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Item 7(b)(i) of the provisional agenda[1]

REPORTS ON PROJECTS WITH SPECIFIC REPORTING REQUIREMENTS: WITH NO OUTSTANDING ISSUES

An overview

1. This document includes reports on projects related to HCFC phase-out management plans,[2] a Kigali HFC implementation plan, and a pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (decision 91/65).[3] Table 1 lists the reports on projects with specific reporting requirements submitted to the 99th meeting which, after the Secretariat's review, have no outstanding issues and therefore do not require the Executive Committee to consider them individually.

Table 1. Reports on projects with specific reporting requirements with no outstanding issues

Country	Project title	Paragraphs
A. Reports related to HCFC phase-out management plans		
Argentina	HCFC phase-out management plan (stage II – progress report on the implementation of the work programme associated with the fourth and final tranche, including report on the availability of low-global-warming-potential (GWP) alternatives to HCFC-141b in the foam sector and transitional use of high-GWP alternatives)	2–22

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

[2] In line with decision 97/49, UNDP as the designated agency, submitted a progress report on behalf of the Government of China on the implementation of activities under the seventh and final tranche of the solvent sector plan under stage II of the HCFC phase-out management plan. The report is presented in the project proposal document for China (UNEP/OzL.Pro/ExCom/99/45).

[3] In line with decisions 93/95(d) and 96/28(b), UNEP submitted reports on: the provision of technical and policy assistance to low-volume consuming countries to support KIP implementation; and phase II of the global technical assistance project for twinning of ozone officers and energy-efficiency policymakers to support Kigali Amendment objectives. The reports are presented in the document on UNEP's Compliance Assistance Programme Budget for 2027 (UNEP/OzL.Pro/ExCom/99/77)

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.

Country	Project title	Paragraphs
Bangladesh	HCFC phase-out management plan (stage II – progress report on the implementation of the work programme associated with the final tranche)	23–31
Lesotho	HCFC phase-out management plan (stage II – report on the status of adoption of safety standards for flammable refrigerants and the establishment of mandatory certification of technicians in line with decision 87/41(b))	32–37
Nigeria	HCFC phase-out management plan (stage II – report on the status of the temporary use of R-410A in converted manufacturing lines and cessation of HCFC-22 use by Somotex Nigeria Limited in line with decision 98/34(c)(ii))	38–46
Senegal	HCFC phase-out management plan (stage II – progress report on the implementation of the work programme associated with the combined second and third (final) tranches)	47–54
B. Report related to a Kigali HFC implementation plan		
Viet Nam	Kigali HFC implementation plan (stage I – addition of implementing agency and transfer of funds – industrial refrigeration sector)	55–65
C. Report related to a pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (decision 91/65)		
India	Design and development of a pilot-scale energy-efficient rotary compressor along with microchannel heat exchanger compatible with R-290 technology at Godrej & Boyce Mfg. Co. Ltd (final report)	66–86

A. Reports related to HCFC phase-out management plans

Argentina: HCFC phase-out management plan (stage II – progress report on the implementation of the work programme associated with the fourth and final tranche, including report on the availability of low-GWP alternatives to HCFC-141b in the foam sector and transitional use of high-GWP alternatives) (UNIDO and the Government of Italy)

Background

2. At its 97th meeting, in approving the fourth and final tranche of stage II of the HCFC phase-out management plan (HPMP), the Executive Committee requested the Government of Argentina and UNIDO inter alia to submit, on a yearly basis until completion of the project, progress reports on the implementation of the work programme associated with the final tranche; the updated list of downstream polyurethane (PU) foam enterprises being assisted by the Multilateral Fund under stage II, including HCFC-141b consumption phased out, the subsector concerned, the baseline equipment and the technology adopted; and the revised dates for the commitment by the Government of Argentina to issue bans on the import and use of HCFC-141b pure or contained in pre-blended polyols for the manufacture of PU foam, on the import and use of HCFC-22 and HCFC-142b for the manufacture of extruded polystyrene (XPS) foam, and on the import and use of HCFC-141b for flushing refrigeration circuits during servicing.[4]

3. At the 98th meeting, the Executive Committee requested the Government of Argentina and UNIDO, in line with decision 92/31(c)(ii), to provide as part of the yearly progress report on the implementation of the final tranche of stage II of the HPMP, due at the 99th meeting, an update on local market availability of low-global-warming-potential (GWP) alternatives to HCFC-141b in the foam sector and on the transitional use of high-GWP alternatives (decision 98/5).

HCFC consumption

4. The Government of Argentina reported a consumption of 66.40 ODP tonnes of HCFCs in 2025, which is 83 per cent below the country's HCFC baseline for compliance and is consistent with country programme implementation report for the same year. The overall reduction of HCFC consumption in 2025,

[4] Decision 97/39(b)(ii) and (iii)

in compliance with the Montreal Protocol reduction target for the year, was influenced by the reduced imports and production of HCFC-22, as well as by non-issuance of import quotas for HCFC-141b for the manufacturing of PU foam and HCFC-22 and HCFC-142b for the manufacturing of XPS foam. The 2021–2025 HCFC consumption is shown in table 2.

Table 2. HCFC consumption in Argentina (2021–2025 Article 7 data)

HCFC	2021	2022	2023	2024	2025	Baseline
Metric tonnes (mt)						
HCFC-22	1,459.72	2,508.29	2,230.00	2,168.46	1,058.39	4,859.5
HCFC-123	77.01	74.15	32.69	12.99	40.33	74.7
HCFC-141b	740.20	763.93	360.87	346.66	67.14	1,031.1
HCFC-142b	15.09	0.62	6.05	12.17	0.0	268.1
Total (mt)	**2,292.02**	**3,346.99**	**2,629.61**	**2,540.28**	**1,165.86**	***6,281.3**
ODP tonnes						
HCFC-22	80.28	137.96	122.65	119.27	58.21	267.3
HCFC-123	1.54	1.48	0.65	0.26	0.81	1.5
HCFC-141b	81.42	84.03	39.70	38.13	7.39	113.4
HCFC-142b	0.98	0.04	0.39	0.79	0.00	17.5
Total (ODP tonnes)	**164.23**	**223.51**	**163.39**	**158.45**	**66.40**	***400.7**
Maximum allowable consumption	260.45	200.35	200.35	200.35	130.22	--

* Including 47.9 mt (1.0 ODP tonne) of HCFC-124

Progress report

Progress report on the implementation of the work programme associated with the fourth and final tranche

5. On behalf of the Government of Argentina, UNIDO submitted a report on progress achieved in the implementation of remaining activities of stage II, as summarized below.

Regulatory framework

6. The bans on the import and use of HCFC-141b pure or contained in pre-blended polyols for the manufacture of PU foam, on the import and use of HCFC-22 and HCFC-142b for the manufacture of XPS foam, and on the import and use of HCFC-141b for flushing refrigeration circuits during servicing remain under development and are foreseen to enter into force no later than December 2027. In the meantime, since January 2025, no HCFC-141b import quotas have been allocated for PU foam applications and no HCFC-22 and HCFC-142b import quotas have been allocated for XPS foam applications.

Manufacturing sector

Systems house umbrella project in the polyurethane foam manufacturing sector

7. The umbrella project has adopted a revised implementation modality, with incremental operating costs (IOCs) issued directly to eligible downstream PU foam enterprises rather than channelled through systems houses. This adjustment was introduced to improve the traceability and verification of IOC reimbursements, as many downstream users were procuring formulations from multiple systems houses, which made the allocation and monitoring through intermediary entities operationally challenging. To date, 139 downstream enterprises have been identified as eligible beneficiaries by the participating systems houses in accordance with the eligibility criteria established under stage II of the HPMP. UNIDO has initiated the processing of agreements, with the first batch comprising the largest five downstream enterprises. These agreements are currently under review by UNIDO's Procurement Unit and, once finalized, will enable the commencement of reimbursements and support the conversion of downstream users to HFO-based technologies.

8. Regarding the updated list of downstream PU foam enterprises being assisted by the Multilateral Fund under stage II of the HPMP required under decision 97/39(b)(iii) a., the verification process was initiated in August 2025, when HFO-based formulations became available in the country. To date, UNIDO provided a partial list with the names of 34 eligible beneficiary downstream users based on information provided by two participating systems houses. The Secretariat recommends including an updated list in the next annual report.

Report on the availability of low-GWP alternatives and the transitional use of high-GWP alternatives to HCFC-141b in the foam sector (decision 98/5)

9. At its 92nd meeting, in approving the third tranche of stage II of the HPMP for Argentina, the Executive Committee noted that the lack of supply of low-GWP alternatives to HCFC-141b had delayed the implementation of activities in the PU foam sector that would otherwise have resulted in the phase-out of 85.92 ODP tonnes of HCFCs; that high-GWP alternatives could be used on a transitional basis if alternatives remained locally unavailable; and that the Government would report to each meeting on the progress made towards ensuring that the selected technologies and associated components were commercially available, on the understanding that IOCs would not be funded until transition to the agreed alternatives was complete.[5]

10. UNIDO has since reported on this issue at ensuing Executive Committee meetings,[6] most recently noting that the availability of HFO-1233zd(E) went from a trial phase to a more regular supply arrangement, and that local systems houses had been maintaining sufficient operational inventories to avoid supply disruptions. The country's sole HFO supplier was looking to reduce reliance on ton tanks while improving medium-term supply continuity, and a local fractionation scheme to improve short-term HFO availability was under discussion. The price of HFO-1233zd(E) was not expected to exceed US $18/kg, and the only enterprise still using HFCs was a reseller who reported difficulties buying and importing HFO-based systems without loss of lifetime stability during shipment. Despite achieving significant progress, the issues of availability and pricing of low-GWP alternatives had not been fully resolved, and high-GWP alternatives are still used on a transitional basis.

