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FINAL REPORT ON THE EVALUATION OF HCFC PHASE-OUT PROJECTS IN THE REFRIGERATION AND AIR-CONDITIONING MANUFACTURING SECTOR

Background

1. The evaluation for the phasing-out of HCFCs in the refrigeration and air-conditioning (RAC) manufacturing sector was approved as part of the monitoring and evaluation work programme for 2015 at the 73rd meeting (decision 73/7). The terms of reference for the desk study on the HCFC phase-out projects in the RAC manufacturing sector[1] was approved at the 74th meeting (decision 74/8(b)).

2. The desk study included an in-depth review of the existing documentation as well as the information gathered from interviews and discussions with members of the Secretariat, bilateral and implementing agencies (IAs). The findings from the desk study were presented to the 75th meeting[2]. Several issues were raised by the Executive Committee *inter alia* the lack of standards and regulations on the use of RAC equipment using flammable refrigerants; challenges with regard to technology, and an evolving landscape for alternatives; and the sustainability of the conversion of the RAC manufacturing projects. It was also pointed out that the RAC sector would become the largest HCFC-manufacturing sector in Article 5 countries, and would represent an increasingly large part of funding requests under stage II of HPMPs. It was therefore important for the second phase of the evaluation to take this into account. Further to the discussion, the Executive Committee *inter alia* invited bilateral and IAs to take into account, when appropriate, the findings and recommendations of the desk study on the evaluation of HCFC phase out projects in the RAC manufacturing sector in the design and implementation of projects in that sector (decision 75/7(b)).

3. The terms of reference for phase two of the evaluation of HCFC phase-out projects in the RAC manufacturing sector were approved as part of the monitoring and evaluation work programme for 2016 at the 75th meeting (decision 75/9(b)). The terms of reference are contained in Annex I to the present document.

[1] The terms of reference could be found in document UNEP/OzL.Pro/ExCom/74/10/Corr.1.
[2] UNEP/OzL.Pro/ExCom/75/9.

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.

4. The Senior Monitoring and Evaluation Officer (SMEO) is submitting the Final report on the evaluation of HCFC phase-out projects in the RAC manufacturing sector in response to decision 75/9(b).

Methodology

5. The SMEO identified technical experts with the required expertise and know-how on the RAC sector to address all the elements in the terms of reference. The experts were provided with the RAC project proposals and other documents available at the Secretariat including the report of the desk study on the HCFC phase-out projects in the RAC manufacturing sector. The report included a first set of conclusions and identified the sample of countries to be visited for further data collection.

6. Further to extensive discussions with the Secretariat and the relevant IAs, the SMEO decided to undertake the field missions to the following eight Article countries: Argentina, China, Indonesia, the Islamic Republic of Iran, Jordan, Lebanon, Serbia and Thailand. After further consultations and with the representatives from the Governments of the countries concerned, field visits were conducted between March and September 2016. The list of RAC enterprises visited in each country and the technologies selected by each enterprise are listed in Annex II to the present report.

7. For the field visits, the SMEO and her technical experts were accompanied by representatives of the IAs concerned. During the missions, extensive discussions were held with NOU staff and stakeholders in the Government and in the industry, and RAC enterprises included in the projects were visited. The SMEO expressed the appreciation of the representatives from the Governments of Argentina, China, Indonesia, the Islamic Republic of Iran, Jordan, Lebanon, Serbia and Thailand for the assistance and support provided during the evaluation process; as well as UNDP, UNIDO and the World Bank for assisting in the organization and successful conclusions of the field visits.

8. After the conclusion of the field visits, the independent consultants drafted individual country reports based on the analyses of information gathered at the enterprise level, from interviews and discussions with National Ozone Officers (NOO), enterprise managers and Government officials and the representatives of the relevant IAs. The draft country reports were sent to the relevant countries and the IAs for their comments and observations. The SMEO also submitted the country reports for their review by the Secretariat through the Chief Officer. All the comments and observations received from all stakeholders at the country level and the relevant IAs, as well as from the Secretariat (through the Chief Officer[3]), were addressed by the SMEO with the assistance from the technical experts, and incorporated in the final country reports. The country study documents can be found on the Secretariat's website (restricted area for Executive Committee members as these documents are confidential and for restricted use).

9. The final report of the evaluation of HCFC phase-out projects in the RAC manufacturing sector is based on the findings of each country report as well as those contained in the previously prepared desk study. The report presents first key findings and conclusions, followed by detailed findings associated with each of the terms of reference of the study, and concludes with a recommendation.

Key findings and conclusions

10. It is important that the selection of alternative refrigerants and their operating systems be based on a thorough analysis that includes energy efficiency, environmental impacts, safety, economic considerations as well as social consequences. Enterprises should evaluate in detail the availability and/or limitations of equipment and quality refrigerants before deciding on a course of action for conversion.

[3] The Chief Officer organized several meetings between the SMEO and the staff of the Secretariat to discuss each of the eight country studies and the final report of the RAC manufacturing evaluation.

11. With the current state of flux with relation to RAC technologies, it is important for a technology awareness mechanism to be set up in every country, to inform manufacturers of the various technical advancements.

12. Economic as well as environmental sustainability can only be applied to conversion projects that had a successful completion and are presently producing equipment with the new technology. Unfortunately, few enterprises, despite completing their conversion and developing prototypes for HFC-32 are instead manufacturing high-GWP-based equipment. The reason being a lack of market demand and the servicing sector's reluctance to deal with flammable refrigerants. Those enterprises could anytime revert to manufacturing HFC-32 equipment if/when the market conditions allow it. There is a need for Government support through legislation, standards limiting GWP of refrigerants used in RAC applications, and awareness campaigns for a successful sustainability of projects.

13. Related to the above issues it is worth noting that enterprises in China are very large and if, for any reasons, a line is not producing, this can be compensated by increasing production of other lines (not converted by the Multilateral Fund (MLF)) which produce high-GWP equipment, so that the total production capacity of the enterprise is not much affected. In other countries, however, enterprises are much smaller and having part of their production capacity idle may put the financial viability of the enterprise at risk. As such, the need to temporarily manufacture high-GWP-based equipment may be understandable.

14. Installation of such equipment does not mean that the conversion can be considered successful. It is recommended that when such situation occurs, countries and IAs should report to the Executive Committee on the causes of this situation as well as the strategy to address them; it should indicate the steps the Government will take to enable the enterprises to start manufacturing equipment based on the agreed technology, as well as a timeline for when such manufacturing is expected to commence.

15. In some countries incremental operating costs (IOC) was paid even if the enterprise is not manufacturing the agreed technology. This approach is not acceptable and IOC cannot be used otherwise than initially planned. On the other hand, one country has developed an effective mechanism to use IOCs to encourage the uptake of HC-290 air-conditioners in the market. While the specifics may vary based on national circumstances, this approach should be emulated by other countries.

