or HFC-32. The phase-out at these enterprises was confirmed by third-party verification. The remaining enterprise (Kelvin India Refrigeration, 1.50 mt), which converted to R-290, achieved its phase-out of HCFC-22 as confirmed on-site by third-party verification, but was not able to provide the documentation required for the remaining milestones under its MoA; the balance of US $17,139 for this enterprise will therefore not be disbursed. The other 10 enterprises (18.86 mt) declined to sign their MoAs for reasons similar to those in the AC sector, and transitioned to other technologies, including high-GWP HFCs, with their own resources; their phase-out of HCFC-22, achieved through the manufacturing ban, was verified on site. A total of US $424,789 will be returned to the Multilateral Fund from this sector, consisting of US $407,650 associated with the 10 enterprises that did not participate and US $17,139 for Kelvin India Refrigeration.

Technical assistance for the manufacturing sector (UNDP)

13. A cooperation agreement with a national Government technical institution specialized in the cooling sector has been signed to support enterprises in their technology conversion activities alongside international experts. The institution assisted 23 micro- and seven small-sized enterprises in the commercial refrigeration manufacturing sector and four micro- and three small-sized enterprises in the AC manufacturing sector by providing hands-on safety compliance, product redesign, and production line optimization planning and advisory/independent oversight, and to ensure the safe and sustainable handling of flammable alternative technologies (i.e., R-290 for commercial refrigeration manufacturing and HFC-32 for AC manufacturing). The institution is also conducting research and development on optimized low-GWP components (including compressors and heat exchangers) and will continue to provide hands-on facilitation to enterprises through 2030.

Refrigeration servicing sector

14. Strengthening capacity in the refrigeration servicing sector (UNDP): The training kits[3] procured under the first tranche were delivered, installed, and commissioned at 119 industrial training institutes (ITIs), and the resident RAC instructors were trained; an impact analysis estimated that approximately 5,000 students (3 per cent women) have benefited from hands-on training with the equipment. In addition, procurement was initiated for training kits for an additional 250 ITIs, to be completed by June 2027; these ITIs will be adopted by 12 RAC manufacturers through four-party MoAs, under which the manufacturers will mentor faculty and students, conduct training-of-trainers, and facilitate apprenticeships and job placements.

15. Strengthening capacity in the refrigeration servicing sector (Germany): Eight training partners were contracted, and three workshops were held to train 70 master trainers of the training partners; 1,139 technicians were trained and certified in good servicing practices and the installation of room air-conditioners, including using flammable refrigerants; the procurement of equipment for ITIs was

[3] Including basic refrigeration and electrical cycle units, split AC training unit, commercial refrigeration training unit and industrial refrigeration unit for rack systems.

completed in cooperation with UNDP; sets of 18 RAC tools[4] were provided to the eight training partners; and servicing tool kits[5] were delivered to 680 trained and certified technicians and 110 RAC service centres. Terms of reference (TORs) were finalized for the feasibility study on the refrigerant recovery, recycling, and reclamation (RRR) infrastructure. TORs were also finalized for an independent monitoring programme to evaluate the quality and effectiveness of technician trainings.

16. Enabling activities for the servicing sector (UNEP): The following enabling activities were implemented with the assistance of UNEP:

(a) Policy and enforcement framework: Seven capacity-building workshops were held for 518 Central and State Pollution Control Board (PCB) officials, with 500 copies of a training manual disseminated; five risk-profiling workshops were held for 189 customs officers, based on a risk-profiling module developed with the National Academy of Customs, Indirect Taxes and Narcotics (NACIN); one training-of-trainers for 21 customs officers and ten workshops for 526 customs officers on HCFC trade control were held, and the training module for new customs officers was updated; one of the two planned training videos was developed; and a standard operating procedure (SOP) for enforcement officers, covering the enforcement chain from licence verification to inspection, sampling, reporting and disposal, was developed and demonstrated during the training of new customs officers. Content for the occupational safety materials has been prepared, with the manual to be finalized by July 2027;

(b) Sector-based ODS policy development: The study on district/passive cooling, the practical guidance on ammonia/low-GWP alternatives in the cold chain, the study on transport refrigeration, the practical guidance for cooling equipment in IT data centres, the study on convenience stores, the study on indigenous/not-in-kind RAC technologies, the policy study on women in the RAC sector, and a practical guidance for chillers were completed and released; the compendium of ODS and HFC phase-out legislation and policies (review of the regulatory and policy framework) is under final review. TORs have been finalized for the translation of the code of good servicing practices into eight languages, the knowledge products on green buildings, and the university course module, which will start in November 2026. TORs for the study on handling ODS-based and non-efficient systems were finalized and the process for selecting a suitable national partner initiated, with the study expected to be completed by June 2027 and launched at the 2027 World Ozone Day. The study on the standards and labelling programme, the refrigerant management voluntary programme and awareness campaign, the national code of standards, the materials for targeted awareness workshops on low-GWP technologies, and the social media campaign promoting career opportunities for women in the servicing sector have not yet started;

(c) Awareness, outreach, and communication: The first of the eight planned issues of the quarterly newsletter was completed; two videos were developed on the equipment support provided to ITIs and on feedback from ITIs; the website and management information system were regularly updated; end-user awareness campaigns are being carried out as part of World Ozone Day celebrations; and three additional stakeholder consultations were held on the HCFC bans, bringing the total under stage III to eight consultations with approximately 500 participants (25–30 per cent women). The translation of end-user campaign materials into eight languages will be initiated in the first quarter of 2027 and the two Ozone2Climate roadshows will be conducted in conjunction with the Air Conditioning

[4] Including, inter alia, room AC unit, refrigerant recovery equipment, leak detectors, double stage vacuum pumps, and other tools to facilitate the hands-on training and certification of service technicians in the field.

[5] Including, inter alia, electronic refrigerant leak detectors, refrigerant recovery cylinder, digital micron gauge and double stage vacuum pumps, plus a comprehensive range of servicing instruments.

and Refrigeration Exhibition (ACREX) organized by the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE); and

(d) Technical assistance, mainstreaming, and impact monitoring: Sixteen field visits to training institutions and industry, six webinars with approximately 180 participants (20-25 per cent women), and two stakeholder consultation workshops were conducted to identify opportunities and barriers to the participation of women in the RAC sector.

Project implementation and monitoring

17. Of the US $674,572 approved for the project management unit (PMU) under the second tranche, US $17,320 had been disbursed for project staff and consultants (US $12,500) and monitoring including third-party on-site verification of participating enterprises (US $4,820).[6]

Level of fund disbursement

18. As of 14 October 2026, of the US $17,183,063 approved so far, US $9,881,436 had been disbursed (US $6,789,405 for UNDP, US $768,116 for UNEP, and US $2,323,915 for the Government of Germany), as shown in table 2. An amount of US $1,077,410 for UNDP will be returned to the Fund from activities in the manufacturing sector. The remaining balance of US $6,224,217 will be disbursed in 2026 and 2027.

Table 2. Financial report of stage III of the HPMP for India (US $)

Agency	First tranche		Second tranche		Total		
	Approved	**Disbursed**	**Approved**	**Disbursed**	**Approved**	**Disbursed**	**Balance***
UNDP	6,166,500	5,708,489	5,495,933	1,080,916	11,662,433	6,789,405	4,873,028
UNEP	668,215	543,116	1,011,000	225,000	1,679,215	768,116	911,099
Germany	1,700,643	1,700,643	2,140,772	623,272	3,841,415	2,323,915	1,517,500
Total	**8,535,358**	**7,952,248**	**8,647,705**	**1,929,188**	**17,183,063**	**9,881,436**	**7,301,627**
Disbursement rate (%)	**93**		**22**		**58**		

***** Includes US $1,077,410 to be returned at the present meeting to the Multilateral Fund (US $652,621 from AC manufacturing and US $424,789 from commercial refrigeration).

Implementation plan for the third tranche of stage III of the HCFC phase-out management plan

19. The following activities will be implemented between January 2027 and December 2029:

(a) Technical assistance for the manufacturing sector (UNDP): Continue providing support to the converted enterprises in cooperation with the national technical institution (US $100,000, plus funds from previous tranches);

(b) Strengthening capacity in the refrigeration servicing sector (UNDP): Procure and deliver servicing tool kits to 2,200 additional trained and certified technicians and 400 RAC service centres; deliver training kits to 250 additional ITIs; and assess the servicing needs of HCFC-123-based chillers and firefighting equipment (US $2,059,000, plus funds from previous tranches);

(c) Strengthening capacity in the refrigeration servicing sector (UNDP, with funds transferred from the Government of Germany): Train and certify 10,000 RAC technicians in good servicing practices and the installation of room air-conditioners, including with flammable

[6] 100 per cent of the funding allocated to the PMU under the first tranche (i.e., US $448,930) had also been disbursed.

refrigerants; and train the instructors of the 12 state-of-the-art RAC training centres (US $2,396,887 to be transferred from Germany);

(d) Strengthening capacity in the refrigeration servicing sector (Germany): Complete the training and certification of 6,000 RAC technicians; conduct three training programmes for trainers of the training partners; train officials of key Government departments (e.g., railways and public works departments) on good servicing practices; raise awareness of the certification programme among informal technicians, of leak prevention among end users, and of R-290 safety at ITIs and national skill training institutes; promote the participation and retention of women in the sector; monitor and analyze the impact of the training; and complete the RRR business model assessment (funds from previous tranches);

(e) Enabling activities in the refrigeration servicing sector (UNEP) (US $1,168,825, plus funds from previous tranches):

(i) Policy and enforcement framework: Completion of activities from previous tranches (two training videos, border dialogues with neighbouring countries, procurement of refrigerant identifiers for NACIN training centres, and four trainings to the occupational safety enforcement authorities); two workshops for PCB officials; update of the risk-profiling module and three risk-profiling workshops for enforcement officials; update of the training module for new customs officers; five workshops for customs officers (40-50 participants each) and two training-of-trainers; one workshop for importers and exporters; and 12 workshops for occupational safety enforcement authorities (US $251,000);

(ii) Sector-based ODS policy development: Completion of activities from previous tranches (the code of good servicing practices in eight languages, knowledge products on green buildings, materials for targeted awareness workshops for building developers and for cold-chain stakeholders, a study on subsector-specific codes of good practice for the cold chain, a study on the standards and labelling programme with the Bureau of Energy Efficiency, and national standards and codes); completion and dissemination of the university modules for architects and building designers and initiation of modules for civil and mechanical engineers; development and implementation of the refrigerant management voluntary programme and awareness campaign; and development/update of national standards and codes for the building, cold chain, and transport sectors (US $470,825);

(iii) Awareness, outreach, and communication: Nine issues of the quarterly newsletter; three awareness videos; an awareness campaign for servicing technicians in rural areas through radio and television in eight languages; continued end-user awareness campaigns during World Ozone Day; website updates; four workshops to promote women in the RAC sector; and two Ozone2Climate roadshows (US $334,500);

(iv) Technical assistance, mainstreaming, and impact monitoring (US $112,500); and

(f) Project monitoring (UNDP): Continued coordination, management and monitoring support to MoEFCC, including monitoring and verification of the sustainability of the phase-out at converted enterprises, one procurement process, three project board meetings, and preparation of the fourth tranche request: Includes project staff and consultants (US $165,000), travel-related costs (US $45,000), monitoring including third-party on-site verification of participating enterprises (US $215,000), management information system,

communication and operational costs (US $39,295), and workshops, meetings and contingencies (US $40,000) (US $504,295).

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

Report on HCFC consumption and verification

20. The Secretariat noted that India does not import HCFC-22 and that while consumption of HCFC-22 had decreased by 84 per cent between 2024 and 2025, increased production for feedstock uses had offset a portion of the production for controlled uses. UNDP confirmed that the Government monitors carefully the country's HCFC-22 production and feedstock uses to ensure there is no diversion of HCFC-22 for controlled uses.

21. Noting that the differences in reported and verified HCFC consumption were due to the fact that the verification report did not consider production, import and export of HCFCs for feedstock uses, the Secretariat encouraged UNDP to consider including such production, import and export in the scope of future verification reports.

Progress report on the implementation of the second tranche of stage III of the HCFC phase-out management plan

Legal framework

22. The Government of India has issued HCFC production and import quotas for 2026 in accordance with the Montreal Protocol control targets and the targets set its Agreement with the Executive Committee.

Manufacturing sector

23. The Secretariat sought to better understand why the four AC manufacturing enterprises decided not to participate in the project, noting that HFC-32 has become the dominant technology in the market in many Article 5 countries, including countries in the region. In addition, while two of the enterprises that decided not to participate are micro-sized enterprises (i.e., less than 1 mt of consumption) and one is a small-sized enterprise (less than 4 mt), one of the enterprises that decided not to participate in the project, Voltas, is a large and technologically advanced enterprise that already manufactures HFC-32-based units on other lines. UNDP clarified that the decision by the four enterprises not to participate was not related to the choice of technology but was rather a business decision based on their specific scale, weighing of the additional legal requirements under the conversion against the allocated funding thresholds, and their corporate strategies. The decision of Voltas was driven by sectoral and application-specific complexities as the manufacturing line to be converted manufactured commercial AC (ducted units and packaged systems). The adoption of a mildly flammable refrigerant for this application presents engineering challenges that do not exist in standard split-type AC units (for room and light commercial applications) given the larger charge sizes and restrictions under IEC 60335-2-40, ASHRAE 15 and additional local standards and safety norms.

24. Similarly, the Secretariat sought to better understand why the 10 commercial refrigeration manufacturing enterprises decided not to participate in the project, noting the successful conversion to the technology by other enterprises in the sector, including 26 micro- and small-sized enterprises and ten enterprises with consumption between 6 mt and 20.9 mt, and that, of the 10 enterprises that did not participate, six were micro-sized, three had consumption of less than 3 mt, and one (Voltas) has consumption greater than 12 mt. UNDP clarified that for the nine enterprises with consumption less than 3 mt, the decision not to participate in the project was driven primarily by commercial considerations. In particular, and in contrast to the 26 micro- and small-sized enterprises that chose to participate in the project, those

nine enterprises considered that the funding allocated under the project was insufficient to cover their conversion and plant-safety infrastructure costs and that the required co-financing made the project not financially viable. The decision of Voltas not to participate in the project followed a corporate evaluation of its long-term manufacturing portfolio effectiveness, resulting in the enterprise deciding to rationalize its product lines by phasing out its specialized, low-volume (higher unitary equipment charge sized) commercial refrigeration manufacturing operations in India, allowing the enterprise to consolidate its corporate resources and focus capital investments on high-volume, core manufacturing segments.

Refrigeration servicing sector

25. The Secretariat noted with appreciation that the Government had established a formalized, nationally recognized certification system for RAC technicians, that 1,139 technicians have been trained and certified, and that essential RAC tools and equipment have been provided to eight training partners. Regarding the plan of action to complete the training and certification of 25,000 technicians by 2029, UNDP clarified that the initial phase of the project focused on establishing a robust and sustainable operational framework, including approval for the certification system from the National Council for Vocational Education and Training (NCVET), finalizing complex assessment modalities with the Electronics Sector Skill Council of India as the assessing body, and executing legal agreements with the national training partners. With this foundational framework now fully operational, the pace of training will accelerate substantially, and it is planned to train and certify 16,000 technicians by April 2028. Operating at this accelerated capacity, which also accounts for concentrating training activities during the industry's off-season (October to March), the project is on track to achieve the overall target of 25,000 certified technicians by the end of 2029.

26. The adoption and mentorship programme between RAC manufacturers and ITIs was also noted as a valuable public-private partnership to advance technology adoption. UNDP explained that the programme aims to sustain skilled technician development by aligning ITI training with industry needs, strengthening teaching and facilities through manufacturer mentorship and trainer development, and connecting students to apprenticeships, internships and preferential job placements in the RAC sector. The programme will operate for an initial five years, renewable by mutual consent.

27. Regarding the business model for RRR, UNDP clarified that the RRR feasibility study is scheduled for completion by December 2027 and the model will be based on the results of the study that will identify and address skill gaps and training needs for technicians regarding RRR; develop strategies to improve technician access to specialized recovery tools and equipment; and design and implement incentive mechanisms to motivate and drive widespread participation in RRR practices across the servicing sector.

Project implementation and monitoring

28. In line with precedent projects, the Secretariat discussed with UNDP an appropriate return associated with the PMU given that the number of manufacturing enterprises participating in the project was reduced. UNDP highlighted that the PMU had invested considerable resources, administrative effort, and time to engage with the 14 enterprises that had decided to exit the project, including conducting initial site visits, reviewing baseline technical capacities, and attempting to facilitate their conversion to the agreed alternative technologies. In addition, two independent technical verifications were undertaken, one at the beginning of the project to confirm their eligibility and one to verify their phase-out, resulting in incurred costs against the PMU budget. In view of the level of funds to be returned from the manufacturing enterprises (US $1,077,410), the agreed funding provided for the PMU (calculated at 7 per cent), and taking into account the work already undertaken by the PMU to assist the enterprises, it was agreed that UNDP would return US $39,919, plus agency support costs of US $2,794, associated with the PMU.