11. At the present meeting, following consultations held with key suppliers and local systems houses, UNIDO reported that the technology supplier and systems houses continue to work to streamline import processes, requirements and documentation for returnable cylinders with a view to improving delivery times for future HFO imports. UNIDO further indicated that some uncertainty remained regarding the consistency of the supply chain, as only one supplier had begun deliveries, with delays of about two months, while another had decided not to supply the Argentine market at this stage, and a third had yet to complete any deliveries. While progress continues to be made, the supply chain remains fragile and is not yet fully consolidated.

12. On the concerns previously reported by UNIDO about potential regulatory changes regarding fluorinated substances and restrictions on per- and polyfluoroalkyl substances (PFAS), the report indicated that regulatory uncertainty persisted despite progress reported by one supplier in addressing the matter in one country. In this regard, one non-Article 5 systems house in Argentina reported that its headquarters had raised questions concerning potential future restrictions on HFOs following efforts to introduce an HFO-based formulation. UNIDO reiterated the commitment of the country and systems houses to transitioning to HFOs, provided that cost and logistical barriers continue to be addressed.

[5] Decision 92/31(a) and (b)

[6] Documents UNEP/OzL.Pro/ExCom/93/20 (paragraphs 2–9), UNEP/OzL.Pro/ExCom/94/9 (paragraphs 5–14), UNEP/OzL.Pro/ExCom/96/11 (paragraphs 5–18), UNEP/OzL.Pro/ExCom/97/36 (paragraphs 10–15 and 31–32) and UNEP/OzL.Pro/ExCom/98/6 (paragraphs 10–21).

Refrigeration servicing sector

13. Under the fourth tranche of stage II of the HPMP, 882 servicing technicians have received training on good practices for handling flammable refrigerants, and 301 technicians became certified. The training support modality was revised, with UNIDO providing increased financial support for training and certification costs, which improved access to the programme and resulted in an increase in training delivery. UNIDO is in the process of contracting an additional trainer to expand training activities to additional regions of the country, such as Patagonia and Tierra del Fuego.

14. A total of 280 tool kits procured in 2025 arrived in Argentina and are currently being delivered to trained and certified technicians in different cities. Procurement of 220 additional tool kits for newly certified technicians is underway to comply with the target of 1,000 tool kits delivered.

15. A new refrigerant reclaim unit has been procured and is awaiting delivery to an enterprise that will become the country's second refrigerant reclamation centre. Delivery is expected early next year, after which installation and commissioning activities will start.

16. Awareness activities were also implemented, and monitoring visits were conducted to verify the delivery of procured tool kits, as well as the implementation of training activities and the certification of technicians.

17. Of the total US $9,866,238[7] approved for stage II of the HPMP for Argentina, US $4,756,022 has been disbursed. The remaining balance of US $5,110,216 (out of which US $2,664,690 is already committed in ongoing activities) will be disbursed in 2026–2027.

Secretariat's comments

Implementation of the work programme associated with the fourth and final tranche

18. The Secretariat notes that substantive progress has been made in the refrigeration servicing sector, including the establishment of an operational technician certification system and the upcoming establishment of a second refrigerant reclaiming centre. Implementation remains on track to achieve the outputs planned for the stage, including the training of 4,000 technicians, certification of 1,000 technicians, and distribution of tool kits to 1,000 certified technicians.

19. At the Secretariat's request, UNIDO confirmed that stage II of the HPMP would be completed by 31 December 2027, in line with the extension provided by decision 97/39(c)(i).

20. UNIDO also confirmed that the regulatory bans on the use of HCFC-141b (pure or in pre-blended polyols) for PU foam, HCFC-22 and HCFC-142b for XPS foam, and HCFC-141b for flushing refrigeration circuits were under development and were scheduled to enter into force no later than December 2027. In the meantime, since January 2025, no import quotas have been issued for HCFC-141b used in PU foam applications and for HCFC-22 and HCFC-142b used in XPS foam applications.

Report on the availability of low-GWP alternatives and transitional use of high-GWP alternatives to HCFC-141b in the foam sector (decision 98/5)

21. The Secretariat notes that further progress has been achieved in discussions with the HFO supplier and systems houses, and in increasing the availability and more regular supply of HFOs. Despite the additional progress made, the issues of availability and pricing of low-GWP alternatives have still not been fully resolved. Therefore, in line with decision 92/31(c)(ii), the Secretariat recommends that the Government of Argentina provide, as part of the next yearly progress report on the implementation of the final tranche of

[7] Including deductions for US $75,000 in line with decision 92/31 (b)(i) and (b)(ii).

stage II of the HPMP, due at the 101st meeting, an update on the local market availability of low-GWP alternatives to HCFC-141b in the foam sector and transitional use of high-GWP alternatives, which will allow for the identification and reporting of any unforeseen circumstances that may arise before completion of the PU foam project.

Recommendation

22. The Executive Committee may wish:

(a) To note the progress report on the implementation of the work programme associated with the fourth and final tranche of stage II of the HCFC phase-out management plan and the report on the availability of low-global-warming-potential (GWP) alternatives and transitional use of high-GWP alternatives to HCFC-141b in the foam sector for Argentina, provided by UNIDO and contained in document UNEP/OzL.Pro/ExCom/99/19;

(b) To request the Government of Argentina and UNIDO to provide, as part of the yearly progress report on the implementation of the final tranche of stage II of the HPMP, due at the 101st meeting:

(i) The updated list of downstream polyurethane foam enterprises being assisted by the Multilateral Fund under stage II, including HCFC-141b consumption phased out, the subsector concerned, the baseline equipment and the technology adopted; and

(ii) An update on local market availability of low-GWP alternatives and on the transitional use of high-GWP alternatives to HCFC-141b in the foam sector.

Bangladesh: HCFC phase-out management plan (stage II – progress report on the implementation of the work programme associated with the final tranche) (UNDP)

Background

23. At its 94th meeting, in approving the third and final tranche of stage II of the HCFC phase-out management plan (HPMP) for Bangladesh, the Executive Committee inter alia requested the Government of Bangladesh, UNDP and UNEP to submit, on a yearly basis, progress reports on the implementation of the work programme associated with the final tranche through completion of the project (decision 94/32(c)).

Progress report

24. In line with decision 94/32(c), UNDP and UNEP, on behalf of the Government of Bangladesh, have submitted a progress report providing a status update on project activities as at September 2026, including the following:

(a) Operational completion of the manufacturing sector component, including successful conversion of five refrigeration and air-conditioning (RAC) manufacturing enterprises that participated in the project, to HCFC-free technologies and commencement of commercial production using R-290 and HFC-32.

(b) Achievement of a total phase-out of 17.09 ODP tonnes of HCFC-22 through manufacturing sector conversions.

(c) Entry into force of the national ban on the manufacture and import of HCFC-22-based room air conditioners (up to 1.5 TR) starting from 1 January 2026, ensuring the sustainability of the HCFC phase-out achieved in the country.

(d) Continued implementation of servicing sector activities, including specialized training on the safe handling of flammable and low-global-warming-potential (GWP) refrigerants, leak prevention and good servicing practices, with 1,880 technicians trained through 94 batches, as of September 2026.

(e) Strengthening of customs and enforcement capacity through customs officer training, training-of-trainers programmes, curriculum updates and continued integration of ozone-related controls into the national customs framework.

25. As of September 2026, of the US $5,449,814 approved, US $5,285,998 had been disbursed. The balance of US $163,816 will be disbursed by the end of 2026.

26. Key factors contributing to the successful implementation of the project included the timely implementation of policies and regulations; strong partnerships with customs and import/export control authorities; close coordination with, and capacity-building of, importers and distributors of HCFCs and HCFC-based equipment; engagement of national stakeholders, including relevant Government institutions and industry representatives; the adjustment of project activities based on lessons learned; and the use of information technology tools for training and communication.

Secretariat's comments

27. The Secretariat notes that implementation of stage II is substantially complete. All manufacturing sector activities have been completed, including the conversion of five room air-conditioner manufacturing enterprises from HCFC-22 technology to low-GWP alternatives (R-290 and/or HFC-32). These activities resulted in the phase-out of 17.09 ODP tonnes of HCFC-22. A national restriction on the manufacture and import of HCFC-22-based room air conditioners (up to 1.5 TR[8]) entered into force on 1 January 2026 to support the sustainability of the phase-out achieved under the project.

28. The Secretariat further notes that substantial progress has been achieved in the servicing sector. As of September 2026, 1,880 RAC technicians had been trained. Customs and enforcement capacity-building activities have also been implemented, including customs officer training, training-of-trainers programmes and updates to national training curricula.

29. UNDP confirmed that the Government of Bangladesh expects to operationally complete stage II by 31 December 2026. The remaining activities consist primarily of 13 technician-training batches expected to train approximately 260 additional technicians, completion of asset handover arrangements and project closure activities. UNDP further confirmed that financial completion will be undertaken in accordance with UNDP and national procedures, which allow disbursement against completed activities for up to 12 months following operational completion.

30. The Secretariat requested clarification regarding the proximity of the 2025 HCFC consumption level to the target of 23.6 ODP tonnes for that year and the safeguards in place to ensure that the country remains in compliance with HCFC targets. UNDP explained that Bangladesh would continue to implement regulatory measures to control HCFC imports through its licensing and quota system, while reducing demand for HCFCs through technician training and certification, and refrigerant recovery and recycling activities. These combined measures are expected to support the Government in remaining in compliance with its HCFC phase-out obligations.