16. Thus, sustainability is still an issue with the introduction of particular HC-290 and HFC-32 technologies and equipment even when adequate size compressors are available. Enterprises which have converted to R-410A technologies by and large have assured markets, thereby assuring sustainability within existing controls and bans on HCFC-22 and HCFC-22-based products.

17. It is recommended to promote and support regional research institutions/centers in investigating the efficiency of various alternative refrigerants at high-ambient temperatures. It would be useful for countries to introduce licensing and import permits for all chemicals being used as refrigerants. For countries producing their own refrigerants (e.g., HC-290, R-600A, R-717 and CO_2), there should be mandatory reporting requirements for manufacturers of RAC equipment on a regular basis. This will allow for the NOU and the Government to monitor what technologies are in use and take any action that may be necessary.

18. Countries that opt for flammable, toxic and/or high-pressure refrigerants must have relevant mandatory standards in place. The country needs to build robust institutional mechanisms to ensure the proper awareness and enforcement of these standards. The standards should cover (as relevant) transportation, storage, and use of these refrigerants at both the manufacturing and servicing levels. Mandatory production line standards should also be developed. Regular inspections and certifications, and standardized testing should also be included under the standards.

19. More work needs to be done in most countries on national standards on safety in the transport, storage and handling of flammable refrigerants. Relevant safety standards at manufacturing and servicing levels are a must with the current and new refrigerants coming into market. However, all enterprises that opted to convert to HC-290 or HFC-32 have developed their own internal safety standards where the necessary and required safety systems in their production lines and/or testing facilities have been installed.

20. Servicing equipment using flammable refrigerants is a major issue that requires proper training of service technicians and awareness campaigns to promote the need for understanding risks associated with such practice. Certified training in the handling and servicing of flammable and toxic refrigerants should be mandatory. Training programmes for post-sales independent service technicians need to keep up to date with the technologies that are prevailing in the country. Availability of refrigerant and spare parts for post-sales servicing must be encouraged.

21. Energy efficiency standards should be made mandatory for RAC equipment, with labelling requirements and where possible incentives such as tax exemption should be given. All manufacturers considered energy efficiency during selection of their chosen technology. Several countries have energy efficiency labelling requirements, and also provide incentives/subsidies for appliances which meet a certain criteria of energy efficiency.

22. As air-conditioning products experience a reduction in capacity and energy efficiency as ambient temperate increases, the technology selected to replace HCFC-22 in high ambient temperature, while maintaining its condensing proprieties, is a critical issue. R-410A is not a recommended choice given its already high operating pressure and relatively low critical temperature (72 degrees Celsius). However, in the present market, HC-290 has a similar critical temperature (96.67 degrees Celsius) to the efficiently proven HCFC-22 making it therefore an idea choice for residential units, under the condition that the charge is limited to 300 kg and the proper safety devices are installed.

23. Capacity building activities related to updating information on technically and economically feasible alternative technologies that can be applied by local RAC manufacturers appear to vary from country to country. Various professional bodies and associations have been involved in this activity in the early stages of technology selection, but it is not clear whether there is continued support in this regard. It is recommended to improve the coordination at the regional level among various stakeholders in both public and private sector concerning policies related to energy efficiency and comparable alternatives. UNEP should collaborate with interested countries in harmonizing national/regional policies.

24. Relevant safety and energy standards need to be in place, including a mechanism for industry in each country to be made aware of the new technologies and the developments taking place, both nationally and internationally; and training of technicians in the servicing sector needs to take into account specific requirements for these new technologies as they are introduced.

Specific findings associated with each of the terms of reference of the study

25. This section of the documents presents the specific findings associated with the terms of reference of the study.

Policy, legal and regulatory frameworks

26. Seven out of the eight countries in the sample, the exception being Serbia, had enforceable licensing and quota systems in place at the time of the field visits. During implementation of Serbia's HPMP, priority was given to new regulation on ODS management, as well as on conditions for license issuance to import and export of such substances.

27. Several countries have banned or will be shortly banning, the import and/or manufacture and sale of HCFC-22-based air-conditioners, as summarized in Table 1.

Table 1. Status of ban of HCFCs and HCFC-based products per country visited

Country	Status of bans
Argentina	Purchase or import of HCFC-22 for production of domestic air-conditioning appliances prohibited as of 1 January 2013. Since 2013 manufacturing and assembly of domestic air-conditioning appliances containing HCFC-22 is prohibited. As of 30 September 2013 sale of domestic air-conditioning appliances containing HCFC-22 is prohibited. However, manufacturers in the duty-free zone of Argentina can manufacture for export, but are controlled by Customs and are required to comply with MLF regulations.
China	Import of HCFC-based RAC equipment is banned; and, new manufacturing facilities are banned from producing HCFC-based products.
Indonesia	Prohibited the use of HCFC-22 and HCFC-141b in RAC manufacturing and assembly sectors from 1 January 2015.
Islamic Republic of Iran	Since 2010 the creation of new HCFC-consuming industrial units as well as the expansion of capacity of such enterprises is prohibited.
Jordan	Ban on the use of HCFC-22 by manufacturers and on import of HCFC-22-based equipment effective 31 December 2016; and plans for a total ban of all HCFCs by 2022 for manufacturing only.
Lebanon	A ban on all imports of HCFC-22 except for servicing applications from 1 January 2025.
Serbia	The import of used HCFC-22 units is banned in Serbia. Import of new HCFC-22 units is still allowed but Government has plans to ban it in 2018.
Thailand	Regulations are presently being developed to ban the import of all HCFC-22-based RAC equipment with an anticipated implementation date before the end of 2016. Regulations have also been recently established banning the production of HCFC-22-based RAC equipment up to 50,000 BTU effective 1 January 2017.

28. Argentina, the Islamic Republic of Iran, Jordan and Thailand have introduced energy efficiency labelling requirements for air-conditioning equipment. In Argentina, the end of subsidies granted by the new Government led to an increase of electricity/energy prices and prompted many enterprises to use more energy efficient refrigerants and products. In Jordan, tax exemptions apply for products with energy efficiency of A and above and, effective on 31 December 2016, all air-conditioning appliances for sale in the domestic market must have energy efficiency ratings of no less than grade A, thus achieving the requirement of Executive Committee decision 65/40(d)(ii) and (iii).

National and international standards

29. In Argentina, the Islamic Republic of Iran, Jordan and Lebanon that opted to convert to R-410A, there are no national standard for the use of R-410A, but the manufacturing and servicing sectors follow international standards which have already been developed and globally adopted. The field missions did not find any evidence of inspections and certifications, and standardized testing at enterprise level in any of the countries. In Jordan, the Government has imposed higher energy efficiency standards for all new air-conditioning units than the ones presently on the market. Although there are no national standards in place for the use of high-pressure refrigerants, the countries manufacturers and servicing sector technicians have adopted internationally accepted practices such as ASHRAE 90.1[4].