Gender policy implementation

29. In line with decisions 84/92 and 90/48(c), sex-disaggregated data have been collected for capacity-building and awareness activities: women represented 25-30 per cent of the 518 PCB officials trained, 10-15 per cent of the 526 customs officers trained, 25-30 per cent of the approximately 500 participants in stakeholder consultations, and 3 per cent of the approximately 5,000 ITI students benefiting from the training equipment. A study on promoting the participation of women in the RAC sector was completed and launched, and 16 field visits, six webinars, and two consultation workshops were held to identify opportunities and barriers to women's participation. The third tranche includes four workshops to promote women in the RAC sector and activities to boost the participation and retention of women in the servicing sector. While only two of the RAC technicians trained and certified under the project are women, one woman participated in the training-of-trainers and is expected to be certified soon; in addition, UNDP and the Government are undertaking activities specifically designed to facilitate the participation of women in servicing sector activities and will continue to monitor women's participation in project activities.

Updated Agreement

30. The Government of Germany clarified that the requested transfer of funding under the third tranche to UNDP was the result of a proactive administrative adjustment designed to address a business planning overlap for 2024-2026, while safeguarding the project timeline and effectiveness. The transfer ensures the continued implementation of refrigeration servicing sector activities, thereby enabling that technician training, certification and equipment distribution remain fully on schedule and complementary, unaffected by bilateral business plan adjustments.

31. In view of the transfer of the third-tranche funding of the Government of Germany to UNDP, and the resulting change in agency support costs, the Agreement between the Government of India and the Executive Committee has been updated. Specifically, Appendix 2-A has been revised, and paragraph 17 has been added to indicate that the updated Agreement supersedes that reached at the 91st meeting, as contained in annex I to the present document. The full updated Agreement will be appended to the final report of the 99th meeting.

Sustainability of the HCFC phase-out and assessment of risks

32. The Secretariat considers the risks to the sustainability of the HCFC phase-out to be low in view of the activities being undertaken under the project and the comprehensive regulatory and policy measures put in place by the Government. The most significant stock of HCFC-based equipment remaining by 2030 will be concentrated in room AC and in commercial and industrial refrigeration and chillers. Room AC represents the largest and most widespread installed base of HCFC-22 equipment. Given the vast number of units in residences and small commercial establishments across the country, a substantial portion of this fleet will still be in operation and require servicing beyond 2030. In contrast, while the number of units in commercial and industrial refrigeration and chillers is substantially smaller, these systems often remain in operation for a long time (often 15-20 years or more), meaning that equipment installed before the 2025 manufacturing ban will still require HCFC-22 for servicing well after the 2030 phase-out date.

33. India has a multi-pronged strategy to manage and reduce the HCFC demand for servicing this remaining equipment, ensuring that the servicing tail allowed under the Montreal Protocol is managed sustainably. The primary control mechanism is the strict enforcement of production and import quotas, which will progressively reduce the availability of HCFCs in the market, making them scarcer and incentivizing transition and conservation. The core of the strategy is to reduce the need for virgin HCFCs, including through training and certifying 25,000 technicians on good servicing practices, which will reduce refrigerant leakage during installation, maintenance, and repair; strengthening the capacity of hundreds of ITIs, ensuring that the next generation of technicians enters the workforce with the skills to handle refrigerants responsibly; and promoting RRR. The planned RRR feasibility study and subsequent business model will establish the

framework to recover HCFCs from decommissioned equipment, reclaim them to virgin quality, and make them available to service the remaining fleet. This will reduce the reliance on newly produced or imported HCFCs for the servicing tail.

34. The MoAs signed with the participating manufacturing enterprises include an individual undertaking specifying that the enterprises cannot change technology, including to R-410A, R-407C, R-404A and HFC-134a, and that the enterprises must continue to manufacture with the agreed alternative after the completion of the conversion, as described in paragraph 85 of document UNEP/OzL.Pro/ExCom/91/42. The economic competitiveness of the manufacturing enterprises that converted to low-GWP alternatives under the HPMP will be further strengthened by the continued conversion of remaining enterprises in the relevant sectors under India's phase-down plans. The early conversion of those enterprises to low-GWP alternatives under the HPMP reduced India's HFC consumption and will facilitate such subsequent conversions under the country's Kigali HFC implementation plan. The 1 January 2025 ban on the manufacture of HCFC-based RAC equipment complements the ban on the import of HCFC-based air-conditioners in place since 1 July 2015 and will ensure the sustainability of the phase-out in the manufacturing sector.

Conclusion

35. The Government of India continues to be in compliance with the Montreal Protocol and the HCFC consumption targets stated in its Agreement with the Executive Committee. HCFC consumption in 2024 and 2025 was 71 and 97 per cent below the HCFC consumption baseline and 27 and 40 per cent below the limit established in the Agreement for the respective years. The verification report confirmed that the Government was implementing a licensing and quota system for HCFC production, imports and exports. The phase-out of the manufacturing sector has been completed, including at those enterprises that decided not to participate in the project. A total of 50 participating enterprises manufacturing room AC units, light commercial AC equipment, process chillers and commercial refrigeration equipment successfully converted to HFC-32, R-600a or R-290. A unified certification system for technicians is being implemented, 1,139 technicians have been trained and certified so far, and the country is on track to train and certify a total of 25,000 technicians by 2029. Equipment procured for the ITIs and the training of instructors will enable the continued training and certification of technicians. Enabling activities in the servicing sector continue to strengthen implementation of the HCFC phase-out. The bilateral and implementing agencies have met the 20 per cent disbursement threshold for the previous tranche, disbursing 22 per cent of funds approved.

RECOMMENDATION

36. The Executive Committee may wish to consider:

(a) Noting:

(i) The progress report on the implementation of the second tranche of stage III of the HCFC phase-out management plan (HPMP) for India;

(ii) The transfer from the Government of Germany to UNDP of US $2,396,887, plus agency support costs of US $167,782, approved in principle, associated with the third tranche;

(iii) That the Fund Secretariat has updated the Agreement between the Government of India and the Executive Committee, as contained in annex I to the present document, specifically: Appendix 2-A, based on the transfer of the third-tranche funding of the Government of Germany to UNDP and the associated revised agency support costs; and paragraph 17, which has been added to indicate that the updated Agreement supersedes that reached at the 91st meeting;

(iv) The return to the Multilateral Fund by UNDP, at the 99th meeting, of US $1,117,329, plus agency support costs of US $78,213, consisting of US $1,077,410 associated with 14 enterprises in the commercial refrigeration and air-conditioning manufacturing sectors that did not participate in stage III of the HPMP and one enterprise that did not complete its project milestones, and US $39,919 associated with the reduced workload of the project management unit; and

(b) Approving the third tranche of stage III of the HPMP for India, and the corresponding 2027–2029 tranche implementation plan, in the amount of US $6,715,259, consisting of US $5,060,182, plus agency support costs of US $354,213, for UNDP, and US $1,168,825, plus agency support costs of US $132,039, for UNEP.

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECTS

India

PROJECT TITLE	IMPLEMENTING AGENCY
Conversion from HFC-134a and R-407C to R-290 in the manufacturing of commercial refrigeration appliances at Birla Aircon	UNDP (lead)

NATIONAL CO-ORDINATING AGENCY	Ozone Cell, Ministry of Environment, Forest and Climate Change, Government of India

LATEST REPORTED CONSUMPTION DATA FOR HFCS ADDRESSED IN THE PROJECT

A: ARTICLE-7 DATA (2025)

HFC-134a	18,257.56 mt	26,108,308 CO_2-eq tonnes
R-407C	-528.39 mt*	-937,276 CO_2-eq tonnes*

B: COUNTRY PROGRAMME SECTORAL DATA (2025)

HFC-134a	18,257.56 mt	26,108,308 CO_2-eq tonnes
R-407C	-528.39 mt*	-937,276 CO_2-eq tonnes*

CURRENT YEAR BUSINESS PLAN ALLOCATIONS	**Enterprise**	**Funding US $**	**Phase-out**	
	Birla Aircon	0	mt	0.00
			CO_2-eq tonnes	0

Particular	**Unit**	**HFC-134a**	**R-407C**
HFC used at enterprise	mt	23.77	0.14
	CO_2-eq tonnes	33,989	248
HFC to be phased out through this project	mt	23.77	0.14
	CO_2-eq tonnes	33,989	248
Alternative to be phased in	**Unit**	**R-290**	
	mt	16.73	
	CO_2-eq tonnes	50.19	
Project duration (months)		24	
Initial amount requested (US $)		394,494	
Final project costs (US $)			
Incremental capital costs		335,400	
Contingency (10 % of equipment)		33,540	
Incremental operating costs		72,825	
Total project cost		441,765	
Local ownership (%)		100	
Export component to non-Article 5 countries (%)		0	
Requested grant (US $)		394,494	
Cost-effectiveness	US $/kg	16.50	
	US $/$CO_2$-eq tonne	12.90**	
Implementing agency support costs (US $)		27,615	
Total cost of project to Multilateral Fund (US $)		422,109	
Counterpart funding (Y/N)		Y	
Project monitoring milestones included (Y/N)		Y	

* In 2025, exports of R-407C were higher than imports. The country reported using 54.97 mt of R-407C in the manufacturing of refrigeration equipment in its 2025 country programme data report.

** Not accounting for the phase in of R-290, which is not a controlled substance.

SECRETARIAT'S RECOMMENDATION	Individual consideration

PROJECT DESCRIPTION

Summary of the proposal as submitted

37. On behalf of the Government of India, UNDP as the designated implementing agency has submitted a request for a project to convert the manufacturing of commercial refrigeration appliances at Birla Aircon (Birla) from HFC-134a and R-407C to R-290, in the amount of US $394,494, plus agency support costs of US $27,615, as originally submitted.[7]

38. The proposal also includes an amount of US $224,000, plus agency support costs of US $15,680, for an energy efficiency pilot project to be implemented at the enterprise, submitted in line with decision 91/65. As further described in paragraphs 61 to 63 and 75 of the present document, that request was subsequently withdrawn.

Background

39. India ratified the Kigali Amendment on 27 September 2021, and project preparation funding for stage I of a Kigali HFC implementation plan (KIP) was approved at the 98th meeting.[8]

Status of implementation of other stand-alone HFC projects and activities related to energy efficiency

40. At the 93rd meeting, the Executive Committee approved the project for the conversion from R-407C and R-410A to HFC-32 in the manufacturing of light commercial packaged and ducted air-conditioning (AC) units at Voltas Limited (Voltas);[9] the project for the conversion of the manufacture of commercial refrigeration appliances at Rockwell Industries Limited (Rockwell) from HFC-134a to R-290;[10] and the energy-efficiency pilot component of the Rockwell conversion project.[11] Also at the 93rd meeting, the Executive Committee approved the pilot project to design and develop, on a pilot scale, energy-efficient rotary compressors along with microchannel heat exchangers compatible with R-290 technology at Godrej & Boyce Mfg. Ltd; a summary of that project and its outcomes is contained in document UNEP/OzL.Pro/ExCom/99/19.

41. The two projects at Rockwell were implemented between 2024 and 2025.[12] Under the energy efficiency pilot, Rockwell optimized the design of 15 model prototypes using high-efficiency compressors, heat exchangers, and electrical components. Testing showed that the optimized R-290 prototypes consumed less energy than the HFC-134a baseline models. The data and methodologies from the pilot could inform strategies for the HFC phase-down under India's upcoming KIP. The project at Voltas was submitted in line with decision 87/50(e) in advance of the KIP and aimed to phase out 63,383 CO_2-eq tonnes (30.29 mt of R-407C and 4.63 mt of R-410A), which would be deducted from the country's HFC consumption eligible for funding identified in the KIP. The project was completed in December 2025.

Policy, regulatory and institutional framework

42. The Government of India has an established licensing system for the import and export of HFCs that has been in place since 2022. The licensing system is enforced by the Directorate General of Foreign

[7] As per the letter of 7 September 2026 from the Ministry of Environment, Forest and Climate Change of India to UNDP.
[8] Decision 98/26
[9] Decision 93/77
[10] Decision 93/78
[11] Decision 93/89
[12] The project submitted in line with decision 87/50(e) in advance of the KIP aimed to phase out 31,328 CO_2-equivalent (CO_2-eq) tonnes (21.91 mt of HFC-134a), which would be deducted from the country's HFC consumption eligible for funding identified in the KIP.

Trade (DGFT), Ministry of Commerce and Industry, operating on the technical recommendations of the Ozone Cell. The Ozone Cell, established under the Ministry of Environment, Forest and Climate Change, is the central body for all Montreal Protocol activities. The Ozone Cell holds responsibility for institutional coordination, drafting regulatory notifications, managing data inventories, liaising with scientific institutions, and representing India's strategic interests multilaterally. Comprehensive HFC data reporting under Article 7 of the Montreal Protocol has been fully operational since 2022. The Bureau of Energy Efficiency (BEE), under the Ministry of Power, is the agency responsible for nationwide energy efficiency and conservation policies, including the standards and labelling programme, which regulates energy performance for cooling equipment.

43. The strategic policy direction and execution of projects is governed by the Empowered Steering Committee (ESC), chaired by the Secretary of the Ministry of Environment, Forest and Climate Change and comprising representatives of key ministries and stakeholders. The ESC is supported by the Technology Finance Standing Committee and the Standing Committee on Monitoring, to ensure the integrity of evaluation and implementation.

Minimum energy performance standards

44. India, through the BEE, has established minimum energy performance standards (MEPS) and an energy-labelling mechanism to monitor and assess energy-efficiency implementation. Mandatory standards and labelling are in place for room AC, commercial chillers, deep freezers, and domestic refrigerators. The BEE has also launched voluntary standards for appliances such as visi coolers. Of the products manufactured by Birla, chest freezers, and freezers-on-wheels are therefore subject to mandatory standards and visi coolers to voluntary standards, while water coolers, water chillers, and refrigerated display cabinets and are not covered.

HFC consumption and sector background

45. The Government of India reported a consumption of 80,921,183 CO_2-eq tonnes of HFCs in 2025. The country's HFC consumption baseline for compliance has not yet been established.[13] The 2021–2025 HFC consumption is shown in table 3.

Table 3. 2021–2025 HFC consumption in India (Article 7 data)

Substances	2021	2022	2023	2024	2025
Metric tonnes (mt)					
All HFCs	30,081.29	43,354.71	42,817.22	49,164.71	56,902.90
HFC-134a	10,041.68	17,740.47	15,810.06	15,339.65	18,257.56
R-404A	631.62	1,038.27	1,055.78	2,248.11	4,533.13
R-407C	1,277.57	444.55	46.24	-301.89*	-528.39*
CO_2-eq tonnes					
All HFCs	41,787,290	57,219,531	51,165,562	66,796,901	80,921,183
HFC-134a	14,359,600	25,368,871	22,608,384	21,935,692	26,108,308
R-404A	2,476,961	4,071,680	4,140,347	8,816,188	17,777,123
R-407C	2,266,216	788,563	82,028	-535,504*	-937,276*

* In 2024 and 2025, exports of R-407C were higher than imports. The country reported using 35.41 mt and 54.97 mt of R-407C in the manufacturing of refrigeration equipment in its 2024 and 2025 country programme (CP) data reports.

46. Commercial and industrial refrigeration in India represents the most energy- and emission-intensive segment of India's cooling economy. The sector relies heavily on ultra-high-global-warming-potential

[13] As a country belonging to Group 2 under the Kigali Amendment, the baseline for India will be established based on the average HFC consumption in 2024-2026 plus 65 per cent of its HCFC baseline.

(GWP) HFC blends, primarily R-404A and R-407C. Due to the reliance on field-piped, split refrigeration systems with higher leakage rates than factory-sealed units, direct and indirect emissions in this sector are expected to increase.

47. India's cold-storage market is expanding owing to the growth of quick commerce, shifting infrastructure investments towards decentralized, modular cold rooms in urban locations, and the growth of the deep-frozen and low-temperature segment (below -20°C), driven by increased demand for pharmaceuticals and medicinal products, and processed food.

Project overview

Project objective

48. The project aims to convert two lines manufacturing commercial refrigeration appliances from HFC-134a and R-407C to R-290 at Birla. The conversion would eliminate 23.91 mt of HFC-134a and R-407C consumed annually (23.77 mt of HFC-134a and 0.14 mt of R-407C), equivalent to 34,238 CO_2-eq tonnes (33,989 CO_2-eq tonnes of HFC-134a and 248 CO_2-eq tonnes of R-407C).

49. The conversion project would focus on a single enterprise manufacturing a variety of stand-alone and small-scale commercial equipment. This would support the large-scale replicability and sustainability of the phase-out in the commercial refrigeration sector under the future KIP by allowing India to measure and disseminate the potential for HFC conversion and energy efficiency gains with empirical data that can be shared with other manufacturers.

Enterprise background

50. Birla is an established Indian manufacturer of commercial refrigeration equipment, classified under national legislation as a medium-sized enterprise, and one of the many small and medium-sized enterprises (SMEs) in that sector. It designs and manufactures a range of HFC-based commercial refrigeration products including water coolers, water chillers, freezers-on-wheels, display cabinets, visi coolers, and chest freezers of varying ranges of operating temperatures from minus 18 to plus eight degrees Celsius, serving an array of applications across the commercial, institutional, healthcare, and industrial sectors.

51. The enterprise has two HFC-based manufacturing lines housed within a single integrated plant in Meerut, Uttar Pradesh, India, with an annual manufacturing capacity of 100,000 units, including customized versions of its standard models that use the same refrigeration circuit technology, components, and manufacturing processes.[14] It consumes HFC-134a for the majority of units and a small quantity of R-407C for some water chiller models. In 2025, it manufactured 49,812 units.

