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IMPLEMENTATION OF THE MONTREAL PROTOCOL
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Item 12 of the provisional agenda[1]

INFORMATION ON REFRIGERATION AND AIR-CONDITIONING MANUFACTURING LINES THAT HAD COMPLETED CONVERSION UNDER HCFC PHASE-OUT OR HFC PHASE-DOWN PROJECTS APPROVED UNDER THE MULTILATERAL FUND IN THE CONTEXT OF FUNDING ELIGIBILITY RELATING TO ENERGY-EFFICIENCY PROJECTS UNDER DECISION 94/60 (DECISION 98/23)

1. At the 98th meeting, the Executive Committee requested the Secretariat to prepare a brief document for the 99th meeting providing information on refrigeration and air-conditioning (AC) manufacturing lines that had completed conversion under HCFC phase-out or HFC phase-down projects approved under the Multilateral Fund (decision 98/23).

2. The Secretariat reviewed information on refrigeration and AC manufacturing conversion projects approved up to the 98th meeting in the context of HCFC phase-out management plans (HPMPs) and Kigali HFC implementation plans (KIPs). The findings are presented below.

Conversion projects approved under HCFC phase-out management plans

3. Tables 1 to 5 summarize the manufacturing conversion projects in the refrigeration and AC sectors approved under stages I, II and III of HPMPs, as recorded in the enterprise databases of UNDP, UNIDO and the World Bank. For each country and application, the tables indicate the number of enterprises, the HCFC used, and the alternatives adopted. The last column shows the project completion year or, where enterprises within a project were converted in different years, the range of enterprise completion years. Projects with a completion year later than June 2026 are indicated as ongoing.

4. No refrigerant conversion projects in the manufacture of domestic refrigerators are recorded under HPMPs in the three agencies' databases; the domestic refrigeration entries relate to foam (HCFC-141b) conversions or to HFC-based projects.

5. The tables provide information on the enterprises that were funded by the Multilateral Fund for conversion under HPMPs from HCFCs to alternatives, including HFCs and other

[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.

low-global-warming-potential (GWP) refrigerants. The applications listed include commercial refrigeration, industrial and commercial refrigeration (ICR) (China only), residential AC, commercial AC, and demonstration projects that were approved under HPMPs.

Table 1. HPMP manufacturing conversion projects: commercial refrigeration

Country/Agency	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
HPMP stage I				
Armenia (UNDP)	1	HCFC-22	R-290	2013
Bosnia and Herzegovina (UNIDO)	6	HCFC-22, HCFC-141b	R-404A, methyl formate	2015
Indonesia (UNDP)	4	HCFC-22, HCFC-141b	HFC-32, R-290, cyclopentane	2015–2016
Serbia (UNIDO)	4	HCFC-22	R-410A, ammonia (R-717)	2018
Sub-total – HPMP stage I	**15**			**2013–2018**
HPMP stage II				
Brazil (UNIDO)	38	HCFC-22	R-290, HFOs, other refrigerants	2019–2020
Viet Nam (World Bank)	3	HCFC-22	Ammonia (R-717)	2023
Sub-total – HPMP stage II	**41**			**2019–2023**
HPMP stage III				
India (UNDP)	22	HCFC-22	R-290	Ongoing
Nigeria (UNIDO)	182	HCFC-22	R-290, HFC-32	Ongoing
Sub-total – HPMP stage III	**204**			**Ongoing**

Table 2. HPMP manufacturing conversion projects in China (UNDP): industrial and commercial refrigeration

Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
HPMP stage I				
Compressors	4	HCFC-22	HFC-32, HFO/HFC-134a, CO_2	2016–2019
Freezers, refrigeration and condensing units	4	HCFC-22	NH_3/CO_2, CO_2/HFC-134a, HFC-134a	2016–2019
Multi-connected air-conditioning/Water chillers (heat pump)	8	HCFC-22	R-410A, HFC-32, HFC-134a, NH_3	2016–2019
Unitary air-conditioning	6	HCFC-22	HFC-32, R-410A	2016–2019
Sub-total – HPMP stage I	**22**			**2016–2019**
HPMP stage II				
Heat pump water heaters	4	HCFC-22	HFC-32, CO_2	2022–ongoing
Unitary air-conditioning	6	HCFC-22	HFC-32	2022–ongoing
Water chillers (heat pump)	10	HCFC-22	R-290, R-513A	2022–ongoing

Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
Freezers, refrigeration and condensing units	11	HCFC-22	HFC-134a/NH3/CO_2, HFC-32/ CO_2	2022–ongoing
Compressors	2	HCFC-22	R-513A	ongoing
Sub-total – HPMP stage II	**33**			**2022–ongoing**

Note: These include unitary and multi-connected AC, heat-pump water heaters and compressors, as classified in the sector plan.