30. China has developed and implemented three standards for the use of flammable refrigerants such as HC-290, R-600 or HFC-32 in the manufacturing and servicing sectors: mandatory standard limiting charge size for the use of flammable refrigerants in the room air-conditioning manufacturing process; non-mandatory standard for use of flammable refrigerants in the service sector for installation/ maintenance of small room air-conditioning units; and a standard for RAC (domestic) appliance sector.

[4] *ANSI/ASHRAE/IES Standard 90.1-2016 - Energy Standard for Buildings Except Low-Rise Residential Buildings.*

Standard for product safety for industrial and commercial refrigeration (ICR) and air-conditioning system (follows ISO5149) is still to be approved. Some non-mandatory supporting standards are in the development stage at the time of the field mission, *inter alia*, transport/storage of flammable refrigerants; production line safety for flammable refrigerants; and standard for NH_3/CO_2 cascade systems.

31. In Indonesia, the Government is developing standards for the safe use of HFC-32 in refrigeration and air-conditioning equipment; the enterprises manufacturing HFC-32-based products have their own safety standards in installing and servicing the equipment.

32. Thailand has special regulations Governing safety and transport of all flammable substances including HFC-32. Flammable refrigerants used in the manufacturing sector are also covered by regulations for storage facility design and construction; factory fire and prevention control; management system for occupational health and safety; and, emergency response plan for an uncontrolled release of HFC-32. Regulations have been relaxed, after risk assessment and approval by necessary authorities, for products with a capacity of 36,000 BTU or less, using HFC-32, may be used in a high rise application and is currently under review for a possible increase in product capacity to 50,000 BTU in high rise applications.

Technology-related issues

33. All eight countries visited conducted a detailed review of the alternative technologies available which included: whether the technology was technically and commercially viable; whether alternative refrigerants and the components to use them were readily available; the related safety issues; and, the energy efficiency gains compared to current technology and service requirements. None of the enterprises or countries visited raised any intellectual property rights issues. The technologies selected by each enterprise in each country are shown in Annex II to the present document and summarize in Table 2.

34. Five countries opted for R-410A for all their manufacturers and two countries chose to convert to HFC-32 for all their manufacturers. In China, some enterprises chose R-410A, others HC-290 and the remaining selected HFC-32 for their conversions. Ammonia was selected by China and Serbia for one off applications. Table 2 lists the technology selection by country.

Table 2. Technology selection by countries

Country	Technology selected for conversion of AC manufacturers
Argentina	R-410A
China	HC-290 for residential AC; and HFC-32 and NH_3/CO_2 for the commercial/industrial air-conditioning/refrigeration sub-sector
Indonesia	HFC-32
Islamic Republic of Iran	R-410A
Jordan	R-410A
Lebanon	R-410A
Serbia	R-410A, some R-404A, R-407C, R-507, and HFC-134A
Thailand	HFC-32

35. In Argentina, R-410A was selected because R-410A kits were the only ones available for use as other alternatives were not mature enough. Indeed, at the time the project was submitted to the Executive Committee it was considered that it met the requirements of high efficiency, technical maturity and reliability, and benefitted from an ease in servicing. The obstacles in the project implementation were higher operating pressures, increased cost of kits and requirement for post-sales training of technicians. The biggest challenge mentioned was commissioning of infrared communication systems used for final product, commissioning and testing for three of the five enterprises and related to these, the collaboration with one of the equipment providers.

36. In China, four of the five enterprises visited in the ICR sector which were converting manufacturing lines to HFC-32 and had completed their conversion are not producing because there is no demand. The fifth enterprise has not yet completed the conversion. Similarly, the two enterprises in the room air-conditioning sector converting to HC-290 technology have completed their conversion but are not producing for the same reason. All manufacturers state that they can quickly and seamlessly move back to HFC-32 or HC-290, as the case may be, when there is a market demand. The demonstration project converting room air-conditioning manufacturing lines to HC-290 was successful and some units were exported to Europe, but there is no production for domestic consumption. One enterprise manufacturing commercial/industrial freezer equipment has opted to convert to ammonia/CO_2 and is awaiting components for assembly from equipment provider.

37. A similar case is Indonesia, where all eight enterprises visited have completed their conversion of air-conditioning units from HCFC-22 to HFC-32. Other than Panasonic Indonesia, none of the enterprises have started production of HFC-32-based units since there is no demand for the product. In addition, there is difficulty in finding higher capacity compressors. Furthermore, HFC-32 is not suitable for low-temperature applications, only for medium temperature. The enterprises are using R-410A, R-507 and R-404A, which have a higher GWP. The market in air-conditioning sector is dominated by R-410A while in commercial refrigeration sector it is dominated by R-404A.

38. During the Islamic Republic of Iran's HPMP preparation phase, the NOU and implementing agencies conducted a review of the technology options available. R-410A was selected to replace HCFC-22 as an internationally accepted refrigerant. One of the stakeholders interviewed thought that hydrocarbons would have been a better choice for the country as they can be found internally. The said stakeholder did not consider the safety issues related to hydrocarbons an insuperable problem and also stated that enterprises are only superficially involved in discussions concerning the choice of alternative, which take place mostly at the Government level.

39. In Jordan, the World Bank, enterprise representatives and the Ministry of Environment evaluated the selection of the new technology and undertook a detailed review of the technology options available at that time, which included R-407C, R-410A, and HC-290. These alternatives were assessed against their maturity, cost effectiveness, availability of pre-manufactured kits, compatibility, energy efficiency, environmental impacts, safety, toxicity, market acceptance and service requirements and conditions. R-410A was selected since it fulfilled all the requirements mentioned above. The Government imposed higher energy efficiency standards for all new air-conditioning units in Jordan than the ones presently on the market.

40. Lebanon's HPMP project proposal had conducted a review of the technology options available and was undertaken mostly at the Government level, along with informal discussions with the RAC manufacturing sector and the local chapter of ASHRAE. These discussions revolved around R-410A and HC refrigerants such as HC-290 or HFC-600A. The HC refrigerants were at that time rejected because of the flammability issue as well as the charge restrictions. R-410A was the only logical alternative because of its proven technology and global acceptance on its use.

41. In Thailand, three of the four projects visited have been completed and they have started manufacture of residential air-conditioners. There are some issues with the different suppliers of HFC-32 compressors. Some compressor manufacturers produce up to 24,000 BTU capacity while at least one manufactures up to 36,000 BTU capacity. It appears the information related to availability of larger compressors has not been shared with all air-conditioning manufacturers. In general, prototype testing of HFC-32 units indicates a five per cent energy efficiency increase over similar HCFC-22 units and the products could be cost competitive with equivalent R-410A units.