Enterprise-level HFC consumption

52. Birla manufactures several models of commercial refrigeration appliances with refrigerant charge sizes ranging from 0.21 kg to 2.25 kg depending on the equipment configuration and cooling capacity; the average charge per unit for each product type is shown in table 4.

[14] As noted in paragraph 69 of the present document, stage III of the HCFC phase-out management plan (HPMP) included the conversion at the enterprise of a separate line manufacturing HCFC-22-based water coolers to R-290 and of a residential AC manufacturing line from HCFC-22 to HFC-32.

Table 4. Refrigerant charge and HFC consumption of products manufactured by Birla (2025)

Product manufactured	Refrigerant used	No. of models	No. of units manufactured	Charge per unit (kg)	Consumption (mt)
Manufacturing line 1					
Water coolers	HFC-134a	6	25,000	0.450	11.25
Subtotal (line 1)		***6***	***25,000***	***0.450***	***11.25***
Manufacturing line 2					
Water chillers	HFC-134a	3	650	0.650	0.42
Freezer-on-wheels	HFC-134a	2	2,650	0.375	0.99
Display cabinets	HFC-134a	3	250	0.850	0.21
Visi coolers	HFC-134a	3	10,200	0.550	5.61
Chest freezer	HFC-134a	2	11,000	0.480	5.28
Water chillers based on R-407C	R-407C	1	62	2.250	0.14
Subtotal (line 2)		***14***	***24,812***	***0.510***	***12.65***
Total		**20**	**49,812**	**0.480**	**23.91**

53. The average refrigerant consumption by Birla over the last three years is 21.61 mt of HFC-134a and R-407C, as shown in table 5. The project would phase out the enterprise's 2025 consumption of 23.91 mt.

Table 5. Annual consumption of HFCs at Birla (2023-2025)

Manufacturing line	Refrigerant used	Consumption (kg)			
		2023	2024	2025	Average
Line 1	HFC-134a	9,000	10,125	11,250	10,125
Line 2	HFC-134a	10,137	11,447	12,518	11,367
Line 2	R-407C	95	117	140	117
Total annual consumption		**19,232**	**21,689**	**23,908**	**21,610**

Project description

54. The two lines manufacturing commercial refrigeration products with HFC-134a and R-407C will be converted to R-290 under the project.

55. An evaluation of available technology options was undertaken for the selection of an alternative refrigerant, which found no non-flammable refrigerants that would meet the desired criteria for the replacement at Birla, while alternatives such as hydrofluoroolefins (HFOs) faced market or other challenges. The most technically suitable and commercially viable technology for the conversion was R-290, which, while flammable,[15] would provide environmental benefits as well as favourable technical performance.

56. The project will address the flammability of R-290 through engineering controls, process modifications, and comprehensive training. Measures include redesigning the products to operate safely with a flammable refrigerant; modifying the production line to handle R-290, including explosion-proof components and advanced leak detection; and updating operational procedures and training personnel in the safe handling of R-290.

Cost of the project as submitted

57. The total cost of converting the two manufacturing lines at Birla from HFC-134a and R-407C to R-290, as submitted, is US $1,482,843, consisting of US $598,840 for incremental capital costs (ICCs) and

[15] R-290 is classified as an A3 refrigerant by ASHRAE Standard 34, having a lower toxicity (A) and higher flammability (3).

US $884,003 for incremental operating costs (IOCs). ICCs and IOCs were estimated considering the existing manufacturing infrastructure, manufacturing capacity, number of manufacturing lines, annual manufacturing volumes, baseline consumption, and additional engineering and safety measures required for adopting R-290 technology. Of this total, US $394,494, plus agency support costs, has been requested from the Multilateral Fund, and US $1,088,349 (73 per cent of the total project cost) would be provided through co-financing by the beneficiary.

58. IOCs were calculated at US $884,003 based on incremental costs related to the change of compressors, change of electrical components and controls, and savings from the change of refrigerant. Total IOCs per type of equipment manufactured at Birla are shown in table 6.

Table 6. IOCs proposed for the conversion of Birla per equipment type (US $)

Equipment type	IOCs
Water coolers	534,361
Water chillers	27,615
Freezer-on-wheels	36,937
Display cabinets	2,380
Visi coolers	109,081
Chest freezer	173,629
Total	**884,003**

59. ICCs were requested in the amount of US $598,840 for model redesign, prototyping, and testing; line modifications; installation of a safety system; technical assistance; training of personnel; trial and testing of products; and contingencies, as summarized in table 7.

Table 7. ICCs and IOCs proposed for the conversion of manufacturing lines at Birla

Description	Unit price (US $)	Quantity	Total cost (US $)
Product redesign, prototyping and testing	1,000	20	20,000
Pressure testing equipment (high-pressure air compressor)	20,000	1	20,000
Replacement of jigs and fixtures	7,500	4	30,000
Replacement of the manual production line with an automated conveyor line	80,000	1	80,000
Explosion-proof industrial vacuum pump	3,000	15	45,000
Refrigerant charging machine	45,000	2	90,000
Helium leak detector	30,000	2	60,000
Industrial leak detectors (fixed lines)	4,200	2	8,400
Ultrasonic welding machine (heavy duty)	25,000	2	50,000
Safety system (manufacturing area and finished products storage area)	25,000	2	50,000
Refrigerant distribution system (booster pumps for refrigerant distribution)	13,000	2	26,000
Technical assistance	15,000	1	15,000
Safety audit by third party	20,000	1	20,000
Safety training for plant operators	10,000	1	10,000
Production trials and testing	1,000	20	20,000
Subtotal ICC			*544,400*

Description	Unit price (US $)	Quantity	Total cost (US $)
Contingencies	10%	-	54,440
Total ICC			*598,840*
Total IOC			*884,003*
Total incremental cost			**1,482,843**
Co-financing			1,088,349
Funds requested to the Multilateral Fund			**394,494**

60. The project will result in the phase-out of 23.77 mt (33,989 CO_2-eq tonnes) of HFC-134a and 0.14 mt of R-407C (248 CO_2-eq tonnes). Based on the total incremental cost of the project as submitted, the overall cost-effectiveness of the conversion from the use of HFC-134a and R-407C to R-290 at the two manufacturing lines at Birla amounts to US $62.02/kg, or US $43.31/$CO_2$-eq tonne. The project is expected to be completed within 24 months from approval, between January 2027 and December 2028.

Activities to enhance the energy efficiency of stand-alone commercial refrigeration equipment

61. As part of the conversion project, UNDP also submitted a request for funding under decision 91/65 to maximize the climate benefits from the conversion of the manufacturing lines at Birla by jointly implementing a technical assistance project to enhance the energy performance of the converted equipment by inter alia integrating high-efficiency components and optimizing the equipment design. The technical assistance would also provide data on the incremental costs and verified performance of high-efficiency R-290-based commercial refrigeration equipment, in order to support the BEE in designing a mandatory standards and labelling framework for the sector, including MEPS and star-rating labels, and to provide a replication model for other SMEs.

62. Funding was requested to develop, build, and test approximately 20 optimized prototypes across the product range of the enterprise. The prototypes would integrate high-efficiency components (e.g., variable-speed compressors, higher-efficiency fan motors, and advanced controllers) sourced from the open market and would undergo performance testing and certification at an accredited, independent laboratory; selected units would subsequently be deployed in field trials for at least six months to assess energy consumption and reliability in real operating conditions. The entire process, from design and component sourcing to testing and validation, would be documented, and was expected to deliver the following outputs:

(a) A techno-economic report quantifying the increases in capital and operating costs associated with moving from a standard R-290 design to a high-efficiency model, to inform the setting of realistic MEPS;

(b) Certified performance data and field trial reports establishing energy consumption benchmarks for commercial refrigeration equipment manufactured in India, to avoid the setting of unattainable standards and to provide a baseline for the star-rating labels of BEE; and

(c) A case study and best-practice guide for other SMEs in the sector, demonstrating a validated pathway to manufacturing high-efficiency products.

63. The requested funding under decision 91/65 is aligned with the India Cooling Action Plan (ICAP), which prioritizes the integration of energy efficiency improvements with the refrigerant transition, and was designed to complement existing efforts without duplicating activities or funding. The funding request of US $224,000 would cover the activities listed in table 8.

Table 8. Costs proposed for the energy efficiency pilot project at Birla

Description	Unit cost (US $)	Qty	Total cost (US $)
Technical assistance for product optimization	30,000	1	30,000
Energy-efficiency-optimized design and construction of prototypes	3,500	20	70,000
Performance testing of prototypes	2,200	20	44,000
Certification of prototypes	2,500	20	50,000
Data logging systems for long-term monitoring	1,000	20	20,000
Independent peer review	10,000	1	10,000
Total			**224,000**

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Relation to stage I of the Kigali HFC implementation plan and sustainability of HFC reductions

64. The Birla project proposal was submitted in line with decision 87/50(e) in advance of stage I of the KIP. The Secretariat noted that project preparation funding for stage I of the country's KIP was approved at the 98th meeting and sought to better understand how the project would relate to meeting the overarching strategy for India and when the KIP would be submitted, as requested by the same decision, and whether submitting a sector plan would ensure a more level playing field and the sustainability of the conversion. The Secretariat further noted that the requested IOCs, as submitted, raised concerns about the sustainability of the conversion.

65. UNDP explained that preparation of stage I of the KIP was ongoing and included extensive stakeholder consultations, inter-ministerial coordination, and national sector-wide surveys; the planned timeline for the submission of stage I was being determined through the official national process being led by the Ozone Cell. While stage I was still being prepared, the Ozone Cell anticipated the surveys being undertaken would reveal a significant number of geographically dispersed SMEs manufacturing and assembling commercial refrigeration equipment, and that it was likely that this sector would be a priority under India's HFC phase-down strategies. The Government considered the conversion of the enterprise a critical project designed to generate real-world, domestic techno-economic data on R-290 technology in the context of Indian SME manufacturing. Moreover, the conversion would establish the empirical baseline for technical safety protocols, production-line modifications, and the cost structure and logistics of localized component supply chains, which would need to be replicated. The project would generate the data required to design a realistic, replicable, and low-risk plan for the remaining eligible enterprises under the KIP, ensuring the buy-in of these stakeholders to a future stage I KIP strategy.

66. UNDP further highlighted the highly fragmented nature of the commercial refrigeration manufacturing sector in India, with widely varying manufacturing methods, component access, and financial structures; that the exact number of enterprises manufacturing stand-alone commercial refrigeration equipment would only be known once the rigorous, inter-ministerial KIP survey was complete; that the project would provide real-world experience on the actual ICCs and IOCs in the local Indian market; and that documenting these costs would enable the Government to gather the precise, localized data needed to design a cost-effective, realistic, and successful sector plan or stage I KIP strategy.

67. UNDP also noted that the commercial refrigeration equipment manufactured by Rockwell (i.e., deep freezers and bottle coolers), and by the commercial refrigeration manufacturing enterprises that converted to R-290 under stage III of the HPMP (including Birla for water coolers), tended to be high-volume, mass-market products. Rockwell, for example, operated an automated, single-product, mass-manufacturing line, which meant the safety systems, charging station, and testing rigs were optimized for one type of

product with a consistent charge size, whereas Birla operates a flexible, manual, and semi-automated line that must handle frequent model changeovers, diverse product geometries, and varying refrigerant charge sizes on the same day.

68. The Secretariat noted that the Government required additional time to develop its strategy for stage I of the KIP; that the early conversion of the enterprise would reduce both the country's HFC manufacturing consumption and subsequent demand for HFCs for servicing; and that enterprises in non-Article 5 countries and in Article 5 countries, including in India, had successfully converted to R-290 to manufacture stand-alone commercial refrigeration equipment, and that the market uptake of the technology was broad. As further described below, the Secretariat estimates IOCs that are considerably lower than those estimated by UNDP, suggesting that the risks to the sustainability of the conversion are manageable in the absence of a sector plan and policy and regulatory measures to restrict the manufacture and import of HFC-based equipment. Finally, the Secretariat noted that the project was eligible under decision 87/50(e).

69. UNDP confirmed that through the project, the two manufacturing lines would cease consuming HFCs and would be converted to R-290. The enterprise also manufactures other refrigeration and air-conditioning equipment. In particular, under stage III of the country's HPMP, the enterprise converted a separate line manufacturing water coolers from HCFC-22 to R-290 and a residential AC manufacturing line from HCFC-22 to HFC-32. Upon completion of the project, the only HFC consumption of the enterprise will be HFC-32 for the manufacture of residential AC units.

Deduction of HFC reductions from the starting point

70. The phase-out of 34,238 CO_2-eq tonnes (23.77 mt of HFC-134a and 0.14 mt of R-407C) resulting from the approval of the present project will count against the consumption eligible for funding identified in the KIP. Accordingly, once the starting point for sustained aggregate reduction in HFC consumption is established, the reductions proposed by this project will be deducted in accordance with the methodology agreed under the HFC cost guidelines (decision 96/50(b)).

Technical and cost-related issues

71. The Secretariat noted that a stated purpose of the project was to demonstrate to other SMEs that the transition to R-290 is feasible, thereby creating a replicable model for the large number of other SMEs in the sector to convert to the technology, and that in line with decision 95/86(c), Birla is not considered an SME; and inquired whether this purpose of the project could be met by raising awareness of other local enterprises that already manufacture with R-290 or by undertaking the conversion at an enterprise that met the definition of an SME under decision 95/86(c). UNDP clarified that under the Micro, Small and Medium Enterprises Development Act, Birla is classified as a medium-sized enterprise based on its composite capital investment in plant and machinery and annual turnover.

72. The Secretariat and UNDP discussed in detail each of the items required for the conversion at Birla and agreed to a number of adjustments. The costs related to the pressure testing equipment were removed as the baseline equipment for the current HFC-134a-based manufacturing can be applied to R-290-based technology; funding to replace the manual manufacturing lines with automated conveyor lines was removed as this is an ineligible upgrade; the 15 explosion-proof industrial vacuum pumps requested were reduced to two units for the recovery stations, in line with the conversions under stage III of the HPMP; and, given the range of refrigerant charge in the baseline equipment manufactured, a helium leak detector was not considered incremental. Following conversion, R-290 consumption would be 24 kg/day; accordingly, an external refrigerant storage and distribution system could be used but was not required. Instead, daily R-290 use could be addressed with a vented cabinet, which needs to include sensors and a change-over valve to allow smooth and safe transition between cylinders. As the cost of two such cabinets with accompanying safety systems would be comparable to the requested funding, the enterprise would have flexibility to use the agreed funding as originally proposed or for the procurement of vented cabinets and associated safety

systems. Funding for technical assistance was rationalized given assistance already provided for conversion to R-290 for similar equipment under stage III of the HPMP.

73. The Secretariat estimated IOCs based on a 50 per cent reduction in refrigerant charge for HFC-134a and a 35 per cent reduction for R-407C and based on the refrigerant prices provided;[16] and taking into account the safety-related measures required to isolate potential ignition sources and the difference in price of HFC- versus R-290-based compressors, which is expected to decrease as the local supply chain is established. This resulted in estimated IOCs of US $72,825 and total incremental costs of US $441,765, which exceed the funding eligible under the HFC cost guidelines; accordingly, the agreed eligible funding for the conversion is US $394,494, as reflected in table 9. While agreeing with the eligible funding for the project, UNDP considered the Secretariat's estimated IOCs unrealistic, inter alia noting that electrical components located in potential R-290 leak paths must be certified as non-sparking, hermetically sealed, or intrinsically safe; and that the compressor price difference proposed by the Secretariat was consistent with high-volume multinational procurement of small fractional-horsepower (HP) domestic refrigeration compressors rather than the 1/3 to over 2 HP compressors used by Birla.

Cost of the project as agreed

74. The agreed cost of the project for the conversion from HFC-134a and R-407C to R-290 in the manufacturing of commercial refrigeration appliances at Birla in India amounts to at least US $441,765, including a Multilateral Fund grant of US $394,494 and co-financing by the beneficiary of at least US $47,271, as shown in table 9.

Table 9. Proposed and agreed costs for the conversion of manufacturing lines at Birla

Description	Proposed cost (US $)	Agreed cost (US $)
Product redesign, prototyping and testing	20,000	20,000
Pressure testing equipment (high-pressure air compressor)	20,000	0
Replacement of jigs and fixtures	30,000	30,000
Replacement of the manual production line with an automated conveyor line	80,000	0
Explosion-proof industrial vacuum pump	45,000	6,000
Refrigerant charging machines (2)	90,000	90,000
Helium leak detector	60,000	0
Industrial leak detectors	8,400	8,400
Ultrasonic welding machine	50,000	50,000
Safety system	50,000	50,000
Refrigerant distribution system	26,000	26,000
Technical assistance	15,000	5,000
Safety audit by third party	20,000	20,000
Safety training for plant operators	10,000	10,000
Production trials and testing	20,000	20,000
Contingencies	54,440	33,540
Total ICC	*598,840*	*368,940*
Total IOCs	*884,003*	*72,825*
Total	**1,482,843**	**441,765**
Eligible funding	**394,494**	**394,494**

[16] The price of HFC-134a provided in the submission is consistent with that provided in the CP data report; the CP report does not provide a price for R-407C or R-290.