Table 3. HPMP manufacturing conversion projects: residential air-conditioning

Country/Agency	Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
HPMP stage I					
Algeria (UNIDO)	Residential and commercial AC	1	HCFC-22	R-32	2023
Argentina (UNIDO)	Residential and commercial AC	9	HCFC-22	R-410A	2017
China (UNIDO)	Residential AC	20	HCFC-22	R-290, R-410A	2016–2019
China (UNIDO)	Compressors	3	HCFC-22	R-290	2016
Indonesia (UNDP)	Residential AC	1	HCFC-22	HFC-32	2014
Iran (Islamic Republic of) (UNDP)	Residential AC	1	HCFC-22	R-410A	2015
Jordan (World Bank)	Residential AC	2	HCFC-22	R-410A	2016
Lebanon (UNDP)	Residential AC	1	HCFC-22	R-410A	2014
Syrian Arab Republic (the) (UNIDO)	Residential AC	1	HCFC-22	R-290, HFC-32	2025
Thailand (World Bank)	Residential and commercial AC	11	HCFC-22	HFC-32	2016–2017
Sub-total – HPMP stage I		**47**			**2014–2025**
HPMP stage II					
Bangladesh (UNDP)	Residential AC	5	HCFC-22	R-290, HFC-32	2020
China (UNIDO)	Residential AC	11	HCFC-22	R-290	2020–ongoing
China (UNIDO)	Compressors	4	HCFC-22	R-290	Ongoing
Egypt (UNIDO)	Residential AC	5	HCFC-22	HFC-32	2022
India (UNDP)	Residential AC	6	HCFC-22	HFC-32	2020–2024
Lebanon (UNDP)	Residential and industrial AC	1	HCFC-22	HFC-32	2020

Country/Agency	Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
Pakistan (UNIDO)	Residential AC	1	HCFC-22	HFC-32	2021
Philippines (the) (UNIDO)	Residential and commercial AC	4	HCFC-22	HFC-32	2022
Viet Nam (World Bank)	Residential and commercial AC	2	HCFC-22	HFC-32	2023
Sub-total – HPMP stage II		**35**			**2020–ongoing**
HPMP stage III					
Nigeria (UNIDO)	Residential AC	2	HCFC-22	R-290, HFC-32	2025
Sub-total – HPMP stage III		**2**			**2025**

Table 4. HPMP manufacturing conversion projects: commercial air-conditioning

Country/ Agency	Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
HPMP stage I					
Indonesia (UNDP)	Commercial AC	4	HCFC-22	HFC-32	2014–2015
Jordan (UNIDO)	Commercial AC (including foam)	1	HCFC-141b, HCFC-22	Cyclopentane, R-410A	2015
Sub-total – HPMP stage I		**5**			**2014–2015**
HPMP stage II					
Bangladesh (UNDP)	Chillers	1	HCFC-22	R-290, HFC-32	2020
Egypt (UNIDO)	Commercial AC	2	HCFC-22	HFC-32/hybrid systems	2020
Lebanon (UNDP)	Air-conditioners and cold rooms	1	HCFC-22	HFC-32	2022
Lebanon (UNDP)	Commercial AC	1	HCFC-22	HFC-32	2022
Sub-total – HPMP stage II		**5**			**2020–2022**
HPMP stage III					
India (UNDP)	AC (type not specified)	4	HCFC-22	HFC-32	Ongoing
India (UNDP)	Chillers	1	HCFC-22	HFC-32, R-290	Ongoing
Sub-total – HPMP stage III		**5**			**Ongoing**

Table 5. Manufacturing conversion projects as stand-alone demonstration projects

Country/ Agency	Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
China (UNDP)	Residential AC	1 (Midea)	HCFC-22	R-290	2013
China (UNDP)	ICR	1 (Yantai Moon)	HCFC-22	NH_3, CO_2	2014
China (UNDP)	Commercial AC	1 (Tsinghua)	HCFC-22	HFC-32	2014

Country/ Agency	Application	No. of enterprises	HCFCs used	Alternatives adopted	Year of completion
Colombia (UNDP)	Commercial AC	1 (Thermostar)	HCFC-22	R-290	2018
Saudi Arabia (World Bank)	Commercial AC	1 (Petra KSA)	HCFC-22	R-290 and HFC-32	2018
Saudi Arabia (UNDP)	Residential AC	1 (Alessa)	HCFC-22	Low-GWP	2023

Conversion projects approved under Kigali HFC implementation plans

6. Tables 6 to 8 summarize the manufacturing conversion projects in the refrigeration and AC sectors approved under stage I of KIPs, as recorded in the enterprise databases of UNDP, UNIDO, the World Bank, and bilateral agencies. For each country and application, the tables indicate the number of enterprises, the HFCs used, the alternatives adopted, and, where applicable, the year of completion.