42. In Serbia, the technologies were selected with the formulation of the HPMP, in accordance with the Serbian market and following global and especially European Union (EU) trends. R-410A was seen as

a possible alternative for some of the manufactured products such as air-conditioning equipment and for a range of heat pumps and ammonia was a well-known and common refrigerant on old Serbian refrigeration systems used for large commercial and industrial installations. The HPMP for Serbia included conversion of four manufacturers of refrigeration equipment to R-410A and ammonia. The four enterprises included in the HPMP are not using HCFC-22 in their manufacturing processes. All products have been adapted for the alternative refrigerants. Several HFCs are used for new products. Ammonia has only been applied by one of the enterprises for a special installation in a big cold storage room and is eventually used for servicing and maintenance of old systems. Also, HCFC-22 is applied to maintenance of old installations.

Delays in implementation

43. Most enterprises in all countries experienced some delays in procurement and delivery of equipment for various reasons. In the Islamic Republic of Iran, for example, the project was delayed for more than one year because of the economic sanctions. The enterprise, Mehr Asl, missed some deadlines and had to sign amendments to the agreement concerning the new schedule. The delays relate to the late arrival of machinery, more specifically of compressors, which in addition was retained for a long time by customs. In addition, UNDP changed its payment modality from U.S. dollars to Euros, which forced the enterprise to change its money transferring mechanism, and caused delays in payments to the subcontractors.

44. In Jordan, the cause was a delay in the development and testing of the prototype provided by Midea, a Chinese enterprise.

45. In Serbia, the NOO left and was not replaced for two years leading to delays in project implementation difficulties in communication between UNIDO and recipient enterprises. Another major reason for delays is that ICC investment component for manufacturing conversion (UNIDO component) was released by the Fund as per the Agreement and Executive Committee decision in two tranches (50 per cent disbursement with the second tranche). It was agreed with the NOU to initiate conversion process for two enterprises and then to continue with the rest when the funds were available. There was also an issue related to the Value Added Tax (VAT), which is not covered by UNIDO but is required at customs. It caused major delays, with goods stuck in custom warehouse for several months.

Demonstration projects

46. Of the eight countries, only in China demonstration projects on the RAC sector had been approved: The two demonstration projects conducted by Midea (conversion of small air-conditioners to HC-290) and GMCC (Meizhi) (manufacturing of HC-290 compressors) had been completed. In the case of Midea, there was production for exports but not for the domestic market as there is no demand as yet. GMCC is manufacturing compressors for dehumidifier applications only. The technology selected as well as the lessons learned from the conversions were disseminated amongst other enterprises within the country. For example, this transfer of technology and guidance added value to the success of Linda's compressor conversion demonstration project (ahead of schedule), which is now producing compressors for dehumidifier applications as there is no demand for air-conditioning applications as yet. In addition, the knowledge gained from the demonstration projects was instrumental in the development stage of three separate standards for hydrocarbon refrigerant servicing/storage/transport and production line safety.

Flammability and toxicity issues

47. HC-290 and HFC-32 are flammable refrigerants, while ammonia is toxic. Countries that have opted for these technologies acknowledge that adequate standards are required for the transport, storage and handling of these refrigerants. Some standards have been developed, while others are still in the

development stage. Acceptance of flammable refrigerants by the servicing sector is a major issue and awareness campaigns and proper training of service technicians are urgently needed.

48. Because of the absence of national standards in China for production line safety, the enterprises conducted their own research as to what additional safety systems were needed. In addition, the absence of national safety standards for servicing and installation of products containing flammable refrigerants may have affected the market introduction of the products. Standards are still under development and most of them will not be mandatory.

49. Indonesia selected HFC-32 as their final choice for conversion. The Government removed HFC-32 from the list of highly flammable substances and is developing standards for HFC-32's safe use in RAC equipment. The enterprises manufacturing HFC-32-based products have their own safety standards in installing and servicing the equipment.

50. In Serbia, ammonia has been used only for one new installation and is eventually used for maintenance of old refrigeration systems. Only certified engineers are allowed to manage ammonia systems. The lack of skills in the servicing sector has been a barrier for widespread of ammonia systems. It appears there is limited training availability at the moment.

51. To promote the use of HFC-32-based air-conditioners in Thailand, regulations have been relaxed for products with a capacity of 36,000 BTU or less, using HFC-32, which may be used in a high rise application and is currently under review for a possible increase in product capacity to 50,000 BTU in high rise applications.

Safety-related issues

52. While there may be some deficiencies in national standards on safety in transportation, storage, and handling of flammable refrigerant, all enterprises that opted to convert to HC-290 or HFC-32 have developed their own internal safety standards. All have installed the necessary and required safety systems in their production lines and/or testing facilities. However, national standards would allow for a common level of safety across all manufacturers. Countries which converted to R-410A did not face any safety issues.

53. In China, all enterprises mentioned that in addition to the Fund's funding they also used their own resources to: to conduct explosion-proof testing for equipment; building storage for refrigerant; installation of alarm systems and ventilation system; and, purchasing charging machine, pressure pump and other equipment, which covers delivery, storage, installation, maintenance, operation and abandonment. It is assumed that the various components needed were available. However, during the field evaluation it became apparent that the installation of safety devices for flammable refrigerants was at the discretion of the enterprise and varied from adequate to extensive. This lack of uniformity (due to inadequate standards) does not create any immediate safety concern, since most enterprises are not in production, however once production starts up, consistent line safety standards should be in place.[5]

54. In Indonesia, Panasonic, the only enterprise to produce residential air-conditioning units with HFC-32, incurred rather high expenses in ensuring that all required safety devices and equipment were put in place (i.e., sensors, alarms, explosion proof fixtures and ventilation/controls).

[5] UNIDO does not consider this issue to be a problem and states that all planned conversions are moving ahead without problems. The split air-conditioning assembly line safety issues are similar to the R-600A refrigerator assembly safety problems. That issue has been resolved over a decade ago and many million such products are produced annually. The production equipment suppliers are the same for both sectors and most of the main equipment is identical (i.e., charging machines, leak and gas detectors, safety devices, and ventilation system).

Role of international enterprises

55. Other than Indonesia and Thailand, international enterprises did not appear to have any influence on the selection of new technology refrigerants. In Indonesia, Panasonic adopted the new HFC-32 technology and began production, and may be considered a trendsetter that may influence the market. In Thailand, Daikin Manufacturing has not only contributed to training programmes but has also conducted massive public advertising campaigns on the efficiency and safety of HFC-32 products. This campaign has been successful and consumers are demanding HFC-32 air-conditioning products.