Activities to enhance the energy efficiency of stand-alone commercial refrigeration equipment

75. Regarding the request for funding under decision 91/65 to enhance the energy efficiency of stand-alone commercial refrigeration equipment manufactured by Birla, the Secretariat noted with appreciation the Government's efforts to improve the energy efficiency of equipment manufactured by the enterprise and recognized that enhancing the energy efficiency of the equipment would enable the market uptake of the R-290-based equipment. However, in line with decision 95/87(d), which extended the window for submitting projects under decision 91/65 to the 100th meeting only for servicing sector activities, the project is not eligible under decision 91/65. The Secretariat encouraged the Government to consider submitting to a future meeting a request for funding for a project to improve the energy efficiency of water coolers, water chillers, freezers-on-wheels, display cabinets, visi coolers, and chest freezers through a project submitted under decision 94/60, noting the applicable conditions for such a submission. In that regard, the Secretariat encouraged the Government to consider submitting a sector-wide conversion project, to implement a ban on the import and manufacture of HFC-based equipment, and to jointly submit a project under decision 94/60 to enhance the energy efficiency of the equipment during the HFC phase-down. This comprehensive approach would ensure a level playing field among manufacturers and importers and create the necessary enabling environment to help ensure the uptake of energy-efficient, low-GWP equipment. The Secretariat further noted that under such a project, Birla would be eligible to receive additional capital costs (including, for example, product design and testing, which could include development of prototypes; training of personnel; and factory upgrades) as well as additional operating costs (above the agreed IOCs under the present project), in line with the energy efficiency targets proposed. Subsequently, the Government withdrew the project, and UNDP noted the intention of the Government to submit a project under decision 94/60 to a future meeting.

Sustainability, replicability and assessment of risks

76. The Secretariat considers that the most significant risk to the sustainability of the project is that the enterprise will convert to R-290 technology in the absence of controls on imports of HFC-based stand-alone commercial refrigeration equipment and the manufacturing of such HFC-based equipment by other enterprises in the sector. Undertaking the conversion as part of a sector plan that includes policy and regulatory measures to restrict the continued manufacturing and import of HFC-based stand-alone commercial refrigeration equipment would avoid that risk. While there is some risk, the Secretariat considers the level of risk to be reasonable: R-290 technology is widely accepted for use in stand-alone commercial refrigeration equipment in markets around the world. Other enterprises in India already manufacture R-290-based stand-alone commercial refrigeration equipment. Increasing acceptance of R-290 technology in the country, including through the project, will enable the establishment of the supply chains and economies of scale that will enable manufacturers to manufacture R-290-based systems cost effectively, including after the provision of IOCs under the present project.

77. The implementation of the project will reduce the country's HFC consumption, help establish the supply chains for R-290 components, and build confidence in the technical and financial feasibility of the conversion to R-290 technology for other local manufacturers. Similarly, while the Government was still formulating its strategy for stage I of the KIP, the project will build confidence that other local manufacturers, including SMEs, can convert to R-290-based technology and remain competitive in the market, thus enabling the Government to consider including a sector plan as part of its stage I phase-down strategy.

RECOMMENDATION

78. The Executive Committee may wish to consider approving the project for the conversion from HFC-134a and R-407C to R-290 in the manufacturing of commercial refrigeration appliances at Birla Aircon in India, in the amount of US $394,494, plus agency support costs of US $27,615 for UNDP, on the understanding:

(a) That 34,238 CO_2-eq tonnes of HFCs would be deducted from the starting point for sustained aggregate reductions in HFC consumption once it had been established; and

(b) That the project would be integrated into stage I of the Kigali HFC implementation plan for India, once the plan had been fully formulated for submission for consideration by the Executive Committee.

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

India

PROJECT TITLE	AGENCY
Pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration on the use of HFO-1233zd(E) and HFO-1234ze(E) as refrigerants in water-cooled centrifugal and screw chillers	UNDP (lead)

PROJECT OBJECTIVE
This project aims to demonstrate the energy efficiency of low-GWP, alternative chiller technologies in the commercial and industrial air-conditioning sectors of India through the replacement of two HFC-134a-based systems at two end users.

NATIONAL COORDINATING AGENCY	Ozone Cell, Ministry of Environment, Forest and Climate Change, Government of India

ARTICLE 7 DATA (Annex F)	**Year: 2025**	56,902.90 mt	80,921,183 CO_2-eq tonnes

PROJECT DETAILS		
HFC consumption in the RAC servicing sector in 2025 (country programme data)	mt	18,897.65
	CO_2-eq tonnes	36,141,298
Project duration	months	36
Grant amount requested from the Multilateral Fund	US $	752,199
Grant amount agreed	US $	494,734
Project support costs for UNDP	US $	34,631
Total cost of project to Multilateral Fund	US $	529,365
Energy-efficiency savings to be achieved through the project	kWh/year	407,000
Co-financing		Yes
Project monitoring milestones included		Yes
Minimum energy performance standards for relevant applications are established		Yes
Minimum energy performance standards for relevant applications are enforced		Yes

SECRETARIAT'S RECOMMENDATION	Individual consideration

PROJECT DESCRIPTION

Summary of the proposal as submitted

79. On behalf of the Government of India, UNDP as the designated implementing agency has submitted, in line with decision 91/65, a request for a pilot project to enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities), in the amount of US $752,199, plus agency support costs of US $52,654, as originally submitted.[17]

Background

80. Information on India's Kigali Amendment ratification; previously approved HFC projects; the implementation of other activities related to energy efficiency; the policy, regulatory and institutional framework, including information on the minimum energy performance standards (MEPS); and HFC consumption can be found in paragraphs 39 to 47 of the present document.

Project overview

Project objective

81. The project aims to establish replicable, scalable, and energy-efficient alternatives to HFC-134a-based equipment in the medium- and large-capacity, water-cooled chiller subsector of India's commercial and industrial air-conditioning sector through the implementation of two subprojects: a demonstration of a centrifugal chiller with a capacity of 650 tons of refrigeration (TR) using low-pressure HFO-1233zd(E) and a demonstration of a twin-screw chiller with a capacity of 500 TR using mildly flammable HFO-1234ze(E).

Project beneficiaries

Operators of HFC-134a-based central chillers: Commercial and industrial end-user facilities

82. Demonstration sites will be selected from the active commercial and industrial customer base of Blue Star Limited (Blue Star), the technology provider selected for the project. To be eligible, the end users must currently operate an ageing HFC-134a chiller ready for retirement; they must agree to baseline energy monitoring; and the facility's plant room must have adequate space. Additional criteria specific to each chiller type are as follows:

(a) Demonstration of centrifugal chiller using HFO-1233zd(E): The site must have a substantial and continuous baseload cooling demand (e.g., a data centre, large hospital, or industrial process) to validate the full-load coefficient of performance (COP) and overall system stability; and

(b) Demonstration of twin-screw chiller using HFO-1234ze(E): The site must have a variable cooling load profile (e.g., a commercial office building or hotel) to demonstrate the integrated part-load value (IPLV) and seasonal efficiency gains delivered by the variable frequency drive (VFD); the site must also meet all ventilation and safety requirements for handling a mildly flammable refrigerant.[18]

[17] As per the letter of 7 September 2026 from the Ministry of Environment, Forest and Climate Change of India to UNDP.

[18] HFO-1234ze(E) is classified as an A2L refrigerant by ASHRAE Standard 34, having a lower toxicity (A) and lower flammability (2) with a slow burning velocity (L).

Project description

83. The pilot project comprises two demonstrations to replace two HFC-134a-based commercial chillers with energy-efficient, low-global-warming-potential (GWP) alternatives at selected end-user clients of Blue Star. Each demonstration will include the end-user selection and agreement process; procurement, installation, and commissioning of the new chillers, including safety and leak-detection components; decommissioning and refrigerant recovery of the replaced chillers, including the safe storage or destruction of the recovered HFC-134a; evaluation and performance monitoring; capacity-building for service technicians, plant engineers, and safety personnel; and awareness-raising workshops to promote alternative technologies by sharing the data with the Bureau of Energy Efficiency (BEE) and industry stakeholders.

Project 1: Demonstration of centrifugal chiller using HFO-1233zd(E)

84. The demonstration involves replacing an HFC-134a-based, water-cooled centrifugal chiller with a cooling capacity of 650 TR currently in service at a selected end-user facility with continuous cooling needs. The baseline unit will be replaced by a water-cooled centrifugal chiller using HFO-1233zd(E) with the same cooling capacity; the water-cooled centrifugal chiller is a highly energy-efficient technology, and HFO-1233zd(E) is a refrigerant with zero GWP that can be used in low-pressure centrifugal chillers. The baseline unit is operating at an Indian Seasonal Energy Efficiency Ratio (ISEER) of 7.89 under standard commercial load profiles, and the replacement unit will have an ISEER of 9.01 under identical operating conditions, for an overall seasonal energy-efficiency improvement of approximately 14.2 per cent compared to the baseline unit.

85. The new unit will contain a high-efficiency centrifugal compressor with specialized impellers and gas path designs matched to HFO-1233zd(E)'s low pressure and high volumetric flow characteristics; a motor designed to minimize electrical and mechanical losses under full- and part-load operations; and a two-stage economizer vessel subsystem to reduce compressor suction superheat and lower overall compression work.

86. The demonstration aims to promote the use of energy-efficient technology in commercial and industrial facilities in India with continuous cooling needs, including at large hospitals, airports, pharmaceutical manufacturing hubs, and technology infrastructure such as data centres.

Project 2: Demonstration of twin-screw chiller using HFO-1234ze(E)

87. The demonstration involves replacing an HFC-134a-based, water-cooled twin-screw chiller with a cooling capacity of 500 TR currently in service at a selected end-user facility with variable cooling needs. The baseline unit will be replaced by a water-cooled twin-screw chiller using HFO-1234ze(E) with the same cooling capacity; the replacement unit will maintain the high part-load efficiency of the VFD screw platform while substituting the refrigerant with HFO-1234ze(E), a mildly flammable hydrofluoroolefin (HFO) refrigerant with a GWP of 0. The baseline unit is operating at an ISEER of 8.46, and the replacement unit will have an ISEER of 8.88, for an overall seasonal energy-efficiency improvement of 4.96 per cent compared to the baseline unit.

88. To ensure safety and compatibility and to optimize performance, the new unit will contain a unit-integrated, continuous leak detection, alarm, and emergency ventilation control system to safely manage the mild flammability of HFO-1234ze(E) inside the plant room, and the flooded shell-and-tube heat exchangers and electronic expansion devices will be modified and optimized to match the specific volume and thermodynamic properties of the new refrigerant, preventing throttling losses and maximizing the active heat-transfer surface area.

89. The demonstration aims to promote the use of a safely integrated, low-GWP technology in medium to large commercial and industrial facilities with variable cooling profiles operating in the 500-1,500 TR chiller-plant range, such as hospitals, hotels, and office buildings.

Cost of the pilot project as submitted

90. The project costs were estimated at US $752,199 for the two demonstrations of energy-efficient, low-GWP commercial chiller systems at selected end-user clients of Blue Star.

91. The total cost of US $752,199, plus agency support costs, as initially submitted, was requested from the Multilateral Fund. The project was expected to be completed within 24 months from approval, between January 2027 and December 2028. Table 10 presents the breakdown of the proposed activities and costs for the project.

Table 10. Activities and costs of the project, as submitted (US $)

Project no.	Project components and activities	Cost (US $)
1	Cost difference between a 650 TR, HFC-134a baseline chiller and the optimized HFO-1233zd(E) centrifugal chiller system	262,791
2	Cost difference between a 500 TR, HFC-134a baseline chiller and the optimized HFO-1234ze(E) screw chiller system	106,393
1, 2	End-user site safety integration in the plant room, including mandatory A2L-compliant leak detection sensors, mechanical ventilation interlocks, and safety upgrades	202,147
1, 2	Decommissioning and refrigerant recovery, including certified recovery cylinders, technician labour, and the safe transport of the recovered HFC-134a from each site	48,941
1, 2	Performance monitoring equipment, including high-accuracy power meters, flow meters, and data-loggers required to verify the COP and IPLV improvements over 12 months	102,137
1, 2	Capacity-building and dissemination, including specialized training for service technicians, plant engineers and safety personnel on low-pressure and A2L refrigerants, plus industry dissemination workshops	29,790
Total		**752,199**

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Eligibility under decision 91/65

92. This proposal meets the eligibility criteria of decision 95/87(d), since it has been submitted prior to the 100th meeting of the Executive Committee, and the activities proposed are in line with the criteria of decision 91/65(b)(i)d., since they are part of a project in the servicing sector and were not previously funded. In line with decision 91/65(b)(iv), the Government of India has confirmed that if India were to mobilize funding from sources other than the Multilateral Fund for energy-efficiency components when phasing down HFCs, the project would not result in the duplication of activities among those funded by the Multilateral Fund and those funded from other sources; the information on project progress, results and key learning would be made available, as appropriate; the date of completion of the project would be set as no more than 36 months after the date of approval by the Executive Committee; and a detailed project report would be submitted to the Executive Committee within six months of the date of completion of the project.

Minimum energy performance standards

93. Under the Energy Conservation Act, 2001, BEE has established legally binding MEPS for all vapour-compression cycle water-cooled and air-cooled chillers sold, manufactured, or imported in India. Initially launched as a voluntary programme, the scheme was transitioned into a mandatory compliance regime effective 1 January 2026. Centrifugal and screw chillers must comply with IS 16590 performance and testing standards and meet the designated MEPS threshold (1-star prequalification criterion) to be legally sold in the Indian market.

94. In addition, India has a mandatory star-labelling programme (ranging from 1 star to 5 stars) administered by BEE for all commercial-scale chillers. The star-rating bands are calculated based on the ISEER, which uses measured values for both the full-load COP and the IPLV. The current mandatory star-rating tables for water-cooled and air-cooled chillers are officially gazetted and valid from 1 July 2026 to 31 December 2029; upgraded MEPS and star ratings are expected to be promulgated by the end of 2029. The seasonal efficiency data generated from the project will be provided to BEE to enable it to refine the ISEER calculation methodologies and establish ambitious star-labelling bands for HFO-based chiller platforms in subsequent label validity periods.

Coordination with the Kigali HFC implementation plan

95. As discussed in paragraphs 64 and 65 of the present document, project preparation funding for stage I of the country's Kigali HFC implementation plan (KIP) was approved at the 98th meeting and the process for preparing stage I was ongoing. Accordingly, it was not yet clear whether activities to address HFC consumption in the manufacturing and servicing of chillers would be included in stage I. UNDP highlighted that mid-sized chillers (i.e., with a capacity of 500-650 TR) are widely used in India's commercial cooling infrastructure. The two chillers to be demonstrated were selected to validate two distinct, high-impact technology pathways: (non-flammable) HFO-1233zd(E) for baseload applications and (mildly flammable) HFO-1234ze(E) for variable-load applications. While surveys were still being conducted under the preparation process for stage I of the KIP, UNDP estimated that this subsector accounted for an estimated 10-12 per cent of HFC-134a consumption in the commercial refrigeration and air-conditioning sector, with manufacturing accounting for approximately one third of the subsector consumption and servicing of existing chillers accounting for the remaining two thirds. With large individual charges (250-450 kg/unit) and long equipment lifetimes, the subsector represents a significant and growing servicing bank. Preliminary estimates suggest there are four or five major domestic chiller manufacturers, accounting for approximately two thirds of the market, with imported equipment accounting for the remainder.

Selection of technology provider

96. As originally submitted, the project identified the technology provider for the project. Noting that projects under decision 91/65 are not intended for the manufacturing sector, the Secretariat sought to better understand why a particular provider had been selected and whether this would entail technical assistance to the local manufacturing enterprise. UNDP clarified that the Government of India had advanced the selection of the technology provider ahead of the final selection of the beneficiaries in order to expedite implementation once the project was approved, the provider having already completed the engineering design and pre-sourced the critical imported components so that the equipment could be supplied without delay. The project was designed and budgeted exclusively at the end-user level: no funding was allocated to manufacturing lines or factory facilities, and any assistance for the conversion of manufacturing operations from HFCs to low-GWP alternative technologies would be considered during the preparation of stage I of the KIP.

97. Noting that a pilot project under decision 91/65 to demonstrate energy-efficient equipment at end users should not be specific to a particular manufacturer, the Secretariat requested the basis on which Blue Star had been identified as the technology provider. UNDP explained that the enterprise had been selected

through an openly advertised national expression of interest (EoI) process, evaluated by a Technical Advisory Committee (TAC) comprising Government, academic and sector experts. The TAC selected Blue Star based on its advanced technology readiness levels and immediate capacity to deliver verified low-GWP systems based on HFO-1233zd(E) and HFO-1234ze(E). UNDP further indicated that while other domestic manufacturers possess general engineering awareness, the TAC's evaluation found that no other domestic enterprise was commercially ready to supply locally manufactured 500–650 TR HFO-based prototype chillers to replace HFC-based ones and commit the required technical and financial resources for immediate field deployment.