[8] Tonne of refrigeration (TR)

Recommendation

31. The Executive Committee may wish to note the final progress report on the implementation of the work programme associated with the final tranche of stage II of the HCFC phase-out management plan for Bangladesh, submitted by UNDP and UNEP and contained in document UNEP/OzL.Pro/ExCom/99/19.

Lesotho: HCFC phase-out management plan (stage II – report on the status of adoption of safety standards for flammable refrigerants and the establishment of mandatory certification of technicians in line with decision 87/41(b)) (Government of Germany)

Background

32. At its 94th meeting, in approving the second tranche of stage II of the HCFC phase-out management plan (HPMP) for Lesotho, the Executive Committee requested the Government of Germany to submit a report on the status of adoption of safety standards for flammable refrigerants and the establishment of mandatory certification of technicians in line with decision 87/41(b), at the first meeting of every year starting in 2025 until the submission of the third tranche of stage II of the HPMP (decision 94/20).[9]

Status report

33. In response to the decision, the Government of Germany has provided the following status report.

Adoption of safety standards for flammable refrigerants

34. The national ozone unit has maintained regular engagement with the Lesotho Standards Institute (LSI) regarding the development and adoption of the safety standards. During the discussions held in 2026, LSI expressed that they would like to wait for the ongoing review process of ISO 5149 to be completed before incorporating the relevant changes based on the technical inputs of the ISO 5149 review; the experts involved inter-alia pointed out that the changes expected are likely to be minimal. Following this, LSI reassured that the standards would be adopted by the end of the year 2026.

Establishment of mandatory certification of technicians

35. The Recognition of Prior Learning for safe handling of flammable refrigerants was finalized in 2025. After training 10 technicians in the pilot assessment in November 2025, the second batch of assessments took place in 2026 and in total 40 technicians were licensed throughout the country. By the end of 2026, identification cards for the licensed technicians would be issued and their names would be maintained in the registry.

Secretariat's comments

36. The Government of Germany informed that the activities relating to adoption of safety standards for flammable refrigerants and establishment of mandatory certification of technicians are progressing satisfactory and that technical experts are providing relevant inputs for timely completion of the pending tasks.

Recommendation

37. The Executive Committee may wish to note the report on the status of adoption of safety standards for flammable refrigerants and the establishment of mandatory certification of technicians in line with

[9] Annex IX to document UNEP/OzL.Pro/ExCom/94/67

decision 87/41(b) associated with stage II of the HCFC phase-out management plan for Lesotho, as submitted by the Government of Germany and contained in document UNEP/OzL.Pro/ExCom/99/19.

Nigeria: HCFC phase-out management plan (stage II – report on the status of the temporary use of R-410A in converted manufacturing lines and cessation of HCFC-22 use by Somotex Nigeria Limited in line with decision 98/34(c)(ii)) (UNDP, UNIDO and the Government of Italy)

Background

38. At the 98th meeting, UNIDO reported that two enterprises in air-conditioning (AC) manufacturing, Somotex Nigeria Limited (Somotex) and Sacral Industries Limited (Sacral), for which conversion to an alternative with low global-warming potential had been approved, were temporarily using R-410A to maintain business viability, and that the two enterprises had committed to ceasing the use of R-410A in AC manufacturing by 31 December 2026 (decision 98/34(b)). The Executive Committee inter alia requested UNIDO to report to the 99th meeting on the status of use of the interim technology for those enterprises as well as the cessation of HCFC-22 use by Somotex (decision 98/34(c)(ii)).

39. UNIDO provided an update to the present meeting in line with that decision.

Status report

Somotex Nigeria Limited

40. UNIDO confirmed that Somotex ceased using HCFC-22 in AC manufacturing on 3 October 2024, with no HCFC-22 consumption since; the verification of the destruction of HCFC-22 baseline equipment by the national ozone office (NOO) and UNIDO has been scheduled for 19 November 2026.

41. In 2026, Somotex's R-410A manufacturing declined while HFC-32 manufacturing increased. From January to October 2026, HFC-32-based products accounted for 60.3 per cent of the enterprise's AC manufacturing and R-410A for 39.7 per cent. The enterprise confirmed that it will base its residential AC product range entirely on HFC-32 starting from 1 January 2027.

Sacral Industries Limited

42. The report for Sacral confirmed that, as reported to the 98th meeting, the enterprise ceased using HCFC-22 in AC manufacturing on 31 December 2023, with no HCFC-22 consumption since; the verification of the destruction of HCFC-22 baseline equipment by the NOO and UNIDO has been scheduled for 19 November 2026.

43. Manufacturing with R-410A decreased from 2024 to 2025, and there was no use of R-410A in the enterprise's AC manufacturing from January to October 2026.

44. The two enterprises each provided a signed letter of commitment for the complete phase-out of the import, production, sale and use of HCFC-22 and R-410A refrigerants and all related technologies in their AC manufacturing by 31 December 2026, and to base their residential AC product range entirely on HFC-32 from 1 January 2027. All obsolete HCFC-22 and R-410A manufacturing equipment and related materials will be destroyed.

Secretariat's comments

45. Both Sacral and Somotex have ceased AC manufacturing with HCFC-22. Sacral reported that they have not consumed R-410A in 2026, while Somotex continues to use R-410A; both enterprises have committed to cease manufacturing with R-410A by 31 December 2026. Accordingly, the Secretariat

recommends that no further funding be provided to Sacral and Somotex until UNIDO has confirmed that the enterprises have ceased manufacturing air conditioners with R-410A, as discussed further in document UNEP/OzL.Pro/ExCom/99/64.

Recommendation

46. The Executive Committee may wish:

(a) To note the report on the status of use of the interim technology R-410A by Sacral Industries Limited (Sacral) and Somotex Nigeria Limited (Somotex), which had converted their air-conditioning (AC) manufacturing lines to HFC-32 technology, submitted by UNIDO in line with decision 98/34(c) and contained in document UNEP/OzL.Pro/ExCom/99/19;

(b) To further note the cessation of HCFC-22 use in AC manufacturing at Somotex; and

(c) To request UNIDO to report to the 100th meeting on the status of use of the interim technology described in subparagraph (a).

Senegal: HCFC phase-out management plan (stage II) – progress report on the implementation of the work programme associated with the combined second and third (final) tranches (UNEP and UNIDO)

Background

47. At its 97th meeting, with the approval of the combined second and third (final) tranches of stage II of the HCFC phase-out management plan (HPMP) and an extension of the duration to 31 December 2027, the Executive Committee requested the Government, UNEP, and UNIDO to submit progress reports on the implementation of the work programme associated with the final tranche on a yearly basis until the completion of the project, and the project completion report to the first meeting of the Executive Committee in 2028 (decision 97/54).

HCFC consumption

48. The Government of Senegal reported, in its Article 7 and country programme implementation data, consumption of 6.60 ODP tonnes of HCFCs in 2026, which is 81.8 per cent below the country's HCFC baseline for compliance and is in accordance with the maximum allowable consumption for that year.

Progress report

49. On behalf of the Government of Senegal, UNEP, as lead implementing agency, has submitted the annual report on progress achieved on the implementation of activities under stage II of the HPMP.

50. Activities implemented in the servicing sector under the UNEP component are as follows:

(a) *Strengthening the enforcement of ODS regulations and capacity-building for enforcement officers:* Developed training manual for customs; conducted training for 80 internal trade controllers and auditors on Montreal Protocol issues; finalized plan for two training programmes for customs officers in 2026;

(b) *Capacity-building of refrigeration and air-conditioning (RAC) servicing technicians and establishment of a certification scheme:* Conducted five training programmes for 150 technicians, industrial refrigeration specialists and trainers from vocational schools on good service practices and safe handling of flammable refrigerants; initiated development of manuals for vocational and technical training centres; decided to partake in the

certification scheme being developed by the Italian Association of Refrigeration Technicians for African Francophone countries. Senegal is expected to join the second cohort in 2027; and

(c) *Activities to maintain energy efficiency in the refrigeration servicing sector:* Identified and engaged relevant stakeholders; held one meeting to improve coordination among relevant agencies. Conducted one meeting with policymakers and industry stakeholders to promote minimum energy performance standards and energy efficiency.

51. Activities implemented in the servicing sector under the UNIDO component are as below:

(a) *Strengthening of the centres of excellence:* UNIDO submitted the feasibility report for the establishment of a recovery and reclamation system in Senegal to the Secretariat in April 2026 as per decision 97/54(e), and accordingly, initiated the establishment of a national network of refrigerant recovery and recycling (RR) workshops, supported by a central facility. [10] Preparation activities and finalization of the list of equipment and its specifications to be procured for RR workshops were completed. Procurement has been initiated and is expected to be completed by January 2027; training will commence following the delivery of relevant equipment.

Level of fund disbursement

52. As of September 2026, of the US $453,000 approved for the combined second and third (final) tranches of stage II of the HPMP, US $130,000 had been disbursed by UNEP, and no funds had been disbursed by UNIDO. The balance of US $323,000 will be disbursed in 2026 and 2027.

Secretariat's comments

53. The Secretariat noted that the progress report provided the required information on the progress of activities. Since the approval of the tranche in December 2025, activities to strengthen the capacity of customs officers and RAC technicians have been initiated, with implementation continuing in 2026 and 2027. While there is no disbursement under the UNIDO component, it was noted that 10 workshops were identified to receive the equipment, and a centre was selected to provide them with technical assistance. Procurement was initially delayed as finalization of the long-term agreements with the vendor took longer than planned. Procurement has been initiated now, with delivery expected in January 2027. UNEP confirmed that all activities of stage II of the HPMP are expected to be completed by the end of 2027 as planned.