Destruction of ODS equipment

56. With the exception of Thailand, all enterprises in the seven countries confirmed that ODS manufacturing equipment that could not be re-used in the new manufacturing line were destroyed. Vacuum pumps, leak detectors, charging machines (retrofitted) were mostly retained. In Thailand, all equipment has yet to be destroyed and verified by the NOU. Many of the enterprises have kept some HCFC-22 for servicing of their products under warranty.

Replication of technologies to other countries

57. Availability of technology for conversion to R-410A does not appear to be a problem and could be easily replicated. Conversion to HC-290 or HFC-32 does not appear to be mature as yet. Although several manufacturers have converted their lines to be able to manufacture HFC-32 systems, nearly all of them are reluctant to actually start manufacturing. Until such time, enforceable standards are in place and domestic demand picks up making the manufacturers move to the new technologies, the conditions will not be in place for replication of technology to other manufacturers domestically or in other Article 5 countries. Non-availability of full range of HFC-32 compressors and easy availability of quality HFC-32 appears to be another issue.

Technical assistance and awareness

58. Capacity building activities related to updating information on technically and economically feasible alternative technologies that can be applied by local RAC manufacturers vary from country to country. Various professional bodies and associations have been involved in this activity in the early stages of technology selection, but it is not clear whether there is continued support in this regard. The NOUs also played an important role.

59. The China Household Electrical Appliance Association, in consultation with appropriate stakeholders and working groups such as the Manufacturers Trade Association, along with FECO, played a vital part in not only the continuous development of industry standards but also in disseminating information amongst the conversion project participants. As mentioned above, the two demonstration projects conducted by Midea (conversion of small air-conditioners to HC-290) and GMCC (Meizhi) (manufacturing of HC-290 compressors) were completed and the technology selected as well as the lessons learned were disseminated amongst other enterprises within the country. In addition, the knowledge gained from the demonstration projects was instrumental in the development stage of three separate standards for HC servicing/storage/transport and production line safety.

60. The Government of Indonesia has taken measures to promote industry interactions for adoption of HFC-32 in a safe and efficient manner, through the RAC association of Indonesia. Technical experts who are also associated with ASHRAE chapters in the region provide technical inputs to facilitate industry conversion process.

61. In Jordan, all technical assistance is conducted by the NOU in conjunction with the Vocational Training Centre or by international consultants along with equipment suppliers. In addition to the training

and workshops organized, the NOU prepared a series of informative visual material for dissemination. Among these, a poster with the description of all gases. It also carried out workshops for the Chambers of Industries.

62. In Serbia, information about feasible alternatives can be found on the Ministry's website (mainly information about regulations). Also, the RAC Association distributed a technical journal on a quarterly base were special ozone articles (in Serbian and English) are included, as well as news and trends on the RAC sector. The Ministry in cooperation with the national RAC Association promotes ozone and climate friendly technologies at the annual heating, ventilation, air-conditioning and refrigeration conference every year. Participants of the forum are informed about national and EU ODS and F-gas regulations and also about the Montreal Protocol and related activities. The Ministry implements its programmes in close cooperation with relevant institutions, by organizing scientific and professional meetings and conferences, as well as exhibitions, presentations, lectures, seminars and workshops.

63. In Thailand, the Federation of Thai Industries took part in the initial consultation on the selection of technology to be used for conversion projects under stage I of the HPMP. However, dissemination of information within the group is very limited and information on this new technology is not shared among its members. An example was the sourcing of HFC-32 compressors. Some manufacturers' suppliers limit capacity to 24,000 BTU while others provide 30,000 or 36,000 BTU. This compressor availability choice is not shared amongst its members fearing it would take away the advantage that one manufacturer would have over another.

Energy efficiency

64. All the manufacturers considered energy efficiency of the new technologies during selection of technologies. Several countries have energy efficiency labelling requirements and also provide incentives/subsidies for appliance, which meet a certain criteria of energy efficiency. In one case, the high cost of electricity is driving the market for energy efficient products, while conversely; in another country electricity prices are very cheap.

65. The end of electricity subsidies imposed by the Government of Argentina led to an increase of electric energy prices. This situation created market criteria for selecting home appliances and therefore new incentives for the enterprises to use a more energy efficient refrigerant. Staff in the enterprises in China stated that energy efficiency was the main criterion for selection of HC-290. Successful production of units using HC-290 will also be eligible for Government rebates/subsidy through the China energy efficiency standard (grade 2 and above).

66. In Indonesia, it is claimed by the manufacturers that energy efficiency with HFC-32 is only marginally improved over HCFC-22. The national RAC Association with the assistance of the NOU is planning an advertising campaign directed at the consumer, on the benefits, reliability and safety of the new technology. In the Islamic Republic of Iran consumers are reluctant to purchase products when labels are not attached, thus indirectly encouraging manufacturers to produce higher quality and more efficient products.

67. In Thailand, Daikin Manufacturing conducted massive public advertising campaigns on the efficiency and safety of HFC-32 products. This campaign has been so successful that consumers are demanding HFC-32 air-conditioning products. On the other hand energy efficiency seems not to be an issue in Serbia as electricity prices are still low.

Financing-related issues

68. The mission was unable to collect reliable financial data at the enterprise level and therefore to carry out a meaningful analysis. Most of the enterprises visited claimed to have incurred higher ICC than

approved. Many of the manufacturers also claimed to have provided moderate to substantial co-funding but detailed financial statements were not forthcoming.

Training for post sales servicing (including refrigerant and spare parts availability)

69. The new technologies related to HC-290 and HFC-32 have yet to have any meaningful market penetration with most manufacturers deciding to wait it out until some demand is created. As a result, there is not much known about the ease of availability of spare parts and quality refrigerant. There is a continuous need for training of independent technicians (as opposed to enterprises' own servicing technicians) in handling flammable and toxic refrigerants as well as knowing the technical issues related to their use in RAC equipment.

70. In some countries the Governments, through the NOUs, were involved in organizing training, an example being Argentina where the *Oficina Programa Ozono* (OPROZ) conducted training of over 850 technicians in the safe use and proper servicing of high-pressure refrigerants such as R-410A and developed professional training and servicing manuals for technical reference by the servicing sector. R-410A kits were the only ones available for use so spare parts were not an issue.

71. Similarly the Ministry of Environment of Jordan has a contract with the Vocational Training Center for the training of trainers and has jointly developed a training manual. Presently, there are 25 trainers who have held 250 workshops. At the completion of each workshop the participants (200 to date) receive a license/certification indicating they have been trained in "Good Practices of Refrigeration" as well as in proper servicing of refrigerants such as R-410A and R-407C. To date, there is no training provided for the safe handling and servicing of HC refrigerants. A training curriculum will be developed by Jordan's Vocational Training Center building on the work already completed under the servicing sector component of Jordan's previous National ODS phase-out plan.