98. The Secretariat noted with appreciation the proactive step taken by the Government to select a technology provider, which would help ensure the timely implementation of the project. While the EoI process focused on domestic manufacturers in order to fulfil a core objective of India's long-term compliance strategy (namely, establishing a sustainable, localized alternative technology supply chain and servicing ecosystem), UNDP confirmed that there was no regulatory or legal framework in India that limits the participation or import of international technologies. The decision to conduct the EoI was a strategic one aimed at maximizing the project's long-term sustainability and replicability within India. The Secretariat understood that UNDP would follow its regular process for selecting the technology provider and that the selection of the two end users to receive the equipment to be demonstrated would be based on technical criteria and would not be restricted to a technology provider's customer base, noting that the Secretariat's assessment of costs might differ from those submitted by a technology provider and would be based on information available from a range of technology providers.

99. Regarding Blue Star, UNDP confirmed that the enterprise is one of India's largest air-conditioning and commercial refrigeration enterprises and a manufacturer of centralized, commercial chiller systems. It has developed optimized, water-cooled chiller designs using alternative low-GWP refrigerants HFO-1233zd(E) and HFO-1234ze(E) using its in-house engineering resources and research and development facility. The conversion of commercial-scale manufacturing lines has not yet taken place due to the high incremental capital costs involved in specialized production tools and safety components, which would increase the equipment purchase cost for industrial and commercial end users. The enterprise's 2023-2025 HFC-134a consumption in the manufacture of centralized, commercial chiller systems ranges from 110 mt to 125 mt.

Technical and cost-related issues

100. The end users to be selected will have HFC-134a chillers that are slated for decommissioning and replacement; the end users would therefore have fully depreciated the value of their existing chiller and can be expected to fully fund a replacement chiller. Accordingly, the funding requested by UNDP was not the price of a replacement chiller but rather the estimated difference in price between a replacement chiller that is based on HFC-134a and an optimized and highly energy-efficient HFO-based chiller. Co-financing by the end user will cover an amount equal to the cost of a new HFC-134a-based chiller (i.e., the replacement it would otherwise have purchased), including associated local civil, mechanical, and electrical modification costs; and the costs associated with certified, permanent decommissioning and legacy refrigerant recovery from the old HFC-134a-based unit. In line with the latter, it was agreed to remove the requested US $48,941 associated with equipment decommissioning and refrigerant recovery.

101. In considering the cost of the HFO-based chillers, the Secretariat noted that HFC-134a is a medium-pressure refrigerant, whereas HFO-1233zd(E) is a low-pressure refrigerant, and that to achieve the same 650 TR capacity, an HFO-1233zd(E) chiller would likely require larger physical components, including larger piping and expanded shell-and-tube heat exchangers; and that due to the difference in volumetric cooling capacity, an HFO-1234ze(E) chiller would similarly likely require larger components, including larger piping and expanded shell-and-tube heat exchangers, than an HFC-134a-based chiller. The Secretariat further noted that while the price of chillers varies, a new 650 TR water-cooled centrifugal chiller using HFO-1233zd(E) refrigerant could be expected to cost between US $225,000 and US $450,000 for the

equipment alone, while an HFC-134a chiller would likely range between US $150,000 and US $350,000; and a new 500 TR water-cooled screw chiller using HFO-1234ze(E) refrigerant could be expected to cost between US $80,000 and US $130,000 for the equipment alone, while a new HFC-134a chiller would likely range between US $75,000 and US $110,000. Those indicative prices, however, do not account for the optimized components and design changes needed to maximize the energy efficiency of the chillers. For example, UNDP anticipates that project 1 would require advanced aerodynamic impellers and optimized heat exchanger surface areas specifically designed to maximize energy performance under India's high-ambient and high-humidity seasonal fluctuations, while project 2 would not be based on a fixed-speed screw chiller but feature an advanced, variable-speed twin-screw architecture designed to optimize seasonal part-load efficiency (IPLV/ISEER). Inverter-duty screw compressors engineered specifically for low-density HFOs and their specialized harmonic-filtered drive panels are not manufactured in India, resulting in increased costs. In addition, the initial charge of pure HFO-1234ze(E) and specialized synthetic polyolester oils command a price premium over HFC-134a, adding to the incremental first cost of commissioning. Based on those considerations, the incremental cost for the two chillers was agreed as submitted.

102. Regarding the safety-related costs associated with HFO-1233zd(E), and asphyxiation risks indicated by UNDP, the Secretariat noted that both HFC-134a and HFO-1233zd(E) were heavier than air and can displace oxygen in confined or poorly ventilated mechanical rooms and, therefore, required comparable safety measures to address risks associated with asphyxiation. However, if the chiller is located in a plant room rather than on the end-user's roof, continuous gas detection is mandatory in the plant room and the existing non-dispersive infrared (NDIR) detector used for HFC-134a needs to be replaced, as it will not detect HFO-1233zd(E); in addition, a low-pressure-drop vent stack routed from the plant room to the outdoors to prevent back-pressure from bursting the shell during a relief event is required, given the low operating pressure of HFO-1233zd(E). Regarding the safety-related costs for HFO-1234ze(E), UNDP indicated that if the chiller is located in a plant room, the indoor installation of A2L-based equipment requires a multi-point redundant NDIR optical detector network wired into a safety integrity level 2-certified fail-safe programmable logic controller that is automatically triggered if the concentration of HFO-1234ze(E) reaches 13,000 parts per million (i.e., 20 per cent of the lower flammability limit), activating motorized shunt-trip circuit breakers to de-energize all non-explosion-proof electrical switchgear and activating ATEX-certified spark-proof emergency extraction blowers on an independent backup power loop. In addition, if the plant room is in the basement, heavy-gauge, fire-rated welded extraction ductwork and motorized fire/smoke isolation dampers routed vertically up the building would be required. Based on those considerations, and in line with precedents and including contingencies, safety-related costs for the two chillers were agreed at US $55,550.

103. Regarding the costs related to performance monitoring, UNDP clarified that BEE had not undertaken independent testing on installed chillers when developing the chiller MEPS and labelling but instead relied on desktop benchmarking: compiling manufacturer-submitted factory test-stand data (AHRI 550/590 calorimeter sheets) and international reference tables (ASHRAE 90.1); that neither BEE nor the Ozone Cell owns portable or fixed instrumentation suitable to measure chiller performance and electricity consumption; and that factory calorimeter sheets only test a chiller for a few hours under idealized, steady-state water temperatures, and therefore do not capture real-world tropical condenser fouling, monsoon wet-bulb spikes, sub-atmospheric purge power draw, or VFD part-load efficiency curves over four seasons. BEE is expected to initiate the process to revise the chiller MEPS by December 2027 and high-quality data from the project will inform that process. Accordingly, the costs of performance monitoring were agreed at US $50,000. Noting that chillers are typically sold with annual maintenance contracts, the costs associated with capacity-building and dissemination were rationalized to US $20,000, resulting in total agreed costs of US $494,734 for the project, as summarized in table 11 below.

Monitoring

104. The agreed funding for monitoring includes four months of baseline monitoring, to be conducted during India's high-ambient, peak-load summer season. By capturing continuous, high-accuracy power, water flow, and temperature logs during this peak period, engineers can establish the baseline's worst-case efficiency curve. Using this four-month real-world peak data alongside years of historical plant logs, engineers can build a highly accurate, mathematically validated linear regression model to predict the baseline chiller performance across seasons, eliminating the need to run an inefficient legacy HFC-134a system for a full year. The replacement chillers will be tested over a full 12-month period to capture the chillers' performance across India's distinct climate seasons (extreme summer heat, heavy monsoon humidity, and mild winter).

105. Accordingly, the selected end users will operate the new low-GWP chiller for their daily cooling needs for a minimum continuous monitoring period of 12 months, and will commit to allowing the technology provider, UNDP, and the Ozone Cell unrestricted access to the chiller for performance monitoring, servicing, and data retrieval. All generated energy-efficiency and operational logs will be shared for public dissemination and reporting.

106. The project duration was 24 months, as originally submitted. The Secretariat suggested and UNDP agreed that it would be prudent to extend the duration of the project to 36 months, as allowed under decision 91/65.

Cost of the pilot project as agreed

107. The agreed cost of the pilot project to demonstrate the use of HFO-1233zd(E) and HFO-1234ze(E) as refrigerants in water-cooled centrifugal and screw chillers in large commercial chiller plants using HFC-134a in India amounts to US $494,734, as shown in table 11.

Table 11. Activities and costs of the project, as agreed

Project no.	Project components and activities	Project cost (US $)	
		Submitted	Agreed
1, 2	Cost difference between HFC-134a chillers and optimized HFO chillers	369,184	369,184
1, 2	End-user site safety integration	202,147	55,550
1, 2	Decommissioning and refrigerant recovery	48,941	0
1, 2	Performance monitoring	102,137	50,000
1, 2	Capacity-building and dissemination	29,790	20,000
Total		**752,199**	**494,734**

Energy-efficiency enhancements and estimated savings

108. Project 1 (650 TR centrifugal replacement) is expected to demonstrate an optimized high-efficiency platform resulting in an overall ISEER improvement of approximately 14.2 per cent, resulting in a decrease in energy consumption of approximately 0.32 million kWh/year. Over five years and at an electricity price of US $0.11/kWh, this results in estimated savings of US $176,000. Project 2 (500 TR VFD twin-screw replacement) is expected to achieve an ISEER improvement of approximately 5.0 per cent, resulting in a decrease in energy consumption of approximately 0.087 million kWh/year. Over five years and at an electricity price of US $0.11/kWh, this results in estimated savings of US $47,850.

Sustainability, replicability and assessment of risks

109. The project directly targets mid-sized chillers, which are a significant part of India's commercial cooling infrastructure. Replicability will be supported by demonstrating and documenting the safe and

effective operation of the chillers as well as the electricity savings achieved with the technology. The project results will also inform the upgraded MEPS that will be promulgated in 2029; appropriately set MEPS and labelling requirements will further enhance replicability. In particular, BEE's star labels are directly linked to the Government's public procurement policies, under which Government bodies are required to procure equipment with a high star rating (typically 4 or 5 stars). Accordingly, once BEE establishes new star-rating bands that reflect the technology's enhanced efficiency, the public procurement rules are expected to increase demand for such systems.

110. While sector-wide interventions would further strengthen replicability and reduce risks, stage I of the KIP is still under preparation, so it is not yet clear whether the KIP will prioritize interventions in the chiller sector. Data from the demonstration project will inform not only future MEPS but also the Government's HFC phase-down strategy. Moreover, UNDP expects that hundreds of commercial chillers will be purchased in order to comply with the mandatory 2026 MEPS. Because these chillers have operational lifespans of 25 to 30 years, the technology chosen now will remain in use for decades. By demonstrating the low-GWP, energy-efficient HFO-1233zd(E) and HFO-1234ze(E) technology under local conditions, the project will provide a viable alternative that meets both the current MEPS and those expected in 2029, reduce the country's HFC consumption, and inform the country's HFC phase-down strategy.

RECOMMENDATION

111. The Executive Committee may wish to consider:

(a) Approving the pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): demonstration of the use of HFO-1233zd(E) and HFO-1234ze(E) as refrigerants in water-cooled centrifugal and screw chillers in large commercial chiller plants using HFC-134a in India, in the amount of US $494,734, plus agency support costs of US $34,631 for UNDP;

(b) Noting:

(i) That the Government of India has committed to the conditions referred to in decision 91/65(b)(iv)b. to (b)(iv)d.; and

(ii) That the project will be operationally completed no later than 31 December 2029 and that a detailed project report will be submitted to the Executive Committee within six months of the date of completion of the project, including a detailed description of the activities undertaken to disseminate the results of the technology demonstration and to promote the adoption of the selected energy-efficient alternative technologies.

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

India

PROJECT TITLE	AGENCY
Pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): Demonstration on the use of transcritical CO_2 high-temperature industrial heat pump	UNDP (lead)

PROJECT OBJECTIVE
This project aims to demonstrate the energy efficiency of low-GWP, alternative heat pump technologies in the industrial sectors of India through the replacement of an HFC-134a-based system at an end-user with a transcritical CO_2 high-temperature industrial heat pump.

NATIONAL COORDINATING AGENCY	Ozone Cell, Ministry of Environment, Forest and Climate Change, Government of India

ARTICLE 7 DATA (Annex F)	**Year: 2025**	56,902.90 mt	80,921,183 CO_2-eq tonnes

PROJECT DETAILS		
HFC consumption in the RAC servicing sector in 2025 (country programme data)	mt	18,897.65
	CO_2-eq tonnes	36,141,298
Project duration	months	36
Grant amount requested from the Multilateral Fund	US $	705,100
Grant amount agreed	US $	505,000
Project support costs for UNDP	US $	35,350
Total cost of project to Multilateral Fund	US $	540,350
Co-financing	US $	310,100
Total project cost, including co-financing	US $	815,100
Energy-efficiency savings to be achieved through the project	kWh/year	194,000
Counterpart funding		Yes
Project monitoring milestones included		Yes
Minimum energy performance standards for relevant applications are established		No
Minimum energy performance standards for relevant applications are enforced		No

SECRETARIAT'S RECOMMENDATION	Individual consideration

PROJECT DESCRIPTION

Summary of the proposal as submitted

112. On behalf of the Government of India, UNDP as the designated implementing agency has submitted, in line with decision 91/65, a request for a pilot project to enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities), in the amount of US $705,100, plus agency support costs of US $49,357, as originally submitted.[19]

Background

113. Information on India's Kigali Amendment ratification; previously approved HFC projects; the implementation of other activities related to energy efficiency; the policy, regulatory and institutional framework; and HFC consumption can be found in paragraphs 39 to 47 of the present document.

Minimum energy performance standards

114. India, through the Bureau of Energy Efficiency (BEE), has established minimum energy performance standards (MEPS) and an energy-labelling mechanism to monitor and assess energy-efficiency implementation, as summarized in paragraph 44 of the present document. Currently, high-temperature industrial heat pumps are not covered by a BEE star-labelling schedule or mandatory MEPS.

Project overview

Project objective

115. The pilot project aims to establish replicable, scalable, and energy-efficient alternatives to HFC-based equipment in India's industrial process heating subsector through the demonstration of a transcritical CO_2 water-to-water high-temperature industrial heat pump system with an estimated 400 kW heating capacity at a selected end-user facility in the dairy, pharmaceutical or food processing sector.

Project beneficiary

Operators of HFC-134a-based heat pumps: Commercial and industrial end-user facilities

116. The demonstration site will be selected from one local manufacturer's (Kirloskar Chillers Private Limited (Kirloskar)) active industrial customer base. To be eligible, the end user must currently operate an ageing HFC-134a heat pump for their continuous low-to-medium grade thermal process requirements. The primary candidate will be in the dairy and food processing sector, with pharmaceutical and chemical manufacturing, or automotive and engineering components identified as alternative target industries. Additional criteria are as follows:

(a) *Thermal load profile:* The site must have a continuous, stable process heating load requiring hot water between 70°C and 90°C to ensure uninterrupted data gathering;

(b) *Baseline and decommissioning readiness:* The end user must agree to baseline energy and flow monitoring on the incumbent system to allow for accurate before and after efficiency comparisons, prior to the complete retirement of the existing system; and

[19] As per the letter of 7 September 2026 from the Ministry of Environment, Forest and Climate Change of India to UNDP.

(c) *Space and safety compliance:* The site must have adequate, well-ventilated space suitable for high-pressure CO_2 equipment installation, compliant with national safety regulations.

Project description

117. The pilot project comprises a demonstration project to replace an existing HFC-134a-based industrial process heating system with a transcritical CO_2 water-to-water heat pump system designed for high-temperature applications. The new system will incorporate high-efficiency transcritical compressors, gas coolers, expansion energy recovery devices, and advanced control systems, with an intended 25 per cent improvement in energy performance under India's high-ambient climatic conditions.

118. The demonstration will include the end-user selection and agreement process; procurement, installation and commissioning of the new heat pump including safety and leak-detection components; decommissioning and refrigerant recovery of the replaced system, including the safe storage or destruction of the recovered HFC-134a; evaluation and performance monitoring; capacity-building for service technicians, plant engineers, and safety personnel; and awareness-raising workshops to promote alternative technologies by sharing the data with the BEE.

Technology provider: Kirloskar Chillers Private Limited

119. Kirloskar is one of India's leading commercial air-conditioning (AC) and industrial refrigeration enterprises. It has designed, manufactured and serviced large-capacity centrifugal and screw chillers and industrial heat pumps, and leads the market in adopting alternative low-global-warming-potential (GWP) refrigerants and energy-efficient technologies. The enterprise has developed a CO_2-based heat pump prototype internally; however, the conversion of industrial manufacturing lines has not yet taken place due to limited market demand which attributes to steep incremental capital costs involved in specialized production tools and safety components, which would inflate the equipment purchase cost for industrial and commercial end users. The enterprise's 2023-2025 HFC-134a consumption in the manufacture of heat pumps ranges from 8.80 mt to 10.50 mt.

Cost of the pilot project as submitted

120. The project costs were estimated at US $705,100 for the demonstration of an energy-efficient, low-GWP high-temperature industrial heat pump at one selected end user. The project is expected to be completed within 24 months from approval, between January 2027 and December 2028. Table 12 presents the breakdown of the proposed activities and costs for the project.