Recommendation

54. The Executive Committee may wish to note the annual progress report on the implementation of the work programme associated with the combined final second and third tranches of the HCFC phase-out management plan for Senegal, as submitted by UNEP and contained in UNEP/OzL.Pro/ExCom/99/19.

B. Report related to a Kigali HFC implementation plan

Viet Nam: Kigali HFC implementation plan (stage I – addition of implementing agency and transfer of funds – industrial refrigeration sector) (World Bank and UNEP)

Background

55. On behalf of the Government of Viet Nam, the World Bank as the lead implementing agency submitted a request for the transfer of the industrial refrigeration sector component of stage I of the Kigali

[10] Paragraph 22 of document UNEP/OzL.Pro/ExCom/98/10

HFC implementation plan (KIP) from the World Bank to UNIDO, and for the inclusion of UNIDO as a cooperating implementing agency.[11]

56. At its 93rd meeting, the Executive Committee approved, in principle, stage I of the KIP for Viet Nam for the period 2023–2029, in the amount of US $5,029,063, consisting of US $3,593,183, plus agency support costs of US $251,522, for the World Bank, and US $1,057,980, plus agency support costs of US $126,378, for UNEP.[12] The Agreement between the Government of Viet Nam and the Executive Committee was approved at the 98th meeting.[13] Stage I includes US $614,530 for the industrial refrigeration sector, comprising US $339,530 for the conversion of the heat exchanger manufacturing operations of Quang Thang to ammonia-based technology, and US $275,000 for incentives to end users to purchase ammonia-based industrial refrigeration systems supplied by the converted enterprise.[14] The two parts were designed to be implemented as one project: the end-user incentives were not scheduled to start until Quang Thang was able to supply ammonia-based heat exchangers.

57. Of the US $1,557,792, plus agency support costs of US $109,045, approved for the World Bank for the first tranche, US $234,220, plus agency support costs of US $16,395, was approved for the first two payments of the Quang Thang conversion (VNM/KIP1/91/WB/INV/AC/93). The remaining US $380,310 for the industrial refrigeration sector (i.e., the third conversion payment of US $105,310 and the end-user incentive of US $275,000) was to be requested with the second tranche.

Request for addition of implementing agency and transfer of funds

58. The Government's national regulations, namely the Law on State Budget and the Law on Management and Use of Public Property, do not allow grant funding that is considered official development assistance and public funds to be channelled to private enterprises, as would be required for the enterprise Quang Thang under the World Bank's national execution modality. The industrial refrigeration activities and associated funding were therefore excluded from the overarching project document approved by the Ministry of Agriculture and Environment (Decision No. 2368/QD-BNNMT of 26 June 2025) and from the grant agreement between Viet Nam and the World Bank. Since this constraint is unlikely to be resolved during stage I, and rather than returning the funds, the Government has requested that UNIDO, whose modalities allow it to disburse Multilateral Fund grants directly to enterprises, implement the component. It has also requested that the funds already approved be transferred at the 99th meeting so that it can start making implementation arrangements with UNIDO before the second tranche is submitted.

59. Of the US $234,220, plus agency support costs of US $16,395, approved for this component under the first tranche, none had been disbursed. The rail mobile air-conditioning conversion project (VNM/KIP1/92/WB/INV/AC/93), which was the other investment component approved under the first tranche at US $55,000, plus agency support costs of US $3,850, will remain with the World Bank, as a modality consistent with national budget rules was found for that project.

Status of implementation of the first tranche

60. Appraisal and approval of the World Bank project covering stage III of the HCFC phase-out management plan and stage I of the KIP were delayed by efforts to reconcile national budget laws with the Bank's national execution modality. Appraisal took place in August 2025, once the Quang Thang industrial refrigeration subproject had been removed; the grant agreement was negotiated between September and November 2025, approved by the World Bank in December 2025, signed in January 2026, and became

[11] As per the letter of 29 October 2026 from the Ministry of Agriculture and Environment of Viet Nam to the World Bank.
[12] Decision 93/76(a).
[13] Decision 98/12(gg) and annex XXXVI to document UNEP/OzL.Pro/ExCom/98/64.
[14] Table 12 of document UNEP/OzL.Pro/ExCom/93/93.

effective in April 2026. Management arrangements, the project implementation manual, and the work plan were prepared in parallel during the second half of 2025.

61. The World Bank disbursed US $500,000 to Viet Nam in June 2026; the project management unit was in place by July 2026, when the project launch workshop and targeted consultations with servicing-sector training representatives and rail authorities were held. Memoranda of understanding have been signed with the Viet Nam Railway Authority, the Railway Transport Joint Stock Company under the Viet Nam Railway Corporation, and the Department of Vocational Education and Continuing Education of the Ministry of Education and Training, enabling the rail mobile air-conditioning conversion and servicing sector activities to begin.

Secretariat's comments

62. The requested transfer involves only the industrial refrigeration sector component and does not change the overall funding of stage I of the KIP, the activities, milestones or targets of the other components of the first tranche, or the HFC consumption targets in the Agreement. The request involves the following:

(a) The World Bank will return to the Fund, at the 99th meeting, US $234,220, plus agency support costs of US $16,395, approved under the first tranche for VNM/KIP1/91/WB/INV/AC/93, to be transferred to UNIDO; and

(b) The remaining US $380,310, plus agency support costs of US $26,622, for the industrial refrigeration sector component will be allocated to UNIDO under the second tranche, and the World Bank's allocation for the second tranche will be reduced by the same amount.

63. The World Bank indicated that the second tranche request would be submitted in 2027 and will include the remaining conversion and end-user activities to be implemented by UNIDO and the associated targets.

64. Accordingly, the Secretariat has updated Appendix 2-A and relevant paragraphs of the Agreement to include UNIDO as a cooperating implementing agency and to reflect the transfer of funding and has added paragraph 17 to indicate that the updated Agreement supersedes that reached at the 98th 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. The total funding and agency support costs for stage I remain unchanged at US $4,651,163 and US $377,900, respectively.

Recommendation

65. The Executive Committee may wish:

(a) To note the request by the Government of Viet Nam:

(i) To include UNIDO as a cooperating implementing agency in stage I of the Kigali HFC implementation plan (KIP);

(ii) To transfer to UNIDO the activities of the industrial refrigeration sector component of stage I of the KIP, approved in principle at the 93rd meeting, in the amount of US $614,530, plus agency support costs, initially planned for implementation by the World Bank;

(b) To note that the World Bank will return, at the 99th meeting, the funding of US $234,220, plus agency support costs of US $16,395, to be transferred to UNIDO to implement the activities of the industrial refrigeration sector component approved under the first tranche of stage I of the KIP (VNM/KIP1/91/WB/INV/AC/93);

(c) To note that the remaining funding of US $380,310, plus agency support costs of US $26,622, for the industrial refrigeration sector component would be allocated to UNIDO under the second tranche of stage I of the KIP, with a corresponding reduction in the World Bank's allocation; and

(d) To note that the Fund Secretariat has updated the Agreement between the Government of Viet Nam and the Executive Committee, as contained in annex I to the present document, specifically: paragraphs 9 and 10 and Appendix 2-A, to reflect the transfer of funding and inclusion of UNIDO as a cooperating implementing agency; and paragraph 17 that has been added to indicate that the updated Agreement supersedes that reached at the 98th meeting (decision 98/12).

C. Report related to a pilot project to maintain and/or enhance the energy efficiency of replacement technologies and equipment in the context of HFC phase-down (decision 91/65)

India: Design and development of a pilot-scale energy-efficient rotary compressor along with microchannel heat exchanger compatible with R-290 technology at Godrej & Boyce Mfg. Co. Ltd (final report) (Government of Germany)

Background

66. At its 93rd meeting, the Executive Committee approved, under the funding window for maintaining and/or enhancing energy efficiency established by decision 91/65, the project for the design and development of a pilot-scale energy-efficient R-290 rotary compressor and microchannel heat exchanger at Godrej & Boyce Mfg. Co. Ltd (Godrej) in India, in the amount of US $1,853,795 for the Government of Germany (decision 93/90). In approving the project, the Executive Committee noted, inter alia:

(a) The commitment of Godrej to convert 70 per cent of its production of HFC-32 air conditioners (ACs) to R-290 by 2028 without further support from the Multilateral Fund, and that any remaining eligible HFC consumption for Godrej would be deducted from the country's starting point when the Kigali HFC implementation plan (KIP) was submitted;

(b) The expected direct emission reduction of 437,840 CO_2-equivalent tonnes (CO_2-eq tonnes) by 2028, the commitment of the Government of India to design additional policy measures to promote R-290 and other low-GWP ACs during preparation of stage I of the KIP and to report on the progress of manufacturing R-290 compressors at Godrej under stage I of the KIP; and

(c) That the project would be completed no later than 31 December 2025 and a detailed project report would be submitted within six months of completion.

67. The project aimed to develop R-290 rotary compressors and establish their pilot production at Godrej through three components: redesign of an energy-efficient R-290 compressor for five AC models; development of microchannel heat exchangers (MCHX); and component integration and optimization of R-290 room ACs, including performance and energy-efficiency testing. During the baseline years (2021-2023), Godrej produced half a million ACs, including HFC-32- and R-290-based units, using imported compressors, with R-290 accounting for 5 to 10 per cent of production. The project was expected to raise the efficiency of R-290 ACs from a 5-star rating to an Indian seasonal energy efficiency ratio (ISEER) of 6.61 by 2028, avoiding an estimated 600,000 CO2-eq tonnes of consumption over the life of the equipment.

68. India ratified the Kigali Amendment on 27 September 2021. Project preparation funding for stage I of the Kigali HFC implementation plan (KIP) for India was approved at the 98th meeting;[15] the KIP has yet to be submitted.