72. In Lebanon, no specific training has been conducted for servicing high-pressure refrigerants such as R-410A. The Government is planning an extensive training programme to upgrade instructor knowledge at the vocational training institutions as it relates to new technology refrigerants (R-410A, HFC-32 as well as HC refrigerants). Through this upgrade in instructor knowledge it is hoped that 1,000 service technicians will be trained from 2017 to 2020.

73. Within the HPMP for Serbia, 12 refrigeration experts (several of them from manufacturing enterprises) received training in London during 2012. Also within the HPMP, after the coming in force of new regulation on certification, workshops for trainers were organized and training for certification will begin in the near future. Training is in accordance with the new certification regulation and consists of theoretical and practical sessions. The training of around 400 servicing technicians is planned within the HPMP. Ammonia components for the smaller systems are not available yet. Ammonia systems are not permitted in public areas and available components are more expensive for more than 30 per cent. Lack of skills in the servicing sector has been a barrier for widespread of ammonia systems.

74. In Indonesia enterprises organized internal training, while Panasonic received training from Daikin, a provider, directly as well as from the Panasonic Headquarters. Daikin had an important role in Thailand as well; technology transfer between the NOU, World Bank and Daikin Manufacturing have been instrumental in disseminating information as it pertains to the flammability and safety issues geared around proper servicing and installation of HFC-32 products. Through various training programmes thousands of technicians and factory workers have been trained to date. This intensive training programme has contributed to the success of the HPMP. The curriculum, which has been developed, will eventually make its way into the National Technical Training Institutions to teach the new technician work force on the safety and proper servicing of new technologies such as HFC-32 and HC refrigerants as well.

75. In other countries enterprises organized training like in China where most of the enterprises have organized an internal training on the new technologies. Some included this training into a larger activity on various topics. Others recruited external specialists to carry out the training and included sales persons among the participants. Mehr Asl in the Islamic Republic of Iran has also been conducting its own training. Members of the National RAC Association interviewed think that there is a need for more funding for training in both the manufacturing and servicing sectors. The National Training Institute (TVTO) is involved in training, but less so the RAC Association which, in addition, stated that they had very little to do with alternative technology selection process during the development of the HPMP proposal for the Islamic Republic of Iran.

Sustainability

76. For sustainability of a new technology/product, several issues need to be considered such as environmental issues; easy availability of bought out components (e.g., compressors and refrigerants) both for manufacturing and post-sales servicing and possibly more than one supplier of these components to ensure continuous availability; increased energy efficiency over current products in the market; safety in operation; trained post-sales servicing technicians; acceptance of the new technology by consumers; and most importantly support from Governments through legislation, standards and awareness campaigns.

77. Enterprises, which have converted to R-410A technologies by and large, have assured markets, thereby assuring sustainability as long as all manufacturers have a level playing field with controls and bans on HCFC-22 and HCFC-22-based products. However, this does not appear to be the case for enterprises, which chose to go with HC-290 or HFC-32 for air-conditioning units. Except for one enterprise in Indonesia and for all enterprises in Thailand, production of equipment with alternate technology has not yet started allegedly due to a lack of market demand, availability of critical components, and reluctance of servicing technicians to deal with flammable refrigerants. Thus, sustainability is still an issue with the introduction of HC-290 and HFC-32 technologies and equipment even within the limited capacity of compressor size availability. Only Thailand has successfully introduced the new technology.

78. Government support was seen in Argentina, where, at the time of the conversion, appliances using HCFC- 22 were cheaper than those using R-410A. The Government imposed a legislation, which strictly controls the import of foreign air-conditioning products and was designed to protect the domestic manufacturers from cheaper imports. This action along with good quality control of their final product should ensure long-term sustainability of the sector.

79. In China three enterprises have started production, GMCC, Midea and Linda. In order for this production to continue and grow, continued research and development is required, safety standards must from time-to-time be re-evaluated and addressed, and continued training of assembly line as well as servicing sector technicians to ensure equipment and servicing work meets the expectations of consumers in addition to the manufacturers' quality standards are necessary.

80. In Jordan, Government's legislative policies should provide for manufacturer support in maintaining market share domestically. This action along with good quality control of their final product and continued technological training should ensure long-term sustainability of the sector.

81. The political and economic situation also has an impact as in Lebanon, where the manufacturer visited stated that current production has been reduced to only 30 per cent of its normal rate, which may not be sustainable in the long term. However, the enterprise feels that the economic situation will improve and political tensions will ease allowing delivery of products by land possible to their major export markets like the Islamic Republic of Iran, Iraq and Jordan.

82. Serbia's expected entry in the European Community in the near future encouraged the Government to put in force strict regulations and a certification scheme, which will certainly contribute to sustainability. Also, enterprises preparing for the future are trying to follow the European Community trends and F-gas, which is a challenge. Quota system will contribute also to the sustainability. The import of used HCFC-22 units is banned in Serbia. However, import of new HCFC-22 units is still allowed but the Government plans to ban it in 2018.

83. An additional element is the better energy efficiency of the new appliances, which constitutes an incentive for market acceptance. The Government of Indonesia has taken measures to promote industry interactions for adoption of HFC-32 in a safe and efficient manner, through the RAC Association of Indonesia. Technical experts who are also associated with ASHRAE chapters in the region provide technical inputs to facilitate industry conversion process. In the Islamic Republic of Iran, Mehr Asl believes that as local market is moving towards R-410A, the interest of the population towards more energy efficiency products will increase, and the production of ozone-friendly product will become sustainable at a longer term. As a national enterprise Mehr Asl had contracts with Governmental institutions. It is worth noting that the enterprise encounters competition from importers of split units (e.g., LG).

84. Barring some obstacles, Thailand's conversion projects to HFC-32 should be considered successful as compared to other countries with HFC-32 conversion projects that were evaluated. Required legislation and standards are all in place; training of the servicing sector has been accomplished and is continuing. The new product is being accepted and demanded by consumers.

Recommendation

85. The Executive Committee may wish:

(a) To take note of the final report on the evaluation of the HCFC phase-out projects in the refrigeration and air-conditioning manufacturing sector contained in document UNEP/OzL.Pro/ExCom/77/9; and

(b) To invite the bilateral and implementing agencies to apply, when appropriate, the findings and recommendations of the evaluation of the HCFC phase-out projects in the refrigeration and air-conditioning manufacturing sector in the implementation of projects ng stage II of the HPMPs.