Projects approved under decision 78/3(g) for conversion to alternatives in refrigeration and air-conditioning applications

7. Table 6 provides a summary of the nine refrigerant conversion projects approved under decision 78/3(g). All projects have been completed, and alternatives have been adopted.

Table 6. HFC-related investment projects approved under decision 78/3(g)

Country/Agency	Application	No. of enterprises	HFCs used	Alternatives used	Year of completion
Argentina (UNIDO)	Domestic and commercial refrigerators	3	HFC-134a	R-600a/R-290	2022
Bangladesh (UNDP)	Domestic refrigerators and compressors	1	HFC-134a	R-600a	2019
Dominican Republic (the) (UNDP/Canada)	Commercial refrigeration	1	HFC-134a/R-404A	R-600a/R-290	2020
Jordan (UNIDO)	Commercial AC	1	HFC-134a/ R-407C/R-410A	R-290	2020
Lebanon (UNIDO)	Domestic and commercial refrigerators	1	HFC-134a/R-404A	R-600a/R-290	2020
Mexico (UNIDO)	Commercial refrigerators	1	HFC-134a/ R-404A	R-600a/R-290	2021
Mexico (UNDP/Canada)	Domestic refrigerators	1	HFC-134a	R-600a	2020
Thailand (World Bank)	Commercial refrigerators	1	HFC-134a	R-600a	2021
Zimbabwe (France)	Domestic refrigerators	1	HFC-134a	R-600a	2022

8. Table 7 summarizes the manufacturing conversion projects approved under KIPs, by country and application, indicating the number of enterprises, the HFCs used, and the alternatives adopted. All projects are ongoing and have a completion year later than June 2026.

Table 7. Manufacturing conversion projects approved under stage I of Kigali HFC implementation plans (currently under implementation)

Country/Agency	Application	No. of enterprises	HFCs used	Alternatives adopted
Brazil (UNDP)	Commercial refrigeration	115[2]	HFC-134a, R-404A	R-290
Colombia (UNDP)	Commercial refrigeration	27[3]	HFC-134a, R-404A, R-507A	R-290, CO_2
Costa Rica (UNDP)	Commercial refrigeration	1	HFC-134a	R-290
Egypt (UNIDO)	Domestic refrigeration	15	HFC-134a	R-600a
	Commercial refrigeration	10	HFC-134a, R-404A R-407C	HFC-32
	Residential AC	6	R-410A	HFC-32
Indonesia (World Bank)	Domestic refrigeration	6	HFC-134a	R-600a
Jordan (UNIDO)	Commercial refrigeration	2	HFC-134a, R-404A	R-290
	Residential AC	4	R-410A	HFC-32
Lebanon (UNDP)	Commercial refrigeration	22 SMEs and 25 micro-SMEs	HFC-134a, R-404A, R-408A	R-290
	Residential AC	1	R-410A	HFC-32
Malaysia (World Bank)	Commercial refrigeration	2	HFC-134a, R-404A	R-290, R-600a
	Mobile air-conditioning	1	HFC-134a	HFO-1234yf
Nigeria (UNIDO)	Domestic refrigeration	3	HFC-134a	R-600a
	Residential AC	3	R-410A	HFC-32, R-290
South Africa (UNIDO)	Commercial refrigeration	3	HFC-134a, R-404A	R-600a, R-290
Sri Lanka (UNDP)	Commercial refrigeration	6	HFC-134a, R-404A and R-507A	R-290
	Residential AC	1	R-410A	HFC-32
Thailand (World Bank)	Commercial AC	6	R-410A	HFC-32
Tunisia (UNIDO)	Residential AC[4]	7	HFC-134a, R-410A	HFC-32, R-600a
Viet Nam (World Bank)	Industrial refrigeration[5]	1	R-404A, R-507A	Ammonia (R-717)
	Mobile air-conditioning (train AC systems)	1	R-407C	R-454C

Note: SMEs = small- and medium-sized enterprises

[2] Small 72, medium 36, large 7

[3] Includes three already converted to R-290 and 20 micro enterprises

[4] One enterprise also manufactures cold water dispensers

[5] Through support to one component manufacturer and 11 contractors assembling components

Conversion projects approved under decision 87/50(e) in the context of HFC phase-down

9. The following stand-alone HFC conversion projects, approved under decision 87/50(e), are presented separately as they are not part of a KIP stage. All projects are currently under implementation.