Final report

69. In line with decision 93/90, the Government of Germany submitted the final report on the implementation of the project, summarized below. The full report submitted by the Government of Germany is attached to the present document.

R-290 rotary compressor design and development

70. The variable-speed rotary inverter compressor went through several prototype iterations including repositioning of internal components and openings, revised tolerances, a modified suction accumulator and dedicated tooling, resulting in the compressor's coefficient of performance (COP) increasing across the iterations by about 40 per cent to 3.4, which is within ±2 per cent of the leading R-290 rotary compressor used as a benchmark. The volumetric efficiency is about 93 per cent across a variable-speed modulation range of 1,600 to 5,500 rpm, delivering 1.4 to 5.2 kW cooling capacity. The compressor was independently tested to Indian standard IS 10617:2018+A1:2020, and the Bureau of Indian Standards (BIS) has granted Godrej a licence for production and sale of the R-290 ACs.[16]

Microchannel heat exchangers

71. The MCHX manufacturer provided several condenser designs, and the option offering the highest COP was selected as it presented a system with a special surface treatment to limit fouling and corrosion. Compared with conventional finned-tube copper heat exchangers, the MCHX reduces the R-290 charge by 50 to 100 grams and metal use by 1 to 2 kg per unit, lowering flammability risk and material cost.

AC integration, testing and field trials

72. The certified ISEER of the new split ACs is 5.73 for the 3.5 kW (1 TR[17]) model and 5.78 for the 5.0 kW (1.5 TR) model.[18] Both are above the current 5-star threshold of 5.60 and just 3.7 per cent below the most efficient split AC reported in India (which utilizes HFC-32 and is not constrained by the strict flammable refrigerant charge limits applicable to R-290 systems). Furthermore, compared with the standard baseline 5-star HFC-32 AC in the market, the new R-290 models deliver a 14.6 to 15.6 per cent seasonal energy efficiency gain. Compared with the previous R-290 models (ISEER of 4.57 and 4.70), the ISEER of the new split ACs improved by 23 to 25 per cent, corresponding to a reduction in energy consumption of 18.7 to 20.2 per cent. Results were published on the Bureau of Energy Efficiency (BEE) and BIS portals.[19]

73. The project proposal had targeted an ISEER of 6.61 by 2028, on the assumption that BEE would raise the 5-star level accordingly. Instead, BEE has retained the 5-star threshold at 5.60 and given notice of an increased threshold of 5.80 starting from 1 January 2028; pursuing an ISEER of 6.61 would have added costs that would make the product uncompetitive. Since the ISEER achieved is marginally below the 5-star threshold applicable from 2028, Godrej's research and development teams are continuously exploring further efficiency optimization pathways (such as refined fan blade aerodynamics, advanced electronic

[15] Decision 98/26

[16] Compressor: BIS licence No. 9700214516

[17] Tonne of refrigeration

[18] The compressor design was optimized for 1 TR and 1.5 TR capacity due to statutory safety compliance under Indian flammability standards that limit hydrocarbon charge size at 1.5 TR capacity for compressors as well as thermodynamic charge limitations.

[19] Models HIC 12X5GI and HIC 18K5GI; BIS licence No. 7500224808 under IS 1391 (Part 2):2023.

expansion valve control logic, and microchannel improvements), supported by ongoing third-party testing to improve energy efficiency at the Universidad Politécnica de Valencia in Spain.

74. Some 200 units have been deployed for one-year field trials in Mumbai, Jaipur, Delhi, Kolkata and Chennai, selected to cover the widest range of climatic conditions, and a further 200 units are currently being deployed. Based on bimonthly customer calls over a one-year period, household users report positive levels of satisfaction with the product performance, zero safety incidents and a verified annual in-use refrigerant leakage rate of only 1.5 to 2.0 per cent.

Risk assessment and energy savings

75. A quantitative lifetime flammability risk assessment covering production, transport, storage, installation, servicing and dismantling is being finalized, with preliminary outputs highlighting the importance of technician training, safe procedures for opening the system and the availability of appropriate tools. Based on assumed sales of 350,000 units of 3.5 kW and 150,000 units of 5.0 kW, the report estimates an 11 per cent reduction in energy consumption relative to 5-star HFC-32 units, saving 77.2 GWh and 65,651 CO_2-eq tonnes per year.

Implementation delays, barriers and replicability

76. Although two machines procured under the project were subjected to longer delivery periods, Godrej used existing equipment and technically completed the project. Financial and administrative procedures were delayed by the agency's migration to an upgraded Systems, Applications and Products in Data Processing (SAP) system. Other technical barriers included the need for high-precision prototype components, which required waiting for availability of the existing compressor line; and the limited availability of testing laboratories in India, addressed through in-house accredited testing and external validation. Project results are free from third-party restrictions and can be replicated by other AC manufacturers in India and the region. BEE participated in the project's Advisory Committee, and the results could serve as a benchmark in future ISEER revisions.

Funds approved and disbursed

77. Of the US $1,853,795 approved for this project, the full amount including committed funds, was reported as disbursed, as shown in table 3. Committed amounts will be disbursed once the agency's upgraded financial system is functional. Godrej provided US $5,143,000 as co-financing.

Table 3. Funds approved and disbursed by line item (US $)

Line item	Funds approved (US $)	Funds disbursed* (US $)	Disbursement rate (%)	Balance (US $)
1.1 R-290 rotary compressor design and development, and pilot production	1,318,795	1,318,795	100	0
1.2 Design and development of microchannel heat exchangers	110,000	110,000	100	0
1.3 Component integration and optimization of room ACs	250,000	250,000	100	0
1.4 General (technical assistance including risk assessment)	175,000	175,000	100	0
Total	**1,853,795**	**1,853,795**	**100**	**0**

* Including committed funds: the report does not separate actual disbursements from commitments.

Secretariat's comments

Legal framework

78. The Secretariat questioned how the policies and regulations planned under the KIP would help in promoting sale of R-290-based ACs. The Government of Germany explained that the Government of India reaffirmed its commitment under decision 93/90(b)(iv)(a) to design additional policy measures to promote ACs using R-290 and other low-GWP technologies during the preparation of stage I of the KIP. In line with established national procedure, specific policy instruments and regulatory measures would be developed and are subject to comprehensive inter-ministerial and stakeholder consultations and therefore are not yet finalized.

79. The Government of Germany further reported that, in line with decision 93/90, the preparatory studies are currently examining four key areas: (i) safety standards and codes, including support for appropriate charge limits for flammable (A3) refrigerants, and considering the processes involved in framing and notifying standards by the BIS, efforts will be made to operationalize these standards soon; (ii) synergy with energy efficiency, including coordination with BEE to ensure energy efficiency ratings appropriately recognize low-GWP technologies; (iii) strengthening of the servicing sector and technician training; and (iv) market enabling interventions that include awareness processes to encourage consumer and institutional uptake of low-GWP solutions. The cumulative impact of establishing this supportive framework, once finalized and implemented, is expected to help address market and technical barriers, facilitate investments for domestic manufacturers transitioning to natural refrigerants and support safe installation and servicing of the equipment.

Volume of refrigerant

80. In terms of volume of R-290 expected to be placed in the market, the Government of Germany explained that Godrej plans to produce a cumulative 5 million R-290 split units over the five-year period beginning in 2027, consisting of 3.5 million units of 1 TR and 1.5 million units of 1.5 TR. Further, R-290-based compressors manufactured by Godrej would be used primarily in-house and may also be supplied to other manufacturers in India and abroad. Though the current costs of R-290-based compressors are higher than competing similar capacity compressors, the costs are expected to come down in the long run through higher volumes of manufacturing, advanced materials, inverter optimization and increased local procurement of components.

Technical challenges

81. On resolution of supply chain challenges, the Government of Germany explained that originally Godrej relied on imported R-290 compressors. Over time, external compressor manufacturers deprioritised or discontinued R-290 compressor manufacturing and shifted their capacity towards high-volume HFC/HFO-based compressors. This project eliminated Godrej's dependence on such supply chain uncertainties. With higher manufactured volumes of R-290-based compressors, particularly high-efficiency variable-speed inverter models required to meet tightening national minimum energy performance standards (MEPS), the costs of these compressors are expected to fall and would make the product competitive in the market. Further, Godrej has a distribution and service network, with about 15,000 technicians trained in installation, servicing and maintenance of hydrocarbon-based equipment, and this network would support safe adoption of R-290-based ACs.

82. Regarding specific technical challenges relating to compressor components and consumables during project implementation, the Government of Germany confirmed that there were some challenges in the optimization of some components owing to the thermodynamic and physical properties of R-290, including suction accumulator design, achievement of high-precision tolerances, and lubricant solubility and viscosity management. These challenges were overcome through Godrej's internal product development and the

efforts made to modify the manufacturing facility, including use of dedicated tools for critical internal parts and the selection of high-viscosity synthetic lubricants formulated for hydrocarbon refrigerants.

83. On the MCHX and cost aspects, the Government of Germany reported that the MCHX has a 20 to 30 per cent lower material cost than copper-tube heat exchangers but requires higher initial capital investment (for controlled atmosphere brazing and helium leak testing), it is more difficult to repair in the field and needs anti-corrosion coating in coastal and polluted environments. R-290 compressors currently cost about 25 to 30 per cent more than the equivalent HFC-32 compressors; however, this premium is expected to narrow to 5 to 10 per cent with higher volumes, localisation of components and design optimization. The Government of Germany explained that in order to overcome the high capital intensity of establishing the R-290 compressor pilot line and associated product related research and development, Godrej provided total co-financing of US $5,694,300 (comprising US $5,143,000 in cash co-financing and US $551,300 in-kind co-financing), representing 75.4 per cent of the total project cost of US $7,548,095 approved under decision 93/90 (alongside Multilateral Fund support of US $1,853,795).