Table 12. Activities and costs of the project, as submitted

Project components and activities	Project cost (US $)
Cost difference between HFC-134a baseline heat pump and the optimized CO_2 system, including high-pressure compressors, variable frequency drives, transcritical gas coolers, and electronic expansion valves	395,100
End-user site safety integration including mandatory non-dispersive infrared sensor (NDIR) CO_2 leak detection sensors, mechanical interlocks, and high-pressure relief piping in plant rooms	105,000
Decommissioning and refrigerant recovery including costs for certified recovery cylinders, technician labour, and safe transport and destruction of legacy HFC-134a charge	15,000
Performance monitoring equipment including high-accuracy power meters, mass flow meters, and programmable logic controller (PLC) data-loggers required to verify the 25 per cent energy efficiency improvement	170,000
Capacity-building and training including specialized training for technicians and plant engineers on high-pressure CO_2 safety, plus industry dissemination workshops	20,000
Total	**705,100**

121. In addition, the proposal as submitted included co-financing of US $280,000, consisting of US $95,000 for equipment (the equivalent of an HFC-134a-based heat pump), US $35,000 for site preparation, civil and piping works by the beneficiary end user, as well as US $150,000 on upstream prototype engineering by the technology provider (Kirloskar). Together with the co-financing, the overall cost of the project as submitted was US $985,100.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Eligibility under decision 91/65

122. This proposal meets the eligibility criteria of decision 95/87(d), since it has been submitted prior to the 100th meeting of the Executive Committee, and the activities proposed are in line with the criteria of decision 91/65(b)(i)d., since they are part of a project in the servicing sector and were not previously funded. In line with decision 91/65(b)(iv), the Government of India has confirmed that if India were to mobilize funding from sources other than the Multilateral Fund for energy-efficiency components when phasing down HFCs, the project would not result in the duplication of activities among those funded by the Multilateral Fund and those funded from other sources; the information on project progress, results and key learning would be made available, as appropriate; the date of completion of the project would be set as no more than 36 months after the date of approval by the Executive Committee; and a detailed project report would be submitted to the Executive Committee within six months of the date of completion of the project.

Institutional, policy and regulatory framework

Minimum energy performance standards

123. High-temperature industrial heat pumps are not covered by the MEPS and labelling schemes. The Secretariat asked whether, by implementing the project, the Government of India could commit to formulating and implementing MEPS for the category of equipment being demonstrated. UNDP explained that a legally binding regulation cannot be committed to in advance of the statutory procedures provided for under the Energy Conservation Act, 2001, and it was agreed that the project would formally transmit the seasonal performance data generated to the technical committees of the BEE; that the drafting of a voluntary standards and labelling scheme and star-labelling bands for industrial heat pumps would be initiated within 24 to 36 months of project completion; and that a roadmap would be established for the transition of those bands into mandatory MEPS, following the sequence applied in the country for chillers, variable-speed air-conditioners and beverage coolers. The results would also inform the harmonization of the national safety code IS 16590 and the national pressure-vessel codes with ISO 5149 for high-pressure natural refrigerants in industrial applications.

Coordination with the Kigali HFC implementation plan

124. Preparation funding for stage I of the KIP for India was approved at the 98th meeting[20] and the plan is under preparation. UNDP explained that the pilot project would run concurrently with that preparation and would generate performance and safety data on high-temperature transcritical CO_2 heat pumps under Indian operating conditions to inform the prioritization of sectors under the plan, which remains subject to national consultations, and that the consideration of investment projects to convert the manufacturing of heat pumps from HFCs would be taken up during the preparation of KIP stage I. UNDP estimates that approximately 70 per cent of the HFC consumption associated with industrial heat pumps of this type arises

[20] Decision 98/26

in servicing, against 30 per cent in the first fill of new equipment, the segregated national data being under compilation through the KIP stage I survey.

125. At the suggestion of the Secretariat, the Government of India confirmed that the national training institutions expected to participate in KIP implementation, namely the Industrial Training Institutes and the National Skill Development Corporation, would be formally engaged in the project, and that the training modules developed on the installation and servicing of CO_2-based heat pumps would be co-developed with those institutions and made openly available, rather than retained by the equipment supplier, so that the skills generated are institutionalized in advance of the implementation of the plan.

Selection of the technology provider

126. The Secretariat sought clarification as to why the project proposal seemed to be anchored around a particular technology provider (Kirloskar) and whether this would entail technical assistance to the local manufacturing enterprise. UNDP clarified that the Government of India had advanced the selection of the technology provider ahead of the final selection of the beneficiary in order to expedite implementation once the project is approved. However, the present project is designed and budgeted exclusively at the end-user level: no funding is allocated to manufacturing lines or factory facilities, and any assistance for the conversion of manufacturing operations from HFCs to low-GWP alternative technologies would only be considered during the preparation of stage I of the KIP.

127. On the technology provider selection process, UNDP explained that it was done through an openly advertised national expression of interest (EoI) process conducted by the Ozone Cell and evaluated by a Technical Advisory Committee of government, academic and sector experts; no other domestic enterprise had a commercially ready prototype able to supply a locally manufactured system of this type and no international supplier had joined the EoI process. The selected provider has developed and tested its transcritical CO_2 design as an in-house prototype; no manufacturing line has been converted for series production, as systems of this type and size are custom-made based on market and clients' needs. The enterprise will commission and initially maintain the demonstration system and train the facility's technical team to take over its maintenance.

128. The final selection of the beneficiary end user, from candidate sites pre-screened during project preparation from the industrial client base of the technology provider, rests with the project's independent Technical Advisory Committee, overseen by the Ozone Cell, and will be made against published engineering criteria. It will be formalized through a tri-party Memorandum of Agreement among the technology provider, the Ozone Cell and the end user, to be executed before the equipment is dispatched to the site.

129. The Secretariat noted with appreciation the proactive step taken by the Government to select a technology provider, which would help ensure the timely implementation of the project and contribute to its long-term sustainability and replicability within India. The Secretariat's assessment of costs might differ from those submitted by a technology provider and would be based on information available from a range of technology providers.

Technical and cost-related issues

Technology selection

130. The baseline is a water-to-water heat pump of 400 kW nominal heating capacity which recovers low-grade heat from the existing condenser or effluent circuit of the facility at 30°C to 35°C in order to deliver process hot water continuously at 85°C, a lift of some 55°C at which HFC-134a operates well beyond its efficient range. The field-logged coefficient of performance (COP) of the baseline system is 2.35 at an evaporating temperature of 25°C and a condensing temperature of 88°C. The replacement system exploits the temperature glide of the gas cooler to match the profile of the water being heated, with a COP of around

3.0. It comprises two high-pressure semi-hermetic CO_2 compressors in a two-stage configuration, each with a variable-frequency drive, three heat exchangers rated for transcritical duty (gas cooler, sub-cooler and evaporator), electronic expansion valves and a programmable controller, operating at discharge pressures of 120 to 140 bar.

131. Regarding why the system is configured for heating only, given that heat pumps in the food-processing industry commonly serve both heating and cooling duties, UNDP explained that the facilities concerned already operate a centralized ammonia refrigeration plant for their cooling needs, of which there would be no technical or economic benefit in replacing, and that the heat pump is accordingly designed as a waste-heat recovery system drawing on the heat rejected by those condensers. When asked why this component had not been submitted with the other energy-efficiency proposal for the country addressing industrial applications, UNDP explained that the two reflect distinct specializations identified through the EoI process (large-scale industrial heat pumps as opposed to small and mid-scale cascade systems).

Beneficiary and equipment profile

132. In response to the request of the Secretariat for more specific information on the end user and its industrial process, UNDP explained that the dairy sector had been selected for the demonstration because its hot-water demand coincides with the range in which transcritical CO_2 systems operate most efficiently, because the facilities concerned have abundant on-site waste heat available as a source for the evaporator, and because the heating processes of the more than 1,200 large- and medium-sized processing plants in the organized sector are standardized, which facilitates replication.

133. The demonstration site will be a medium to large automated dairy processing plant in the organized sector with a continuous, year-round demand for hot water at 80°C to 85°C for pasteurization and cleaning-in-place, operating on a 24-hour cycle. The indicative parameters for a representative facility are a 400 kW HFC-134a water-to-water heat pump more than 10 years old, with a charge of 180 kg, annual leakage of 12 to 15 per cent, operating some 6,000 hours a year at an average part-load factor of 75 per cent, with an energy consumption of approximately 1,020,000 kWh. These will be confirmed through a baseline energy audit once the site is selected.

134. Selection by the Technical Advisory Committee will be based on criteria including a continuous and stable high-temperature process heating load, the operation of an ageing HFC-134a system to be retired, and plant-room space and safety conditions able to accommodate high-pressure CO_2 equipment and will be formalized through the Memorandum of Agreement referred to in paragraph 128 above.

Calculation of costs

135. The Secretariat discussed the cost of the different elements of the project with UNDP on the basis of the best available information and noting the limited number of similar funded projects and nature of the technology and application that are custom-made to the needs of each particular client. The following paragraphs highlight the main issues discussed and the final agreed costing.

136. The cost of the replacement system was estimated at US $490,100, against US $95,000 for the conventional HFC-134a heat pump that the end user would otherwise have purchased, leaving an incremental cost of US $395,100 to be met by the Fund; that incremental cost is driven by the twin two-stage semi-hermetic compressors and their variable-frequency drives, the heavy-wall metallurgy rated for 120 to 140 bar and the three heat exchangers rated for transcritical duty. The Secretariat observed that the market information and the precedent projects available indicate a cost ratio between transcritical CO_2 and comparable HFC-based systems of lower than the ratio of five to one implied by the submission; and that an HFC-134a-based heat pump comparable to the one considered for the project would have a larger cost than estimated. UNDP explained that the baseline figure is the verified domestic market price of a mass-produced

single-stage system of equivalent capacity, which is the business-as-usual asset that the end user would acquire. Upon discussion on the matter, equipment cost to be covered by the Fund was reduced to US $365,000.

137. The Secretariat compared the cost of the site safety integration, estimated at US $105,000 as submitted, with international references and proposed an adjustment. UNDP explained that the measures, namely floor-level infrared CO_2 detection, forced emergency ventilation at 15 to 20 air changes an hour, a fail-safe SIL-2[21] safety controller interlocked with fast-acting motorized isolation valves, and a redundant pressure-relief and guided venting manifold, are statutory prerequisites under IS 16590 and ISO 5149 for a system operating at 140 bar in an enclosed machinery room, where the hazards are the rupture of the pressure boundary and rapid oxygen depletion. Upon extensive discussions on the safety issue, it was agreed that the site safety integration cost covered by the Fund would be US $65,000, while the remaining US $40,000 budgeted in the proposal would be co-financed by the beneficiary.

138. The Secretariat also compared the cost of the monitoring and verification equipment, estimated at US $170,000 as submitted, with international references and proposed an adjustment, noting that the price of this component varies substantially with the characteristics of the site and the process. UNDP explained that the system is not a plant sub-meter but the national reference installation from which the BEE and the Bureau of Indian Standards are to derive the first energy performance bands for this category of equipment, and that data able to withstand scrutiny in the course of public rule-making requires research-grade metrology, in particular a high-pressure Coriolis mass flow meter for the CO_2 circuit, Class 0.2S power analyzers and paired Class A resistance temperature detectors, together with formal calibration by an agency accredited to ISO/IEC 17025. Upon discussion on this component, it was agreed that the Fund would cover US $55,000 and that the additional cost, estimated after discussions at US $95,000, would be co-financed.

139. Regarding other costs, UNDP agreed that the cost of US $15,000 for decommissioning of the existing system and the recovery of its HFC-134a charge would be transferred in its entirety to beneficiary co-financing, as this activity is required under any replacement, and as zero-venting recovery is expected under good servicing practices and may be supported through the servicing sector activities already underway in the country. The recovered charge of some 180 kg will not be destroyed; it will be logged, transferred in certified cylinders and reclaimed to the AHRI-700[22] standard at a government-authorized facility, and returned to the host enterprise or to the domestic servicing market, thereby offsetting the consumption of virgin HFC-134a. The local civil, mechanical, piping and electrical works at the facility, of US $35,000, are met by the beneficiary, as submitted; and the capacity-building and dissemination component, of US $20,000, was retained in full for the co-development of the national training curriculum referred to above. It was also agreed to remove the cost of upstream prototype engineering by the technology provider of US $150,000, which had been included in the original submission as co-financing contribution and is therefore not counted in the total cost.

Monitoring

140. As energy-efficiency gains must be demonstrated against the incumbent system, UNDP proposed four months of monitoring of the baseline system during the season of highest process demand, combined with the historical plant logs and a regression model of its year-round performance, followed by 12 months of monitoring of the replacement system, with the matching four-month windows compared. The Secretariat considers a longer baseline period preferable in order to capture more than one season, and the project duration has been set at 36 months, accordingly.

[21] Safety Integrity Level 2
[22] Air-Conditioning, Heating and Refrigeration Institute

Cost of the pilot project as agreed

141. The amount requested from the Multilateral Fund, as submitted, was US $705,100 against co-financing of US $280,000. Following the removal of the upstream prototype engineering element, the transfer of the cost of decommissioning and recovery to the beneficiary, and the review of the individual cost elements against the best available market information from several international sources, the agreed cost of the pilot project to demonstrate the use of a super-efficient transcritical CO_2 high-temperature heat pump in industrial process heating applications in India amounts to US $815,100, including a Multilateral Fund grant of US $505,000 and co-financing by the beneficiary and the technology provider of US $310,100, as shown in table 13.

Table 13. Project activities, total budget and cost breakdown by source, as agreed

Item	Project cost (US $)		
	Total	**MLF grant**	**Co-financing**
Incremental cost of the 400 kW transcritical CO_2 (R-744) high-temperature heat pump over the HFC-134a baseline system	490,100	365,000	125,100
Site preparation including electricals, piping, etc.	35,000	0	35,000
Site safety integration	105,000	65,000	40,000
Performance monitoring	150,000	55,000	95,000
Capacity-building	20,000	20,000	0
Baseline system decommissions and recovery	15,000	0	15,000
Total	**815,100**	**505,000**	**310,100**

142. The co-financing comprises the full commercial cost of the conventional HFC-134a heat pump that the end user would otherwise have purchased; the local civil, mechanical, piping and electrical works required at the facility; and the operational cost of decommissioning and removing the existing system and recovering its refrigerant charge. The Secretariat notes that the co-financing represents some 38 per cent of the total cost of the project, which is consistent with previous approvals for similar types and sizes of application, that the measures concerned are installed at and retained by the facility of the beneficiary, and that the Memorandum of Agreement is to be executed before the equipment is dispatched, which provides assurance of the commitment of the beneficiary before the project is committed to a site.

Energy-efficiency enhancements and estimated savings

143. The replacement system is designed to operate at a COP of 2.90 against the baseline of 2.35, reducing annual energy consumption at the demonstration site from approximately 1,020,000 kWh to 826,000 kWh and delivering savings of some 194,000 kWh per year, equivalent to an improvement of 25 per cent. At an industrial tariff of US $0.12 per kWh, that saving of 255,000 kWh per year is worth some US $30,600 per year to the beneficiary, against which the incremental cost of the replacement system over the conventional equipment that the beneficiary would otherwise have purchased, would be recovered in some 10 to 11 years, within the 15-year service life of the system, while noting that the cost recovery period would be shorter once the uptake of the technology is advanced and the relevant supply chain strengthened. Ultimately, independently verified results from this project are expected to help the Government of India identify measures under the KIP to reduce equipment costs and bring the payback period into an attractive 3-to-5-year range for future buyers.

144. UNDP estimates that the project will avoid direct emissions of approximately 463 CO_2-eq tonnes through the elimination of the annual leakage of the HFC-134a charge over that period, in addition to some 257 CO_2-eq tonnes of emissions that would otherwise arise on the venting of the charge at the end of the life of the equipment, and, on the basis of the revised energy savings and the national grid emission factor, approximately 2,869 CO_2-eq tonnes of indirect emissions. The Secretariat notes that these figures are based

on the indicative parameters of a representative facility and will be confirmed against the baseline energy audit of the selected site and when reporting at the completion of the project.

Sustainability, replicability and assessment of risks

145. UNDP estimates that the industrial and utility-grade segment of the heat pump market in the country, above 100 kW, is served by some 15 to 25 enterprises, with between 60 and 70 per cent of installations imported as pre-assembled units and the remainder supplied or assembled domestically using imported core components, and that no enterprise currently supplies transcritical CO_2 systems of this capacity on a commercial basis. The organized dairy sector alone comprises more than 1,200 large and medium-sized processing plants with standardized pasteurization and cleaning-in-place duties to which the technology could be applied directly, and UNDP identified the brewing and beverage and the packaged fruit juice industries as the subsectors with the highest further potential, their pasteurization, bottle-washing and line-sanitation duties requiring hot water in the same range of 75°C to 85°C, with replication requiring no development of the technology and only the routine external plumbing adjustments needed in order to integrate a modular package into the layout of a particular plant. The pharmaceutical and chemical industries, for jacketed vessel heating and the drying of active ingredients, and the automotive and engineering industries, for degreasing and pre-treatment baths, operate at somewhat lower temperatures and offer further scope.