Annex I

TERMS OF REFERENCE FOR PHASE TWO OF THE EVALUATION OF HCFC PHASE OUT PROJECTS IN THE REFRIGERATION AND AIR-CONDITIONING (RAC) MANUFACTURING SECTOR

Background

1. The desk study prepared during the first phase of the evaluation of HCFC phase-out projects in the RAC manufacturing sector identified a number of issues and provided recommendations that could be applicable to future similar projects. These concern the generalization of the policy framework for the control of import/export and trade of HCFCs as well as bans of new production facilities relying on HCFCs; the application of measures for curbing the growth of the installed base of HCFC-based equipment; the selection of alternatives based on energy efficiency criteria. The study also stresses the importance of the demonstration projects in demonstrating the feasibility of the new technology, as well as in helping promote the acceptability of the new technology and products in the local market. The study also states that project completion reports would increase their usefulness if delivered in a timely manner and following a minimum set of requirements in order to provide the most relevant and useful information.

2. The desk study points out as a cause for concern that important supporting measures, such as relevant safety standards and the associated product certification infrastructure for the chosen alternative are not in place in a timely manner. This could be the cause for problems with the product quality, safety, sustainability and project delays in the future. In addition, the study recommends further inquiry in the issue of energy efficiency as a condition for sustainability for the results of the project.

3. The second phase of the evaluation, based on the collection and analyses of information gathered at the enterprise level during field visits in several countries, will yield a final report which will also use some of the findings of the previously prepared desk study with conclusions and recommendations for the implementation of stage II of HPMPs.

Objective and scope

4. The second phase of the evaluation of RAC manufacturing sector will collect, analyse and review information at the enterprise level, and assess the progress made in the phasing-out of HCFC in the RAC manufacturing sector in projects where the conversion process has been completed or is close to completion. The fieldwork will focus on the following.

<u>Policy, legal and regulatory frameworks</u>

5. The following issues will be addressed:

(a) Were existing policies reviewed to facilitate the phase-out of HCFCs in the RAC sector and in the introduction of HCFC-free RAC technology? What actions were taken in the area of policies, legislations and regulations?

(b) Were there new enforcement procedures and monitoring tools developed to control HCFC use in the sector as well as HCFC-based equipment imports?

(c) Were the policies and regulations including import/export legislations concerning the HCFC and HCFC-based equipment effective? How did the timing of legislation affect the projects? Were there any related incentives?

(d) How has energy efficiency been addressed relative to policies and regulations identified? What incentives and disincentives were included into policies and regulations and what were their impacts on the projects?

(e) Were there inspections and certifications of infrastructure, standardized technical testings, and enforceable technical standards for the alternative technology?

(f) Were there activities to assess standards and codes relevant to the RAC sector use of alternatives to HCFCs?

Technology–related issues

6. Using HCFC-free technology implies adopting innovating approaches leading to environmental benefits, but also overcoming barriers. The evaluation will assess issues related to the use of low GWP technologies and alternatives and will address the following issues:

(a) What was the basis of the alternative technologies selected? Were technologies selected in line with the HPMP or were there other influential factors? What were incentives and barriers for technology choices and implementation? Were there issues related to intellectual property rights and how was this dealt with?

(b) Were there delays in project implementation due to the choice of technology and if so what were their causes?

(c) What was the role of demonstration projects in testing alternative technologies and facilitating the collection of accurate data on costs and application of the technologies and the conditions relevant for the introduction of the alternative technology in the country on a larger scale?

(d) What were the main issues related to the introduction of required standards for the use of flammable and mildly flammable refrigerants related to all the relevant alternatives in the country? What were the barriers and to what extent and how were these removed? Did the length of standards introduction influence the implementation process, and if so how?

(e) Which were the actions taken with regards to those obstacles and to the completion of the relevant conversion projects, with special attention to safety, product quality, and sustainability issues?

(f) Were there requirements for additional investments on safety equipment and systems? Were the various components needed available? How was the commissioning of equipment done?

(g) How did the international enterprises influence the adoption of the alternative technology; and how that influenced project design and implementation? How did small and mediumsize enterprises implement the phase-out process?

(h) Were the manufacturing plant equipment destroyed, and if not why? What was the fate of the ODS in the equipment?

(i) Under what conditions can the alternative technology be replicated to other Article 5 countries, and if not why?

Technical assistance and awareness

7. Many project documents mention the need of improving the technical capacities of the RAC manufacturing enterprises in using alternative technology and in applying appropriate safety and security measures. The evaluation will assess the availability and use of updated information on technically and economically feasible alternative technologies that can be applied by local RAC manufacturers. It will examine the capacity building activities implemented by the project.

8. In some countries the users are not aware of the availability and benefits of the energy efficient variety of RAC technology. The evaluation will examine how technical assistance projects addressed awareness-related challenges. What awareness-raising strategy was used and what were the results? How did the RAC community changed following these activities? What was the role of professional refrigeration associations in helping with and disseminating the information about the new technology?

Financing-related issues

9. The evaluation will examine, appropriately and to the degree possible, the information related to the incremental capital cost (ICC), the incremental operational costs (IOC) and sub-categories for implementing the project (comparing planned to actual costs); what was the cost-effectiveness of the projects and whether there were any changes, when applicable; and the split between energy costs and other operating costs when applicable.

10. It will investigate the co-funding from enterprises for implementing the project and compare this to the planned co-funding. The desk study will draw lessons from co-funding experiences, in terms of both challenges and opportunities.

Post-sale servicing

11. The evaluation will tackle issues related to *inter alia*, training, availability and affordability of spare parts and refrigerants, installation and post-sale costs issues, including market acceptance of the new product. It will also evaluate how the servicing sector managed with the introduction of low GWP alternatives?

Sustainability

12. What happened after project completion? How is the sustainability of the project being ensured? How is the project designed to guarantee and monitor sustainable outcomes? What needs to be in place to ensure that there is buy-in at the consumer level to purchase alternative-based AC that are more energy efficient? Are the new appliances more costly, and how much?

Methodology and schedule of submission

13. The evaluation will yield eight country reports and a final report which will include an analysis of the data collected from the field work through open ended interviews, observations at the plants' location and documents analysis. In addition, the study will take into account the previously prepared desk study, the most recent progress reports submitted by relevant agencies, as well as information gathered from interviews and discussions with members of the Secretariat, bilateral and implementing agencies and National Ozone Offices.

14. It is proposed to visit enterprises at the following countries: Argentina, China, Indonesia, the Islamic Republic of Iran, Jordan, Nigeria, Serbia and Thailand. The sample of countries includes countries with project completed or in the final phase of implementation. Argentina, China, Indonesia, Nigeria, and Thailand have been selected for their advanced status in project implementation; their use of alternatives requiring specific standards, not always in use in the countries; and their use of innovative approaches that will shed additional light into the complexities and challenges of these conversions; the Islamic Republic of Iran as the project has been completed ahead of schedule; Jordan for its stand-alone project and Serbia as a low-volume-consuming country.