84. In terms of safety, the Government of Germany reported that the lifetime flammability risk assessment of the R-290 ACs using leak simulation tests, computational fluid dynamics and a quantitative risk model in accordance with applicable local laws is being conducted and is expected to be finalized in 2027. The Secretariat also notes that Godrej has experience in sales, installation and maintenance of R-290-based ACs and this will further strengthen safe adoption of this technology.

85. The Government of Germany further confirmed that the Government of India would comply with the conditions of decision 93/90 (b). The technical development activities under the pilot demonstration project were finalized by 31 December 2025, and the comprehensive project completion report was submitted within the six-month period following project completion.

Recommendation

86. The Executive Committee may wish to note the report on 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. Co. Ltd., for use in the manufacture of room air conditioners in the context of HFC phase-down for India contained in document UNEP/OzL.Pro/ExCom/99/19.

Annex I

TEXT TO BE INCLUDED IN THE UPDATED AGREEMENT BETWEEN THE GOVERNMENT OF VIET NAM AND THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE REDUCTION IN CONSUMPTION OF HYDROFLUOROCARBONS IN ACCORDANCE WITH STAGE I OF THE KIGALI HFC IMPLEMENTATION PLAN

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

9. The Country agrees to assume overall responsibility for the management and implementation of this Agreement and of all activities undertaken by it or on its behalf to fulfil the obligations under this Agreement. The World Bank has agreed to be the lead implementing agency (the "Lead IA"), and UNEP **and UNIDO have** agreed to be the cooperating implementing agenc**ies** (the "Cooperating **IAs**") under the lead of the Lead IA in respect of the Country's activities under this Agreement. The Country agrees to evaluations, which might be carried out under the evaluation work programme of the Multilateral Fund or under the evaluation programme of the Lead IA and/or the Cooperating **IAs** taking part in this Agreement

10. The Lead IA will be responsible for ensuring coordinated planning, implementation and reporting of all activities under this Agreement, including but not limited to the independent verification as per subparagraph 5(b). The Cooperating **IAs** will support the Lead IA by implementing the Plan under the overall coordination of the Lead IA. The roles of the Lead IA and the Cooperating **IAs** are contained in Appendix 6-A and Appendix 6-B, respectively. The Executive Committee agrees, in principle, to provide the Lead IA and the Cooperating **IAs** with the fees set out in rows 2.2, 2.4 **and 2.6** of Appendix 2-A.

17. **This updated Agreement supersedes the Agreement reached between the Government of Viet Nam and the Executive Committee at the 98th meeting of the Executive Committee.**

APPENDIX 2-A: THE TARGETS, AND FUNDING

Row	Particulars		2023	2024	2025	2026	2027	2028	2029	Total
1.1	Montreal Protocol reduction schedule of Annex F substances	%	n/a	freeze	freeze	freeze	freeze	freeze	10	n/a
		CO_2-eq tonnes	n/a	13,991,360	13,991,360	13,991,360	13,991,360	13,991,360	12,592,224	n/a
1.2	Maximum allowable total consumption of Annex F substances	Reduction in %	n/a	0.0	0.0	0.0	0.0	0.0	10.0	n/a
		CO_2-eq tonnes	n/a	13,991,360	13,991,360	13,991,360	13,991,360	13,991,360	12,592,224	n/a
2.1	Lead IA (World Bank) agreed funding (US $)		**1,323,572**	0	0	**1,132,877**	0	0	522,204	**2,978,653**
2.2	Support costs for Lead IA (US $)		**92,650**	0	0	**79,301**	0	0	36,554	**208,505**
2.3	Cooperating IA (UNEP) agreed funding (US $)		461,696	0	0	440,301	0	0	155,983	1,057,980
2.4	Support costs for Cooperating IA (UNEP) (US $)		55,150	0	0	52,595	0	0	18,633	126,378
2.5	**Cooperating IA (UNIDO) agreed funding (US $)**		**234,220**	**0**	**0**	**380,310**	**0**	**0**	**0**	**614,530**
2.6	**Support costs for Cooperating IA (UNIDO) (US $)**		**16,395**	**0**	**0**	**26,622**	**0**	**0**	**0**	**43,017**
3.1	Total agreed funding (US $)		2,019,488	0	0	1,953,488	0	0	678,187	4,651,163
3.2	Total support costs (US $)		164,195	0	0	158,518	0	0	55,187	377,900
3.3	Total agreed costs (US $)		2,183,683	0	0	2,112,006	0	0	733,374	5,029,063

Row	Particulars	2023	2024	2025	2026	2027	2028	2029	Total
4.1.1	Deductions of HFCs under this Agreement (CO_2-eq tonnes)								1,438,128
4.1.2	Deductions of HFCs from previously approved projects (CO_2-eq tonnes)								0
4.1.3	Remaining eligible consumption for HFCs (CO_2-eq tonnes)								TBD

FINAL REPORT ON 91/65 PROJECTS

1. BACKGROUND

Country: India

Project title: Design and development of a pilot-scale energy-efficient rotary compressor along with microchannel heat exchanger compatible with R-290 technology at Godrej & Boyce Mfg. Co. Ltd

Project objectives:

The objective of this project is to develop R-290 rotary compressors and their pilot production at Godrej & Boyce Mfg. Co. Ltd to enable improvement in energy efficiency, leading towards reduction of the production of R-32 based room air conditioners by the enterprise, thus contributing towards HFC phase-down. This includes:

• Redesign an energy-efficient R-290 compressor for five air-conditioning models for pilot production

• Redesign/Development of microchannel heat exchangers to optimize energy efficiency in resulting air-conditioning products

• Component integration and optimization of R-290 room air conditioners including performance and energy-efficiency testing

Project content: Research and Development ☐ Technical assistance

MEPS developed (yes/no): No (India has its own minimum energy performance standards set by Bureau of Energy Efficiency for variable speed room air conditioners)

Energy efficiency gains quantified (yes/no): Assumptions-based calculations since the project is an R&D project with setting up pilot production.

ExCom decision no.: 93/90 Date (month/year): December 2023

Lead agency: Germany Cooperating agency (if any):

Funds approved (US $): 1.853.795 Funds disbursed (US $):

Co-finance[1] (US $) In cash: US $ 5.143.000 In kind: US $ ----------

2. PILOT DEMONSTRATION - APPLICATION, TECHNOLOGY, AND SECTOR *(AS APPLICABLE)*

Application

PSplit A/C ☐ Commercial A/C ☐ Chillers

☐Commercial ref.[2] ☐ Large commercial ref.[3] ☐ Industrial ref.

Technology

☐ Replacement ☐ Retrofitting (it is an R&D project)

P R-290 ☐ CO_2 ☐ Ammonia ☐ HFC/HFO ------ ☐ Other ----------

☐ Energy measuring and monitoring devices ☐ Advanced platform and digital tools

Sector

☐ Public x P Private Sector[4]: -Air-Conditioning-

☐ No. of beneficiaries ---------- ☐ No. of units/systems ----------

Baseline Tecnology ☐ R-410A ☐ R-404A ☐ R-507 ------- P Other --R 32

Baseline capacity: Godrej produced 0.5 million units including R32 and R290 air conditioners with imported compressors. R 290 amounting 5-10% of the production volume (during 2021 – 2023)

[1] In cash includes purchase of equipment or tools or setting infrastructure, while in-kind is best estimated of support services
[2] Including standalone units, condensing units and monoblocks
[3] Including centralized systems and large cold stores
[4] Hotels, health, supermarkets retail, entertainment, public buildings, etc.

Charge in baseline equipment:

- Refrigerant quantities for R32 (25 models of variable speed room air conditioners covering cooling capacity 3.45 KW to 6.35 KW covering 3, 4, 5-star efficiency class) 370 grams to 1090 grams
- Refrigerant quantities for R290 air conditioner 3400 W capacity is 360 grams

Pilot Summary *(Include brief description about project, technology, and expected outcomes)*

The project aims to design and develop on a pilot scale energy-efficient rotary compressors along with microchannel heat exchangers compatible with R-290 technology and to optimize system design for the manufacturing of room ACs at Godrej & Boyce Mfg Co. Ltd.

The successful completion of this pilot project will address the challenge of availability and accessibility of cost effective and highly efficient R-290 compressors and microchannel heat exchangers by advancing domestic manufacturing of these components, resulting in availability of energy-efficient and low-GWP refrigerant-based ACs in India.

The pilot project will contribute towards HFC phase-down as the enterprise has committed to reduce their production of ACs using HFC-32 by up to 70 per cent by 2028.

The pilot project was also expected to increase the energy efficiency rating of R-290-based ACs, ranging from 1 TR to 2 TR, from its current 5-star rating to an ISEER of 6.61 by 2028, consistent with the improvements in energy efficiency levels required by the Bureau of Energy Efficiency (BEE), Government of India. It is estimated that these improvements in energy efficiency will avoid 600,000 CO2-eq tonnes over the life of the equipment, based on the manufacturing capacity of the enterprise.

3. TECHNICAL ASSISTANCE ACTIVITIES

☐Institutional coordination	☐ MEPS development/update	☐ MEPS enforcement
☐Training	☐ Study and assessment	☐ Outreach and awareness
☐Energy guidelines	☐ Energy auditing	P Other –R&D

4. MEPS

The applicable MEPS for room air-conditioners in India is defined by Bureau of Energy Efficiency (BEE) through the star labelling programme. At present all room air conditioners fall under mandatory compliance standards.
Official metric used by India is Indian Seasonal Energy Efficiency (ISEER) - https://beestarlabel.com/. The minimum energy performance standard for India is ISEER 3.5 corresponding to 1-star split room air conditioners.