Table 8. Stand-alone HFC conversion projects (decisions 87/50(e)) (currently under implementation)

Country/ Agency	Application	No. of enterprises	HFCs used	Alternatives adopted
Argentina (UNIDO)	Residential AC	6	R-410A	HFC-32
Ecuador (UNIDO)	Domestic/Commercial refrigeration	1	HFC-134a	R-600a / R-290
India (UNDP)	Commercial refrigeration	1 (Rockwell)	HFC-134a	R-290
	Commercial AC	1 (Voltas)	R-407C and R-410A	HFC-32
Mexico (UNDP)	Commercial refrigeration	1 (Friocima)	HFC-134a	R-290
Morocco (UNIDO)	Domestic refrigeration	1 (Manar)	HFC-134a	R-600a

Distribution of completed and ongoing projects by sector and by project cluster

10. Tables 9 and 10 present the distribution of completed and ongoing projects by year, disaggregated by sector and project cluster, respectively.

Table 9. Distribution of project completed and ongoing by year and by sector

Sector	Completed by 2016		Completed between 2017–2022		Completed 2023 onwards / ongoing		Total	
	Projects	Enter-prises	Projects	Enter-prises	Projects	Enter-prises	Projects	Enter-prises
Domestic refrigeration	–	–	5	7	5	26	**10**	**33**
Commercial refrigeration	3	11	5	45	14	422	**22**	**478**
ICR	1	1	4	22	6	34	**11**	**57**
Residential AC	6	9	8	56	15	56	**29**	**121**
Commercial AC	3	6	7	8	4	12	**14**	**26**
Mobile AC	–	–	–	–	2	2	**2**	**2**
Total	**13**	**27**	**29**	**138**	**46**	**552**	**88**	**717**

Table 10. Distribution of project completed and ongoing by year and by project cluster

Category of projects	Completed by 2016		Completed between 2017–2022		Completed 2023 onwards / ongoing		Total	
	Projects	Enter-prises	Projects	Enter-prises	Projects	Enter-prises	Projects	Enter-prises
HPMP stage I	10	24	8	66	2	2	**20**	**92**
HPMP stage II	–	–	10	59	10	59	**20**	**118**
HPMP stage III	–	–	–	–	5	211	**5**	**211**

Category of projects	Completed by 2016		Completed between 2017–2022		Completed 2023 onwards / ongoing		Total	
	Projects	Enter-prises	Projects	Enter-prises	Projects	Enter-prises	Projects	Enter-prises
Stand-alone HCFC demonstration	3	3	2	2	1	1	**6**	**6**
HFC projects – decision 78/3(g) (table 6)	–	–	9	11	–	–	**9**	**11**
KIP stage I	–	–	–	–	22	268	**22**	**268**
Stand-alone HFC projects – decision 87/50(e)	–	–	–	–	6	11	**6**	**11**
Total	**13**	**27**	**29**	**138**	**46**	**552**	**88**	**717**

Note (1): Projects with a range of enterprise completion years are classified according to the final year of enterprise conversion. The three period columns are mutually exclusive and sum to the respective total.
Note (2): Additional enterprises in refrigeration and AC applications may have achieved conversion to low-/lower-GWP alternatives but are not included in the analysis above, as detailed information on those enterprises is not available.

Secretariat's observations

11. Tables 9 and 10 cover 717 enterprises that have converted, or are converting, mainly to low-/lower-GWP technologies. By period of completion, 27 enterprises have converted by 2016, 138 enterprises were converted between 2017 and 2022, and 552 enterprises were converted from 2023 onwards or are ongoing. The last group represents 77 per cent of all enterprises in the tables. By sector, commercial refrigeration has the largest number of enterprises (478, or 67 per cent of the total), of which 422 were completed from 2023 onwards or are ongoing. The other sectors are residential AC (121 enterprises), ICR (57 enterprises), domestic refrigeration (33 enterprises), commercial AC (26 enterprises) and mobile air-conditioning (two enterprises, both ongoing). Additional projects in refrigeration and AC applications may have achieved conversion to low-/lower-GWP alternatives, but they are not included because detailed information on them is not available.