146. The principal outputs supporting replication are the validated engineering and safety blueprint for the application and the openly available training curriculum: the performance data, the safety architecture and the operating protocols will be shared with the BEE and the Bureau of Indian Standards and disseminated to industry through technical workshops and the site visits that the beneficiary is committed to hosting under the Memorandum of Agreement, and the safety design will be made publicly available so that subsequent adopters may replicate it at a standardized and lower cost rather than each designing and certifying a system individually. UNDP explained that with the project being confined to the end-user level, the confidential design of the equipment and its components would not be disclosed, while the operational parameters and interface specifications required in order for others to supply and install comparable systems would be published.

147. On the risks to implementation, the specialized components of the system, including the high-pressure compressors, the electronic expansion valves and the Coriolis flow meter, are not manufactured in the country and are subject to lead times of some 16 to 24 weeks; UNDP explained that the technology provider has identified the suppliers and will place advance purchase orders for the long-lead items against its co-financing commitment upon endorsement of the project. The statutory clearances required in order to operate a high-pressure CO_2 system in an operating industrial facility, which involve the factory inspectorate, the fire-safety authorities and, where applicable, the Petroleum and Explosives Safety Organisation, will be sought on the basis of pre-engineered code-compliant safety packages, with the Ozone Cell coordinating with the national safety bodies and the local authorities concerned.

148. The risk that the beneficiary delays the shutdown of the plant or the site preparation works is addressed through the Memorandum of Agreement, which commits the end user to a pre-agreed timeline, and through an installation sequence under which the replacement system is erected, pre-commissioned and pressure-tested in parallel with the incumbent system so that the changeover requires a production shutdown of less than 48 hours. The risk of unsafe handling during commissioning and subsequent maintenance is addressed through the capacity-building component, under which hands-on safety training for servicing technicians and for the facility's own engineers is to be delivered before the equipment is handed over, the commissioning and initial charging being carried out by the technology provider's own specialists.

149. The measures described above are expected to contribute to the strengthening of the country's energy-efficiency framework for this category of equipment, through the transmission of the seasonal performance data to the BEE, the voluntary standards and labelling scheme and the roadmap towards

mandatory MEPS referred to above, and through the updating of the national safety and pressure-vessel codes to accommodate high-pressure natural refrigerants in industrial applications.

RECOMMENDATION

150. The Executive Committee may wish to consider:

(a) Approving the pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): demonstration of the use of a super-efficient transcritical CO_2 (R-744) high-temperature heat pump in industrial process heating applications in India, in the amount of US $505,000, plus agency support costs of US $35,350, for UNDP;

(b) Noting:

(i) That the Government of India has committed to the conditions referred to in decision 91/65(b)(iv)b. to (b)(iv)d.;

(ii) That the project will formally transmit the performance data generated to the technical committees of the Bureau of Energy Efficiency and will initiate the drafting of a voluntary standards and labelling scheme and star-labelling bands for industrial heat pumps, and will also establish an official roadmap for transitioning the voluntary standards into mandatory minimum energy performance standards in the future; and

(iii) That the project will be operationally completed no later than 31 December 2029 and a detailed project report will be submitted to the Executive Committee within six months of the date of completion of the project, including a detailed description of the activities undertaken to disseminate the results of the technology demonstration and to promote the adoption of the selected energy-efficient alternative technology.

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

India

PROJECT TITLE	AGENCY
Pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): demonstration of the use of super-efficient transcritical CO_2 and sub-critical CO_2-NH_3 cascade cooling systems in commercial and industrial refrigeration applications	UNDP (lead)

PROJECT OBJECTIVE
This project aims to demonstrate the energy efficiency of a cooling plant using transcritical carbon dioxide by replacing active, high-GWP HFC-based systems, with two non-HFC refrigerant technologies at commercial end-user facilities, through two separate projects. The project will demonstrate: i) the replacement of an existing R-407C-based condensing unit with a highly energy-efficient 4.5 kW transcritical CO_2 (R-744) condensing unit for modular cold-rooms; and ii) the replacement of an existing R-404A-based cooling system with a 35 TR subcritical CO_2-NH_3 (R-744 to R-717) cascade cooling system delivering process brine at -40°C.

NATIONAL COORDINATING AGENCY	Ozone Cell, Ministry of Environment, Forest and Climate Change, Government of India

ARTICLE 7 DATA (Annex F)	Year: 2025	56,902.90 mt	80,921,183 CO_2-eq tonnes

PROJECT DETAILS		
HFC consumption in RAC servicing sector in 2025 (country programme data)	mt	18,897.65
	CO_2-eq tonnes	36,141,298
Project duration	months	36
Grant amount requested from the Multilateral Fund	US $	862,300
Grant amount agreed	US $	481,000
Project support costs for UNDP	US $	33,670
Total cost of project to Multilateral Fund	US $	514,670
Co-financing	US $	281,300
Total project cost, including co-financing	US $	762,300
Energy-efficiency savings to be achieved through the project	kWh/year	198,800
Counterpart funding		Yes
Project monitoring milestones included		Yes
Minimum energy performance standards for relevant applications are established		No
Minimum energy performance standards for relevant applications are enforced		No

SECRETARIAT'S RECOMMENDATION	Individual consideration

PROJECT DESCRIPTION

Summary of the proposal as submitted

151. On behalf of the Government of India, UNDP as the designated implementing agency has submitted, in line with decision 91/65, a request for a pilot demonstration project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities) through two projects demonstrating the use of transcritical CO_2 and sub-critical CO_2-NH_3 cascade cooling systems in commercial and industrial refrigeration applications, in the amount of US $862,300, plus agency support costs of US $60,361, as originally submitted.

Background

152. Information on India's Kigali Amendment ratification; previously approved HFC projects; the implementation of other activities related to energy efficiency; the policy, regulatory and institutional framework; and HFC consumption can be found in paragraphs 39 to 47 of the present document.

Minimum energy performance standards

153. India, through the Bureau of Energy Efficiency (BEE), has established minimum energy performance standards (MEPS) and an energy-labelling mechanism to monitor and assess energy-efficiency implementation as summarized in paragraph 44 of the present document. Currently, neither of the two specific condensing units addressed in this pilot project, field-installed modular cold rooms served by split condensing units and industrial low-temperature brine chillers, are covered by a BEE star-labelling schedule or mandatory MEPS.

Project overview

Project objective

154. The pilot project aims to address market reluctance to alternative refrigerants by successfully installing and validating these systems at active commercial end-user sites, highlighting replicable installation, safety and operational opportunities, as well as to generate empirical performance data and learnings to support the replication of transcritical CO_2 and CO_2-NH_3 cascade technologies in other facilities in the country and potentially in other countries operating under similar climatic conditions.

155. The India Cooling Action Plan (ICAP) aims to achieve a 20–30 per cent reduction in refrigerant demand and a 25–40 per cent reduction in cooling energy requirements by 2039, requiring targeted measures to replace HFC-based equipment with non-HFC refrigerant systems. These pilot projects illustrate the ways in which advanced technologies can reduce consumption across high-volume and heavy industrial applications, as required in order to reach the ICAP mandate.

Project beneficiary

Commercial and industrial end-user facilities

156. End-user demonstration sites will be selected from the active commercial and industrial customer base of Voltas Limited (Voltas). Project 1 will prioritize quick-commerce dark stores, micro-fulfillment centres or retail food logistics, while Project 2 will prioritize pharmaceutical processing or deep-freeze food logistics. Additional engineering-specific criteria are as follows:

(a) *Thermal load profile:* The selected facility must have continuous, stable cooling and process load requirements to ensure uninterrupted data gathering across varying ambient temperatures;

(b) *Baseline and decommissioning readiness:* The site must currently operate an active R-407C or R-404A system to be retired. The end-user must agree to baseline energy and capacity monitoring on the systems to allow for accurate pre- and post-installation energy efficiency comparisons prior to their decommissioning; and

(c) *Space and safety compliance*: The facility's plant room must have adequate, well-ventilated space capable of accommodating extreme high-pressure CO_2 equipment or toxic or mildly flammable ammonia equipment, compliant with national [23] and international safety regulations.

Project description

157. The pilot project comprises two demonstrations to replace two active HFC-based refrigeration systems with energy-efficient non-HFC refrigerant alternatives at selected end-user clients of Voltas. Each demonstration will include the end-user selection and agreement process; procurement, installation, and commissioning of the new equipment, including high pressure and toxic safety components; decommissioning and refrigerant recovery of the replaced R-407C and R-404A systems, including the safe storage or destruction of the recovered refrigerants; evaluation and performance monitoring including installation of high-precision data loggers, power analyzers and thermal sensors on the new cooling systems; capacity-building for service technicians, plant engineers, and safety personnel; and awareness-raising workshops to promote alternative technologies by sharing the data with the BEE and industry stakeholders.

Project 1: Demonstration of transcritical CO_2 to replace R-407C modular condensing units

158. The demonstration involves replacing an R-407C-based 4.5 kW condensing unit currently in service at a selected end-user facility with a transcritical CO_2 (R-744) system. The baseline unit is operating at a coefficient of performance (COP) of 2.25 W/w, consuming 16,000 kWh annually at 8,000 operating hours. The replacement unit aims to operate at a COP of 2.25 kWh under identical field conditions. This target will reduce annual electricity consumption to 14,400 kWh and deliver a net energy saving of 1,600 kWh/year, or a 10 per cent saving.

159. The new unit will contain a high-efficiency reciprocating CO_2 compressor and a premium-efficiency motor; a transcritical gas cooler circuited to leverage the temperature glide of CO_2 for improved heat rejection in high ambient temperatures; and advanced electronic controls and a high-pressure electronic expansion valve (EEV) to adjust operating pressures to maintain the cycle and its peak efficiency point.

Project 2: Demonstration of CO_2-NH_3 cascade systems to replace R-404A-based systems

160. The demonstration involves replacing a single-stage R-404A industrial refrigeration system at a selected end-user facility with a CO_2-NH_3 cascade system. The baseline unit is operating at a high specific shaft power of 4.21 brake kilowatts (BkW) per ton of refrigeration (TR) and consuming 1,178,800 kWh annually. The replacement unit aims to operate at a specific shaft power of 3.50 BkW/TR, reducing annual energy consumption to 980,000 kWh and delivering operational savings of 198,800 kWh/year.

161. The new unit will bypass the baseline's limitations by splitting the thermal lift between two optimized loops: the low-stage CO_2 loop using R-744 for its high volumetric cooling capacity at ultra-low temperatures and the high-stage NH_3 loop using ammonia for its superior efficiency in rejecting heat to the ambient environment. Additionally, a high-efficiency heat exchanger between the two loops minimizes thermodynamic losses and integrated dual-stage programmable logic controller (PLC) controls synchronize both loops to maintain peak efficiency under varying loads.

[23] IS 16590

Technology provider: Voltas Limited

162. Voltas Limited is India's leading air-conditioning (AC) and refrigeration company, operating across unitary cooling products, commercial refrigeration, engineering projects, and mechanical, electrical and plumbing services. Due to the company's extensive experience with complex heating, ventilation, AC and refrigeration thermodynamic cycles, it is uniquely positioned to undertake this project. Their established network provides a reliable foundation to supply, install, commission, and service the proposed refrigerant systems at the end-user sites.

163. The conversion of commercial-scale manufacturing lines has not yet taken place due to limited market demand attributing to steep incremental capital costs and operational costs involved in specialized production tools and safety components, which would inflate the equipment purchase cost for industrial and commercial end users. The enterprise's 2023–2025 R-404A consumption in the manufacture of centralized, commercial and industrial systems ranges from 6.60 mt to 10.90 mt, and 2023–2025 R-407C consumption ranges from 1.50 mt to 1.80 mt.

Cost of the pilot project as submitted

164. The project costs were estimated at US $862,300 for the two demonstrations of energy-efficient, low-global-warming-potential (GWP) refrigeration systems at selected end-user clients of Voltas.

165. Out of a total cost of US $862,300, plus agency support costs, as initially submitted, 100 per cent has been requested from the Multilateral Fund. The project is expected to be completed within 24 months from approval, between January 2027 and December 2028. Table 14 presents the breakdown of the proposed activities and costs for the project.

Table 14. Activities and costs of the project, as submitted

Project no.	Project components and activities	Project cost (US $)
1	Cost difference between a standard R-407C condensing unit and the optimized CO_2 system (including high pressure compressors, gas coolers and EEVs)	130,000
2	Cost difference between a standard R-404A single-stage chiller and the cascade system (including dual compressors, cascade heat exchanger and PLC)	324,300
1, 2	End-user site safety integration including mandatory non-dispersive infrared sensor (NDIR) CO_2 and ammonia leak detectors, mechanical ventilation interlocks, and high-pressure relief piping at the sites	309,000
1, 2	Performance monitoring equipment including high-accuracy power meters, flow meters, and dataloggers required to verify the COP improvements over 12 months at the end-user sites	79,000
1, 2	Capacity-building and dissemination including specialized training for service technicians on high-pressure CO_2 and toxic ammonia safety, plus industry dissemination workshops	20,000
	Total	**862,300**

166. In addition, the proposal as submitted included co-financing of US $54,500 for Project 1, consisting of US $4,500 for equipment, US $10,000 for site preparation, including electrical and piping works by the beneficiary end user, as well as US $40,000 for research and development and engineering by the technology provider (Voltas). The proposal as submitted for Project 2 included co-financing of US $200,000, consisting of US $65,000 for equipment, US $25,000 for site preparation including electrical and piping works by the beneficiary end user, as well as US $110,000 for research and development and engineering by the technology provider (Voltas). Together with the co-financing, the overall cost of the project as submitted was US $1,116,800.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Project 1: Transcritical CO_2 condensing unit for modular cold rooms

167. The incremental cost of US $130,000 requested for a single 4.5 kW transcritical CO_2 condensing unit is approximately 30 times the cost of the conventional HFC unit that it would replace, while the expected energy savings of 1,600 kWh per year, worth some US $190 to US $220 at the prevailing commercial tariff, would not allow that cost to be recovered within the service life of the equipment. The Secretariat could not foresee how, at that cost differential, the solution would become attractive or replicable, at present, for the small and medium-sized businesses which commonly install equipment in this capacity range; noting that comparable units are available from international suppliers, at Free On Board (FOB) costs, seems to be substantially lower and that a move to transcritical systems would raise the level of service required and the operating costs borne by end users.

168. UNDP explained that the cost reflects the absence of economies of scale at small capacities and the need to import the compressor, gas cooler, high-pressure piping and controls, with the associated freight and duties; that the high upfront cost is itself the market barrier that decision 91/65 is intended to address; and that a domestic demonstration would build end-user confidence at high ambient temperatures and trigger the localization of components, reducing equipment costs by an estimated 40 to 60 per cent. A revised cost structure offered by UNDP, of US $155,000 [24] from the Multilateral Fund against co-financing of US $67,000, did not, in the Secretariat's view, alter the significant cost differential with the baseline technology or the potential substantial reduction in costs due to one successful demonstration, while noting the importance of the sector and the need for an elaborated action plan that could create economies of scale through an attractive economic solution.

169. In light of the above, UNDP and the Government of India agreed that the demonstration of the 4.5 kW transcritical CO_2 condensing unit would be removed from the current submission. The technical case for transcritical CO_2 in small-capacity commercial refrigeration, the cost structure of the application, and the measures required to bring that cost down will be discussed further and considered for inclusion as a long-term action plan for the commercial refrigeration sector within stage I of the KIP for India, which is currently under preparation.

Project 2: Demonstration of CO_2-NH_3 cascade systems to replace R-404A-based systems

Eligibility under decision 91/65

170. This proposal meets the eligibility criteria of decision 95/87(d), since it has been submitted prior to the 100th meeting of the Executive Committee, and the activities proposed are in line with the criteria of decision 91/65(b)(i)d., since they are part of a project in the servicing sector and were not previously funded. In line with decision 91/65(b)(iv), the Government of India has confirmed that if India were to mobilize funding from sources other than the Multilateral Fund for energy-efficiency components when phasing down HFCs, the project would not result in the duplication of activities among those funded by the Multilateral Fund and those funded from other sources; the information on project progress, results and key learning would be made available, as appropriate; the date of completion of the project would be set as no more than 36 months after the date of approval by the Executive Committee; and a detailed project report would be submitted to the Executive Committee within six months of the date of completion of the project.

[24] Including safety, performance monitoring, and capacity-building components.

Institutional, policy and regulatory framework

Minimum energy performance standards

171. Neither industrial process cooling systems nor cascade refrigeration systems are covered by the MEPS and labelling schemes of the BEE. As the BEE requires localized, independently validated data before developing standards for a new technology class, it was agreed that the project would formulate national technical and safety guidelines for the application; initiate the drafting of a voluntary standards and labelling scheme within 24 to 36 months of project completion; and establish a roadmap towards mandatory MEPS. The results would also inform the update of the national safety code IS 16678.

Coordination with the Kigali HFC implementation plan

172. Preparation funding for an investment project at Voltas under the Kigali HFC implementation plan (KIP) investment project was approved at the 92nd meeting, and project preparation funding for stage I of the KIP was approved at the 98th meeting; the plan is currently under preparation. UNDP explained that the pilot project would generate performance and safety data on subcritical CO_2-NH_3 cascade systems under high-ambient conditions to inform the prioritization of sectors under the plan, which remains subject to national consultations, and that the recovery of the HFC charge and the training of technicians would be coordinated with the ongoing HCFC phase-out management plan and future KIP. The Secretariat notes that the results of the demonstration, including the safety blueprint and the costs established, would inform the treatment of low-temperature industrial refrigeration in stage I of the KIP.