As per BEE the ISEER values for different star label for variable speed split room air conditioners are as mentioned below.

(From 1st January 2028 to 31st December 2029) https://beestarlabel.com/Content/Notification/RAC/IAC_Notification_SO_3984_E_dated_28th_August_2025.pdf		
Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star Level	Minimum	Maximum
1 star	3.80	4.29
2 star	4.30	4.69
3 star	4.70	5.19
4 star	5.20	5.79
5 star	5.80	

(From 1st January 2026 to 31st December 2028) https://beestarlabel.com/Content/Notification/RAC/IAC_Notification_SO_4634_E_dated_16th_July_2024.pdf		
Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star Level	Minimum	Maximum
1 star	3.5	3.79
2 star	3.8	4.29
3 star	4.3	4.99
4 star	5.0	5.59
5 star	5.6	

5. ENERGY SAVINGS *(ONLY FOR DEMONSTRATION PROJECTS) - *IT IS A PILOT PROJECT, MEANS "ONCE THE PILOT COMPRESSOR DEVELOPMENT IS SUCCESSFUL, COMPRESSOR PRODUCTION WILL BE RAMPED-UP TO FULL-SCALE PRODUCTION, WHICH IS EXPECTED TO TAKE AN ADDITIONAL TWO TO THREE YEARS POST-PILOT. ONCE THIS IS ACHIEVED THE ENTERPRISE WILL GRADUALLY INCREASE PRODUCTION OF R-290 ACS CONSIDERING MARKET DEMAND.*

Model		Baseline		R290 pilot	
Capacity (nominal)	kW	3.5	5.0	3.5	5.0
Refrigerant		HFC-32		HC-290	
ISEER of 5-star AC	W/W	5.0	5.0	5.6	5.6
Electrical power per unit	kW	0.70	1.00	0.63	0.89
Average daily operating hours (assumed an average)	hours	5.0	5.0	5.0	5.0
Annual operating hours	hours	1,825	1,825	1,825	1,825
Annual energy consumption per unit	kWh	1,278	1,825	1,141	1,629
Number of 5-star units installed (assumption)	-	3,50,000	1,50,000	3,50,000	1,50,000
Total energy consumption = annual energy consumption X number of units installed Please note since it is a pilot project sale is not yet in place; so, the numbers of units are assumed as per Godrej past sales figures	kWh	44,71,25,000	27,37,50,000	39,92,18,750	24,44,19,643
Energy saving in comparison to the baseline capacity of Godrej	kWh			4,79,06,250	2,93,30,357
Energy reduction compared to baseline	-			11%	11%
Emissions factor as per IEA (2022)	kgCO2-eq/kWh	0.85	0.85	0.85	0.85
Energy-related emissions	kgCO2-eq	38,00,56,250	23,26,87,500	33,93,35,938	20,77,56,696

Energy-related emissions reduction	kgCO2-eq			4,07,20,313	2,49,30,804
Energy-related emissions reduction achieved	-			11%	11%

6. Results and Outcomes

Please elaborate on the results achieved and impact generated for each of the planned activities and provide a brief explanation for not meeting the intended initial indicators. Please use categories as included in sections 1 & 2 above.
(For funds approved and disbursed, please merge the cells when detailed funds are not included in the approved proposal)
Note: Refer annexure for more information regarding each line item

Activity / Particulars		Planned outcomes[5]	Actual outcomes	Funds approved (US $)	Funds disbursed (US $)
1. **Activity: Design and development of a pilot scale energy efficient rotary compressor along with microchannel heat exchanger compatible to R-290 technology at Godrej & Boyce Mfg Ltd, for use in manufacturing of room air-conditioners**					
1.1	R-290 rotary compressor design and development, and pilot production	• Design and development of new rotary compressors to achieve the level of energy efficiency needed to produce high efficiency ACs based on R-290. • Development of prototype based on product design simulations. • Testing the thermal performance, • Field trails and finalising the specifications for different models	• Completed. • Improvement in Co-efficient of Performance (COP) of the compressor by about 40%. • Performance testing carried out by an accredited certification laboratory of the Bureau of Energy Efficiency (BEE). • Licence granted by Bureau of Indian Standards (BIS) for production and sale of R-290 based air conditioners (units including compressors) under the IS 1391 Part 2:2023	1,318,795	1,318,795 (incl. committed funds)
1.2	Design and development of microchannel heat exchangers	Develop an optimised design of microchannel heat exchangers for the condensers and evaporators. compatible with R-290 compressors.	• Completed • Reduction in refrigerant charge of 50-100 gms and 1-2 kg of metal compared to conventional fin-tubed heat exchangers, resulting in reduction of risks relating to flammability and safety	110,000	110,000 (incl. committed funds)

1.3	Component integration and optimisation of room ACs	• Integration of the new compressors and optimised microchannel heat exchangers into the new R-290 room for air-conditioning products to improve energy efficiency. • Test for energy efficiency performance according to BEE test standards and compare with the most energy-efficient products with the same coefficient of performance (COP) in the market. • Based on the new design with the R-290 rotary compressors, demonstrate the enhancement in the energy efficiency	• Completed • Extensive testing carried out for performance and efficiency by the accredited laboratories of BEE. • Achieved ISEER of 5.73 for 3.5kW model and 5.78 for 5 kW model respectively, against the existing ISEER of 5.6 for the current 5-star R-290 based split AC models, valid till December 2028.	250,000	(250,000) incl. committed funds)
1.4	General	Technical assistance including risk assessment	• Carried out detailed risk assessment considering varied climatic conditions across the country • Technical support and advise during whole project duration by external expert	175,000	(175,000) incl. committed funds)

Co-financing from Godrej of 5,1 Mio. USD has been committed to the project.

7. IMPLEMENTATION DELAYS *(AS APPLICABLE)*

Select from the list of causes of delays and describe the causes of implementation delays and actions taken:

Cause of delay	Description of cause of delay	Action taken
Governmental delays (structure changes of NOU, ministry and/or institution, coordination with energy or other related authorities)		
Project design, preparation and implementation process including delays in contracting process		
Procurement delay (Enterprise and/or supplier delays)	Due to the current global situation, two machines procured under the grant agreement have longer delivery periods, as anticipated.	Until new equipment will arrive, Godrej continues working with existing equipment and has been able to technically complete the project.
Policy and regulatory framework (e.g., relevant legislation, etc.)		
Exogenous factors (beyond the control of the implementers, such as natural disasters, political instability, pandemics, etc.)		
Availability of alternatives, components or equipment		

Funding process (securing co-finance or disbursement procedural issues)		
Other (describe ----------)	Globally GIZ is shifting to S4/HANA an upgraded SAP system; The internal system is currently disrupted, which leads to delays in financial and administrative procedures	All commitments will be disbursed once the upgraded SAP system is functional.

8. BARRIERS AND CHALLENGES

Please provide the main barriers/challenges faced during project implementation under the categories listed below and describe the actions taken to overcome these challenges, the results achieved, and the likelihood of encountering the same barrier/challenge moving forward.

Barriers/Challenges	Action items and results
1. Technology and technical issues	
The prototype components must be manufactured with high precision. As a result, the assembly cannot be routinely modified to switch between R32 and R290 production, as repeated handling and reconfiguration can lead to internal wear and increased dimensional errors. Therefore, to maintain accuracy, the production team had to wait until the existing compressor line was available to manufacture R290 prototypes before finalizing the design.	Due to the availability of in-house National Accreditation Board for Testing and Calibration Laboratories (NABL)-accredited facilities, preliminary testing was conducted internally, which helped accelerate validation and partially offset the impact on overall timelines.
2. Institutional coordination	
The limited availability of laboratories in India for testing and experimentation of newly developed R290 compressors necessitates reliance on a single facility, which can slow down iterative R&D processes	- Prototypes are developed internally to achieve target efficiency levels, followed by external validation testing. - Independent, third-party performance and reliability testing has been outsourced to a university in Spain to ensure unbiased assessment.
3. Policy and regulations including MEPS enforcement	
4. Cost and co-financing issues	
	-
	-
5. Logistical and administrative issues	
	-

9. OTHERS

1. Details about regional MEPS (if applicable) - *(Summary of maximum ½ page)*
2. Replicability opportunities by the country and/or the bilateral/implementing agency to advance the results of the project to that same or other sector in the same country or within the region - *(Summary in bullets)*

- As per the project agreement, Godrej & Boyce Mfg. Co. Ltd. will ensure that all work results shared with the Ozoncell, MoEFCC and GIZ during implementation are free from third-party copyrights or usage restrictions that could limit their broader application.
- The project is designed so that its outputs (technical knowledge, and lessons learned) can be used for public-benefit purposes, enabling wider dissemination and uptake.
- This approach allows replication by other manufacturers and stakeholders in the RAC sector within India.
- The generated know-how can be transferred to similar market contexts in the region to support low-GWP technology adoption and HFC phase-down efforts.
- Open usability of results facilitates integration into training, standards development, and future bilateral or multilateral initiatives.

3. How the project contributed and connected to the KIP's activities - *(Summary in bullets)*
   - The KIP has not yet been submitted by India.
   - The project aims to reduce HFC consumption in the RAC sector by enabling large-scale potential replacement of HFC-based compressors with R290. This project will accelerate phase-down of HFC.
   - Strengthening domestic manufacturing capacity for low-GWP alternatives by developing R290 rotary compressor production in India
   - Demonstration and market transformation effect as project serves as a "role model" towards adopting scalable models for wider replication within the Indian RAC industry
   - Support's India's HFC phase-down strategy under Kigali Amendment by shifting to R290 in the room air-conditioning sector
4. Possible future actions to strengthen energy efficiency while phasing down HFCs - *(3-4 main action points)*
   - Close cooperation with the Bureau of Energy Efficiency, which was involved in the project implementation as part of the Advisory Committee, constituted for overseeing the implementation of the project
   - ISEER for Rooms ACs is revised periodically, which is finalised in consultation with the AC manufacturers. This project having demonstrated higher ISEER than the existing 5-star ACs, can be used as a benchmark finalising ISEER for Room ACs in future.