12. By project cluster, HCFC phase-out projects account for 427 enterprises: HPMP stage I (92 enterprises), HPMP stage II (118 enterprises), HPMP stage III (211 enterprises) and stand-alone HCFC demonstration projects (6 enterprises). HFC-related projects account for 290 enterprises: projects under decision 78/3(g) (nine projects, 11 enterprises, completed between 2017 and 2022), KIP stage I (22 projects, 268 enterprises) and stand-alone HFC projects under decision 87/50(e) (six projects, 11 enterprises). Of the 552 enterprises in projects completed from 2023 onwards or ongoing, 272 are under HPMP stages I to III (including all 211 under stage III), one is under a stand-alone HCFC demonstration project and 279 are under KIP stage I and stand-alone HFC projects under decision 87/50(e).

13. The Secretariat notes that information on manufacturing lines that have converted without support from the Multilateral Fund, including ineligible and newly established manufacturing lines, is not available for the applications covered under document UNEP/OzL.Pro/ExCom/94/61.[6] Such conversions may include the adoption of both low- or lower-GWP alternatives and high-GWP alternatives to HCFCs and HFCs across the relevant refrigeration and AC subsectors.

14. The Secretariat consulted the relevant implementing agencies regarding the availability of information on enterprises that had converted to HFC-free alternatives or lower-GWP HFCs, without

[6] Further elaboration on the operational framework to support maintaining and/or enhancing energy efficiency described in document UNEP/OzL.Pro/ExCom/93/98 (decision 93/93(d))

financial assistance from the Multilateral Fund. However, detailed information on the number of enterprises involved, the alternatives adopted, and the timing of such conversions was not available.

15. Notwithstanding the absence of comprehensive data, it is recognized that, since 2010, a number of enterprises have transitioned from HCFCs and/or HFCs to low- or lower-GWP alternatives across various refrigeration and AC applications without Multilateral Fund assistance. These transitions were driven primarily by commercial and market considerations, including the relative cost and availability of components and refrigerants, corporate business strategies, and assessments of potential regulatory risks associated with controlled substances, such as anticipated controls on HFCs prior to the adoption of the Kigali Amendment. While undertaken independently of Multilateral Fund assistance, these conversions have contributed to reducing countries' reliance on HFCs.

16. Available information based on technical reports, inputs from industry experts and market trends suggest the following:

(a) *Domestic refrigeration*: Manufacturers largely transitioned to equipment based on R-600a during this period, primarily in response to commercial and market considerations. The conversion projects have resulted in lower HFC consumption both in manufacturing and servicing in those countries.

(b) *Commercial refrigeration*: Conversions were undertaken both to HFC-based technologies and to low- or lower-GWP alternatives. More recently, market and regulatory drivers have increasingly favoured transitions to lower-GWP alternatives and away from high-GWP HFCs. The conversion projects have resulted in lower HFC consumption both in manufacturing and servicing in those countries.

(c) *Residential AC*: The sector has undergone a shift away from HCFCs and high-GWP HFCs, such as R-410A and R-407C, towards lower-GWP alternatives, including HFC-32 and R-454B. In particular, the number of manufacturers adopting R-454B has increased over the past two to three years. The conversion projects have resulted in adoption of alternatives like HFC-32 resulted in lower HFC consumption both in manufacturing and servicing in those countries.

(d) *Commercial AC*: The adoption of lower-GWP alternatives has been more limited. While conversions to refrigerants such as HFC-32 have occurred in some instances, the uptake of other low-GWP alternatives remains relatively modest, although it is increasing. The conversion projects have resulted in lower HFC consumption both in manufacturing and servicing in those countries.

17. Energy-efficiency projects in different refrigeration applications can result in reductions in greenhouse-gas emissions at the national level, depending on the energy sources used, and may reduce power demand, which in turn may reduce the need for investments in power generation, transmission and distribution and result in lower costs for end users. Among these applications, improvements in the energy efficiency of AC equipment may result in greater environmental benefits and energy-cost savings at the end-user level. The full benefits, however, can only be achieved through a sector-wide approach that applies the same minimum energy performance standards (MEPS) to all manufacturers. This would create a level playing field, so that enterprises investing in more energy-efficient designs are not put at a competitive disadvantage compared with those that keep producing lower-efficiency equipment. It would also secure the commitment of all manufacturers to the MEPS and their compliance with them and stop low-efficiency products from staying on the market and ensure sustained energy and emissions reduction.

Recommendation

18. The Executive Committee may wish to note the information contained in document UNEP/OzL.Pro/ExCom/99/81 on refrigeration and air-conditioning manufacturing lines that had completed conversion under HCFC phase-out or HFC phase-down projects approved under the Multilateral Fund in the context of funding eligibility relating to energy-efficiency projects under decision 94/60.