Selection of the technology provider

173. The Secretariat sought clarification as to why the project proposal is anchored around a technology provider and whether this would entail technical assistance to the local manufacturing enterprise. UNDP clarified that the Government of India had advanced the selection of the technology provider ahead of the final selection of the beneficiaries in order to expedite implementation once the project is approved, the provider having already completed the engineering design and pre-sourced the critical imported components so that the equipment could be supplied without delay. The project is designed and budgeted exclusively at the end-user level: no funding is allocated to manufacturing lines or factory facilities, and any assistance for the conversion of manufacturing operations from HFCs to low-GWP alternative technologies would be considered during the preparation of stage I of the KIP.

174. Noting that a pilot project under decision 91/65 to demonstrate energy-efficient equipment at end-users should not be specific to a particular manufacturer, the Secretariat requested the basis on which Voltas had been identified as the technology provider. UNDP explained that the enterprise had been selected through an openly advertised national expression of interest (EoI) process, evaluated by the Technical Advisory Committee comprised of Government, academic and sector experts, as the only domestic enterprise ready to supply field-ready systems for both technologies and to commit co-financing. Additionally, UNDP confirmed that no regulatory framework in India limits the participation of international suppliers, and that the enterprise's CO_2 designs exist as tested in-house prototypes offered to clients with specific requirements, no manufacturing line having been converted for series production.

175. The final selection of the beneficiaries, from candidate sites pre-screened during project preparation, lies with the project's independent Technical Advisory Committee and will take place only after approval, to avoid creating expectations in the market.

176. The Secretariat noted with appreciation the proactive step taken by the Government to select a technology provider, which would help ensure the timely implementation of the project and contribute to its long-term sustainability and replicability within India. The Secretariat's assessment of costs might differ

from those submitted by a technology provider and would be based on information available from a range of technology providers.

Technical and cost-related issues

Technology selection

177. The baseline single-stage R-404A system operates at an evaporating temperature of approximately −30°C, beyond the refrigerant's efficient range, with a specific shaft power of 4.21 BkW/TR. The cascade system splits the thermal lift between a low-stage CO_2 circuit and a high-stage ammonia circuit, linked by a cascade heat exchanger and synchronized by a dual-loop controller.

178. When asked why this component had not been submitted with the other energy-efficiency proposal for the country addressing industrial applications, UNDP explained that the two reflect distinct specializations as identified through the EoI process (small and mid-scale cascade systems, as opposed to large-scale industrial heat pumps).

Beneficiary and equipment profile

179. The demonstration site will be an industrial food processing facility in the western or southern industrial belt region of India with a continuous low-temperature duty, such as blast freezing, individual quick freezing or biologics storage at −30°C to −35°C, to be served by a dual-fluid subcritical CO_2/ammonia (R-744/R-717) cascade system with a dedicated cascade heat exchanger and dual-loop control. The final site will be contracted following approval.

180. In response to the Secretariat's request for baseline data from a potential candidate site, UNDP provided indicative parameters for a representative facility: a 35 TR (123 kW) single-stage R-404A industrial chiller/rack system, with a refrigerant of GWP of 3,922 and a charge of 150 to 200 kg, operating 20 to 22 hours a day on a multi-shift basis for some 7,000 hours a year, with annual leakage of 15 to 20 per cent and energy consumption of approximately 1,176,000 kWh. These will be confirmed through a baseline energy audit once the site is selected. The equipment to be replaced will have been in service for 12 to 15 years and be at the end of its useful life.

181. Selection by the Technical Advisory Committee will be based on mandatory criteria, including a binding commitment to decommission the existing R-404A system and plant-room infrastructure able to accommodate the ammonia safety architecture, and will be formalized through a tri-party Memorandum of Agreement between the technology provider, the Ozone Cell and the end user, to be executed prior to any disbursement.

Calculation of costs

182. The Secretariat discussed the cost of the different elements of the project with UNDP on the basis of the best available information, noting the limited number of similar funded projects and the nature of the technology and the application, which are custom-made to the needs of each particular client. The following paragraphs highlight the main issues discussed and the final agreed costing.

183. The incremental cost of the cascade system over the R-404A baseline was estimated at US $324,300 as submitted. The baseline cost was established from quotations for a standard 35 TR single-stage R-404A system; the incremental cost is driven by the two imported industrial compressors (CO_2 and ammonia), the stainless-steel cascade heat exchanger and the dual-stage controller. Following the review of the individual cost elements against the best available market information, including from Asia, the incremental cost of the system was established at US $389,300, of which US $300,000 would be met by the Fund and US $89,300 co-financed by the beneficiary and the technology provider.

184. The Secretariat compared the cost of the site safety integration, estimated at US $292,500 as submitted, with international references including from Asia, and proposed an adjustment. UNDP explained that the measures, namely a dedicated, physically isolated ATEX-rated (explosion-proof) ammonia machinery room, spark-proof extraction ventilation providing at least 15 air changes an hour, multi-layered electrochemical ammonia and NDIR CO_2 detection, automated emergency shutdown isolation valves with water-scrubber dilution and relief headers discharging four metres above roof level, are statutory prerequisites under IS 16678 and ISO 5149, and that transferring a large share of these costs to the end user could jeopardize the demonstration. Upon discussion of the safety requirements, it was agreed that the site safety integration cost covered by the Fund would be US $125,000, the remaining US $167,000 being co-financed by the beneficiary and the technology provider, as set out in table 15 below, and that the safety architecture would be documented as a pre-engineered blueprint for future end users.

185. The Secretariat also reviewed the cost of the performance monitoring and verification equipment, estimated at US $44,000 for this component as submitted. The funding covers calibrated instrumentation, namely power analyzers, mass and ultrasonic flow meters, temperature and pressure sensors, and data acquisition with telemetry, calibrated by an agency accredited to ISO/IEC 17025, the data being reported to the technical committees of the BEE and the Bureau of Indian Standards. The component was retained in full and will be met by the Fund.

186. Regarding other costs, as the decommissioning of the existing system and the recovery of its R-404A charge would be required under any replacement, UNDP agreed that the related costs would be treated as beneficiary co-financing, with Multilateral Fund support confined to the incremental cost of a certified zero-venting recovery protocol. The recovered refrigerant will be reclaimed to the AHRI-700 standard at a government-authorized facility and reused rather than destroyed. The local civil, mechanical, piping and electrical works at the facility, of US $25,000, are met by the beneficiary; and the capacity-building and dissemination component, of US $12,000, was retained in full. It was also agreed to remove the cost of upstream prototype engineering by the technology provider of US $110,000, which had been included in the original submission as co-financing contribution and is therefore not counted in the total cost.

Monitoring

187. As energy-efficiency gains must be demonstrated against the incumbent system, UNDP proposed four months of baseline monitoring during the peak summer season, combined with historical plant logs, followed by 12 months of monitoring of the replacement system. The Secretariat considers a longer baseline period preferable in order to capture more than one season, and the project duration has accordingly been set at 36 months.

Cost of the pilot project as agreed

188. The amount requested from the Multilateral Fund for this component, as submitted, was US $672,800, against co-financing of US $90,000 once the research and development element had been excluded. Following the review of the individual cost elements against the best available market information from several international sources, including in Asia, the agreed cost of the pilot project to demonstrate the use of a subcritical CO_2-NH_3 cascade cooling system in industrial refrigeration applications in India amounts to US $762,300, including a Multilateral Fund grant of US $481,000 and co-financing by the beneficiary and the technology provider of US $281,300, as shown in table 15.

Table 15. Project activities, total budget and cost breakdown by source, as agreed

Item	Project cost (US $)		
	Total	MLF grant	Co-financing
Incremental cost of the 35 TR subcritical CO_2-NH_3 cascade cooling system over the R-404A baseline system	389,300	300,000	89,300

Item	Project cost (US $)		
	Total	MLF grant	Co-financing
Site safety integration (ammonia machinery room, gas detection, emergency shutdown and pressure-relief systems)	292,000	125,000	167,000
Performance monitoring and verification	44,000	44,000	0
Capacity-building and dissemination	12,000	12,000	0
Site preparation (civil, mechanical, piping and electrical works)	25,000	0	25,000
Total	**762,300**	**481,000**	**281,300**

189. The co-financing comprises the full commercial cost of the conventional R-404A system that the end user would otherwise have purchased, together with the share of the incremental equipment cost shown in table 15 above; the local civil, mechanical, piping and electrical works required at the facility; the operational cost of decommissioning and removing the existing system and the associated write-down of that asset; and a share of the site safety integration and of the performance monitoring. The Secretariat notes that the co-financing represents some 37 per cent of the total cost of the project, which is consistent with previous approvals for similar type and size of applications, that the measures concerned are installed at and retained by the beneficiary's facility, and that the Memorandum of Agreement is to be executed before any disbursement, which provides assurance of the beneficiary's commitment before the project is committed to a site.

Energy-efficiency enhancements and estimated savings

190. The replacement system is designed to operate at a specific shaft power of 3.50 BkW/TR against the baseline of 4.21 BkW/TR, reducing annual energy consumption at the demonstration site from approximately 1,176,000 kWh to 977,200 kWh and delivering savings of 198,800 kWh per year, equivalent to an improvement of 16.9 per cent. At an industrial tariff of US $0.12 per kWh, that saving is worth some US $23,900 per year to the beneficiary, against which the contribution made by the beneficiary over and above the cost of a conventional replacement, would be recovered in some 12 years, within at least 15-year service life of the system while noting that cost recovery period would be less once the uptake of the technology is advanced and relevant supply chain strengthened.

191. UNDP estimates that the project will avoid direct emissions of approximately 1,170 CO_2-eq tonnes, through the elimination of the R-404A charge and its annual leakage of 15 to 20 per cent, and approximately 2,400 CO_2-eq tonnes of indirect emissions through reduced electricity consumption, over that period. The Secretariat notes that these figures are based on the indicative parameters of a representative facility and will be confirmed against the baseline energy audit of the selected site.

Sustainability, replicability and assessment of risks

192. UNDP estimates that there are between 2,000 and 3,000 comparable mid- to large-scale low-temperature installations in the food processing and pharmaceutical sectors in the country to which the technology could be applied directly, and that the growth of the deep-frozen segment below -20°C is expected to add further capacity.

193. The principal output supporting replication is the validated engineering and safety blueprint for the application: the performance data, the safety architecture and the operating protocols will be shared with the BEE and the Bureau of Indian Standards and disseminated to industry through technical workshops and publications, and the safety design will be made publicly available so that subsequent adopters may replicate it at a standardized and lower cost rather than each designing and certifying a system individually. UNDP explained that with the project being confined to the end-user level, the confidential design of the equipment

and its components would not be disclosed, while the operational parameters and interface specifications required in order for others to supply and install comparable systems would be published.

194. On the risks to implementation, the specialized components of the system, including the high-pressure CO_2 compressor, the cascade heat exchanger and the ammonia-rated safety components, are not manufactured in the country and are subject to long lead times; UNDP explained that the technology provider has pre-sourced the suppliers and will pre-order the long-lead items against its co-financing commitment upon endorsement of the project. The statutory clearances required in order to operate ammonia and high-pressure CO_2 in a commercial facility, which involve municipal, building and fire-safety authorities, will be sought on the basis of pre-engineered code-compliant safety packages, with the Ozone Cell coordinating with the national safety bodies and the local authorities concerned.

195. The risk that the beneficiary delays the plant shutdown or the site preparation works is addressed through the Memorandum of Agreement, which commits the end user to a pre-agreed timeline and to the completion of the site works on schedule. The risk of unsafe handling during commissioning and subsequent maintenance is addressed through the capacity-building component, under which hands-on safety training for servicing technicians and for the facility's own engineers is to be delivered before the equipment is delivered to the site.

196. The measures described above are expected to contribute to the strengthening of the country's energy-efficiency framework for this category of equipment, through the national technical and safety guidelines, the voluntary standards and labelling scheme and the roadmap towards mandatory MEPS referred to above, and through the updating of the national safety code to accommodate low-GWP refrigerants in industrial applications.

RECOMMENDATION

197. The Executive Committee may wish to consider:

(a) Approving the pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (non-investment activities): demonstration of the use of a super-efficient subcritical CO_2-NH_3 cascade cooling system in industrial refrigeration applications in India, in the amount of US $481,000, plus agency support costs of US $33,670 for UNDP;

(b) Noting:

(i) That the Government of India has committed to the conditions referred to in decision 91/65(b)(iv)b. to (b)(iv)d.;

(ii) That the project will formulate national technical and safety guideline documents and initiate the drafting of a voluntary standards and labelling scheme, and will also establish an official roadmap for transitioning the voluntary standards into mandatory minimum energy performance standards in the future; and

(iii) That the project will be operationally completed no later than 31 December 2029 and a detailed project report will be submitted to the Executive Committee within six months of the date of completion of the project, including a detailed description of the activities undertaken to disseminate the results of the technology demonstration and to promote the adoption of the selected energy-efficient alternative technology.

Annex I

TEXT TO BE INCLUDED IN THE UPDATED AGREEMENT BETWEEN THE GOVERNMENT OF INDIA AND THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE REDUCTION IN CONSUMPTION OF HYDROCHLOROFLUOROCARBONS IN ACCORDANCE WITH STAGE III OF THE HCFC PHASE-OUT MANAGEMENT PLAN

(Relevant changes are in bold font for ease of reference)

17. This updated Agreement supersedes the Agreement reached between the Government of India and the Executive Committee at the 91st meeting of the Executive Committee.

APPENDIX 2-A: THE TARGETS, AND FUNDING

Row	Particulars	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
1.1	Montreal Protocol reduction schedule of Annex C, Group I substances (ODP tonnes)	1,045.33	1,045.33	1,045.33	522.67	522.67	522.67	522.67	522.67	0.00	n/a
1.2	Maximum allowable total consumption of Annex C, Group I substances (ODP tonnes)	698.82	643.28	643.28	75.85	75.85	75.85	75.85	75.85	0.00	n/a
2.1	Lead IA (UNDP) agreed funding (US $)	6,166,500	0	5,495,933	0	**5,060,182**	0	0	509,332	0	**17,231,947**
2.2	Support costs for Lead IA (US $)	431,655	0	384,715	0	**354,213**	0	0	35,653	0	**1,206,236**
2.3	Cooperating IA (UNEP) agreed funding (US $)	668,215	0	1,011,000	0	1,168,825	0	0	521,960	0	3,370,000
2.4	Support costs for Cooperating IA (US $)	75,486	0	114,210	0	132,039	0	0	58,965	0	380,700
2.5	Cooperating IA (Germany) agreed funding (US $)	1,700,643	0	2,140,772	0	**0**	0	0	714,270	0	**4,555,685**
2.6	Support costs for Cooperating IA (US $)	189,517	0	238,564	0	**0**	0	0	**83,044**	0	**511,125**
3.1	Total agreed funding (US $)	8,535,358	0	8,647,705	0	6,229,007	0	0	1,745,562	0	25,157,632
3.2	Total support costs (US $)	696,658	0	737,489	0	**486,252**	0	0	**177,662**	0	**2,098,062**
3.3	Total agreed costs (US $)	9,232,016	0	9,385,194	0	**6,715,259**	0	0	**1,923,224**	0	**27,255,694**
4.1.1	Total phase-out of HCFC-123 agreed to be achieved under this Agreement (ODP tonnes)										3.50
4.1.2	Phase-out of HCFC-123 to be achieved in previously approved projects (ODP tonnes)										0.00
4.1.3	Remaining eligible consumption for HCFC-123 (ODP tonnes)										0.00
4.2.1	Total phase-out of HCFC-124 agreed to be achieved under this Agreement (ODP tonnes)										13.50
4.2.2	Phase-out of HCFC-124 to be achieved in previously approved projects (ODP tonnes)										0.00
4.2.3	Remaining eligible consumption for HCFC-124 (ODP tonnes)										0.00
4.3.1	Total phase-out of HCFC-141b agreed to be achieved under this Agreement (ODP tonnes)										0.00
4.3.2	Phase-out of HCFC-141b to be achieved in previously approved projects (ODP tonnes)										865.50
4.3.3	Remaining eligible consumption for HCFC-141b (ODP tonnes)										0.00
4.4.1	Total phase-out of HCFC-142b agreed to be achieved under this Agreement (ODP tonnes)										123.70
4.4.2	Phase-out of HCFC-142b to be achieved in previously approved projects (ODP tonnes)										0.00

Row	Particulars	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
4.4.3	Remaining eligible consumption for HCFC-142b (ODP tonnes)										0.00
4.5.1	Total phase-out of HCFC-22 agreed to be achieved under this Agreement (ODP tonnes)										439.29
4.5.2	Phase-out of HCFC-22 to be achieved in previously approved projects (ODP tonnes)										162.71
4.5.3	Remaining eligible consumption for HCFC-22 (ODP tonnes)										0.00
4.6.1	Total phase-out of HCFC-141b contained in imported pre-blended polyols agreed to be achieved under this Agreement (ODP tonnes)										0.00
4.6.2	Phase-out of HCFC-141b contained in imported pre-blended polyols to be achieved in previously approved projects (ODP tonnes)										83.05
4.6.3	Remaining eligible consumption for HCFC-141b contained in imported pre-blended polyols (ODP tonnes)										0.00

* Date of completion of stage II as per stage II Agreement: 31 December 2024.