10. ANNEXURE – EXPANSION TO 6. RESULTS AND OUTCOMES

Design and development of a pilot scale energy efficient rotary compressor along with microchannel heat exchanger compatible to R-290 technology at Godrej & Boyce Mfg Ltd, for use in manufacturing of room air-conditioners

1.1 Compressor design and development

The compressor design and development has essentially been completed, although there will be a continual process of refinement and improvement over the forthcoming years.

Over the course of the project, there have been several prototype iterations. These iterations involved refinements to positioning of internal components and openings, changes to constructional tolerances, modifications to suction accumulator (suction muffler), production of compressor parts using the new (dedicated) tooling and so on. Throughout this process, the efficiency of the compressor (coefficient of performance, COP) increased by about 40%, up to 3.4 (based on rating conditions). The rated efficiency is within ±2% of the leading R290 rotary compressor model, which was used as the benchmark throughout the project. Compressor volumetric efficiency was also raised to about 93%. Testing shows that a wide range of cooling capacities are achieved from low to high compressor speeds, whilst maintaining the high COP, within ±8% across the range from 1600 to 5500 rpm. Similarly, volumetric efficiency varies only by ±4% across the speed range. At 1600 rpm, the nominal cooling capacity is 1.4 kW and 5.2 kW at 5500 rpm.

The compressor was subject to independent performance testing by a certification laboratory, according to the applicable Indian national standard, IS 10617:2018+ A1: 2020 "Hermetic Compressors – Specification", which provides design and construction requirements as well as those for performance testing. The test report confirms the rated efficiency (COP) and nominal rated thermal capacity, as well as compliance to the design and construction requirements according to IS 10617:2018+ A1: 2020.

Because of this, the BIS licence for implementation of the compressors and subsequent sale of AC units has now been granted to Godrej.

1.2 MCHX design and development

Design and development activities for the microchannel heat exchanger (MCHX), intended for use as the condenser in the outdoor unit (ODU) for the air conditioner, was carried out by the MCHX manufacturer. Following internal development procedures within the MCHX producer company, several alternate designs were provided to Godrej for integration into the ODU and subsequent testing. The preferred option, primarily that which offered highest system COP, was then selected for the AC. Moreover, the design was selected to minimise the likelihood of fouling and be subject to corrosion over its lifetime – specifically, by inclusion of a special surface treatment – so as to ensure as much as possible, retention of high efficiency across its working life.

Use of the MCHX yields multiple benefits for the R290 split AC models. In addition to enabling a high energy efficiency, there are benefits in terms of charge reduction relative to a conventional finned-tube HX, an overall reduction on unit mass and of course material cost on account of the use of aluminium in favour of copper. Reduction in refrigerant charge is in the order of 50 – 100 g of R290 and 1 – 2 kg of metals. This can have subsequent benefits in terms of flammability risk reduction and general safety aspects.

1.3 AC design and development

Previous R290 AC designs were used as a baseline for adoption of the new compressor and MCHX. Considerations were given to additional system components, including condenser fan blades and motor, circuit piping, indoor unit fan, motor and finned-tube evaporator, (electronic) expansion device and general control logic. Whilst there are numerous options, for improving energy efficiency of the AC, assessment, selection and applications of measures has to be balanced against practical factors such as reliability, technical maturity and of course, cost.

Performance and efficiency have been confirmed with external testing at Godrej accredited laboratories and approved by an external auditor National Accreditation Board (NABL); final results are available on BEE (link: Search And Compare – Model number HIC 18K5GI and HIC 12X5GI) and BIS portals (https://www.manakonline.in/MANAK/ApplicationLicenceRelatedrpt), license number is **7500224808 for IS standard IS 1391: Part2:2023**. To provide further confidence in the results, the models are also being tested by an independent third-party laboratory. Measured seasonal efficiency (ISEER) of the certified 3.5 kW model is 5.73 and 5.78 for the 5.0 kW model.[6] This is a 23-25% increase over the previous 5-star R290 split AC models. It is also worth noting that the ISEER of the new models is marginally (3.7%) below the highest reported split AC

[6] By comparison the equivalent models tested and certified in 2021/2022, just prior to the proposal submission, were 4.57 and 4.70 for the 3.5 kW and 5.0 kW models, respectively.

model available in India (Abhyankar et al., 2025[7]). The ISEER for 5-star energy level is currently set to 5.6 and is reported by BEE to remain until 2028[8]. The performance results show that this target is at par.[9]

In conclusion, the new R290 split AC models, both 3.5 kW and 5.0 kW, using the improved MCHX design and the new Godrej compressor – as well as other improvements to the refrigerating system – is shown to exceed the 5-star energy label until 2028, as well as the compressor complying with the national compressor standard, IS 10617.

Following development of the R290 ACs, several hundred units (in the first batch 200 ACs) with the new compressors were put into field trials and another 200 units are currently being deployed. Initially 3.5 kW models and subsequently 5.0 kW models, have been and continue to be deployed in residences for field trials. The response of householders so far is positive. For these field trials, there is no physical monitoring, but there is a bimonthly customer satisfaction consultation over a period of one year, along with technician checks if necessary; the purpose is to confirm real life long-term reliability of the ACs. The units have been installed across various Indian cities (Mumbai, Jaipur, Delhi, Kolkata and Chennai). These locations were specifically selected so that the widest range of climate conditions (high and low temperature extremes, high and low humidity) as well as poor reliability of mains power supplies. The second batch is similarly being distributed across the same (city) locations.

Apart from the testing and certification described above, third party testing for compressor performance; reliability, and lifetime is ongoing, done through the Institute for Energy Engineering at the Universidad Politécnica de Valencia, Spain. The objective of this activity is to identify potential design and energy efficiency improvements, ensuring readiness for future regulatory developments, particularly if higher ISEER standards are introduced by BEE beyond 2028. Results will be taken into account by Godrej for further improvement in the future.

For purposes of completion, it may also be stated that the R&D team at Godrej are involved in continuous improvement of the AC energy efficiency, along with cost optimisation and refrigerant charge reduction. Along the project, numerous approaches were identified, investigated and considered and may be subject to future implementation.

1.4 General

The lifetime flammability risk assessment of the completed split AC is being finalized. Observations of AC production facilities, transportation, warehouse and dealer storage facilities and operations have been carried out. In addition, inspections and interviews during normal AC installation, maintenance, repair and dismantling activities have been carried out. Historical system leakage data for AC system has been obtained; Leak simulation testing and concentration measurements are in progress. Resulting data will be fed into a quantitative risk model (QRA) (Colbourne and Suen, 2024[10]; Colbourne, 2011[11]) for calculation of ignition frequencies and

[7] Abhyankar, N., Dominguez, J., Shah, N., Jain, N., Phadke, P. 2025. Accelerating room air conditioner efficiency in India: Grid, economic and policy implications through to 2035. The Electricity Journal, vol. 38, no. 107493

[8] https://beestarlabel.com/Content/Notification/RAC/IAC_Notification_SO_4634_E_dated_16th_July_2024.pdf

[9] It is noted that in the original proposal to the MLF, the target ISEER was to be 6.61, under the assumption 5-star ISEER by BEE for 2028. However, since the approval of the project proposal, the BEE opted to retain the 5-star ISEER level at 5.6; levels to be planned for post 2029 is 5.8 which the R290 compressors have reached. Since pursuing the original value of 6.61 would incur additional costs and thus render the AC unit uncompetitive, this step will be held in abeyance until BEE issue formal notification of what a future ISEER level will be.

[10] Colbourne D., Suen K. O. 2004. Appraising the flammability hazards of hydrocarbon refrigerants using quantitative risk assessment model. Part I. Modelling approach. Int. J. Refrig. 2004.11

[11] Colbourne D. 2011. Risk analysis of flammable refrigerant handling during service and maintenance activities. Proc. 23rd IIR International Congress of Refrigeration: Prague, Czech Republic

quantification of event severities. These calculations will yield lifetime risk values, which will be used to identify possible modifications to the AC, changes to the supply infrastructure/procedures and technical behavioural aspects or tools/equipment requirements, which should help reduce the flammability risk across the AC lifetime.

In general, difference in risk across the different Indian climatic conditions are minimal (for instance, humidity and temperature have negligible impact on flammability risk, compared to numerous other factors). However, proximity to coastal conditions (saline atmosphere) tends to have a notable effect on leak frequency; to leakage data is still being compiled in order to help quantify this parameter. Perhaps one of the most important elements of the flammability risk assessment relates to technician competence and behaviour and this is accounted for by employing a series of technician characteristics, ranging from “informal, poor competence” to “near-perfect, highly competent”. This enables evaluation of certain technician traits, such as competence, availability of tools and equipment, etc. and thus enables determination of particular actions that may lead to significant increase/reduction in risk. In this regard, preliminary outputs indicate importance of technician training, specifically for flammable refrigerants, attention to procedures when accessing (breaking into) the system for repairs, whilst ensuring prior removal of refrigerant and availability of certain tools.
The Computation Fluid Dynamics (CFD) model will run for a few weeks after the leak simulation test currently underway in Vikhroli, Mumbai. Then the output of CFD models needs to be put into the QRA model to run different real-life India specific scenarios to access the potential risk.