15. The final report will be presented to the Executive Committee for consideration at the 77th meeting.

Evaluation organization

16. A team of consultant will be hired to carry on this evaluation. Each consultant will be in charge of elaborating the country evaluation report. The team leader, in cooperation with the other team members will draft the synthesis report. Bilateral and implementing agencies will be involved in participating in the evaluation missions and in providing comments on the reports. The synthesis report will be presented at the 77th Executive Committee meeting and the lessons learnt will be posted on the Secretariat's website.

Annex II

ENTERPRISES VISITED AND STATUS OF CONVERSION

Country	Enterprise Visited	Conversion	Status
Argentina	Multicontrol Commercial AC products such as chillers, heat pumps as well as Roof top equipment	HCFC-22 to R-410A	Implementation completed. HCFC is no longer consumed in manufacturing
	Newsan Residential Split AC (DX/Heat Pumps), Small commercial Splits and Window AC	HCFC-22 to R-410A	Implementation completed. HCFC is no longer consumed in manufacturing
	Radio Victora Residential ductless splits	HCFC-22 to R-410A	Implementation completed. HCFC is no longer consumed in manufacturing
	BGH Residential ductless splits DX and heat pumps, portable and stand-alone equipment	HCFC-22 to R-410A	Implementation completed. HCFC is no longer consumed in manufacturing
China	Midea Portable AC/residential Ductless splits Shunde Base	HCFC-22 to HC-290 Demonstration project	Project completed. 10,000 portable units (sold) 100 split units for demonstration only (no demand)
	Midea Residential heat pumps (Chillers) Chongqing Base	HCFC-22 to HFC-32	Residential heat pump conversion project for HFC-32 still in design stage
	GMCC Meizhi Compressors	HCFC-22 to HC-290 Demonstration project	Project completed. Compressors being manufactured at this time are for dehumidifier application only
	Linda Compressors	HCFC-22 to HC-290	Project completed. Compressors being manufactured at this time are for dehumidifier application only
	TCL Portable AC	HCFC-22 to HC-290	Project completed. No domestic demand to justify start-up
	Gree Small chillers (water source heat-pumps) Large chillers (water source heat-pumps)	HCFC-22 to HFC-32	Project completed. At present the small chiller line is not in production (no market). The large chiller line is limited to demonstration models only
	Dunan Environmental Small commercial chillers (HP) Unitary AC units	HCFC-22 to HFC-32	Project completed. Project line 1 completed being used at present to produce R-410A commercial heat pumps Line is not useable no dedicated equipment such as: charging unit, vacuum pumps or display components for pressure testing/ vacuum readings. Possibly continuing manufacture of HCFC-22 units.

Country	Enterprise Visited	Conversion	Status
	Haier Jiaozhou Residential ductless splits	HCFC-22 to HC-290	Project line 1 complete Project line 2 complete No production (no demand) presently producing R-410A units (can be transformed back to HC-290 quickly if demand requires)
	Haier Huangdoa Residential ductless splits	HCFC-22 to HFC-32	Project completed No Production (no demand)
	Shenzhou Commercial/industrial Freezer equipment	HCFC-22 to NH_3/CO_2	Plan implementation and design stage completed January 2016 awaiting components for assembly from equipment provider
	Geruide Commercial ductless splits	HCFC-22 to HFC-32	Two control cabinets in testing station refurbished to explosion proof Old equipment destroyed Project complete. No production (no demand)
Indonesia	Panasonic Indonesia Residential AC	HCFC-22 to HFC-32	Primary market Indonesia foresees a demand of up to 2 million in the upcoming year. Product capacity ranges from 5,000 thru to 12,000 BTU/H
	PT. Fatasarana Makmur Commercial AC	HFCF-22 to HFC-32	No production (no market) Manufacturer is now producing units using R-407C and R-410A. Units built on speculation for distribution to their suppliers or as factory inventory. This will continue until a market for HFC-32 materializes
	PT. Gita Mandiri Teknik Commercial AC	HFCF-22 to HFC-32	No production (no demand) Presently producing unit containing R-407C and HC-290
	PT. Metropolitan Bayu Industri Commercial AC	HFCF-22 to HFC-32	No production (no market). Conversion will most likely be used to produce R-410A units in the near future
	PT. I.T.U. Airconco Commercial AC	HFCF-22 to HFC-32	No production (no market). Conversion project will most likely be used to produce R-407C units in the near future. Units are produced specifically on customer request only and installed by the manufacturer. No speculative production
	PT Aneka Cool Citratama Commercial refrigeration	HFCF-22 to HFC-32	No Production (no market) Presently producing R-404A units
	PT. Sumo Elco Mandiri Commercial refrigeration/condensing units/ cold rooms	HFCF-22 to HFC-32	No Production (no demand) Presently producing R-404A condensing units
	PT. Rotaryana Prima Commercial refrigeration. – walk-in ref, cold rooms	HFCF-22 to HFC-134A	Equipment containing R-134A is well established and accepted. Anticipate no problem with consumer acceptance of new product
	PT. Alpine Cool Utama Commercial refrigeration – condensing units/ cold rooms	HFCF-22 to HFC-32	Completed. No Production (no demand) No actual production line exists specifically for HFC-32. The system is made to the specifications required by the customer as is the production of R-404A unit. (Shared production with existing R-404A assembly). Enterprise only fabricates the steel platform and the surge tank on site. All other components are purchased separately to construct the final HFC-32 ICR product

Country	Enterprise Visited	Conversion	Status
Islamic Republic of Iran	Mehrasl- Tabriz Commercial/industrial air-conditioning products such as: absorption chillers, fan coil units, electric chillers roof top units, and to lesser degree limited quantities of ductless splits. Process was converted from HCFC-22 to R-410A	HCFC-22 to R-410A	Actual production started in 2015
Jordan	Petra Engineering Industries Commercial/industrial RAC equipment such as chillers, residential and commercial split AC, packaged units and is a global supplier of explosion proof air conditioning systems for the oil and gas industry	HCFC-22 to R-410A and development of a HC-290 air-conditioning system prototype	Conversion to R-410A successfully completed without any significant delays. The HC-290 prototype experience some delays in obtaining the required components: such electrical devices and compressors
	General Deluxe Residential split AC and domestic refrigerators	HCFC-22 to R-410A	Conversion to R-410A is in the final stages of completion, prototype testing has hindered the actual production of the new product and as cased slight delays in start up
	NRC National Refrigeration Enterprise Residential split AC and domestic refrigerators	HCFC-22 to R-410A	Conversion to R-410A is in the final stages of completion, prototype testing has hindered the actual production of the new product. They are currently not producing any Air conditioning systems using HCFC-22 or R-410A
Lebanon	Lematic of six different models of residential AC	HCFC-22 to R-410A	Actual production start date March 2014. At present there is no production on the project conversion line due to seasonal demands
Serbia	Alfa Clima Heat pumps air/ water, air/ air and water/ water. Special equipment for temperature control in the wine manufacturing. Pasteurizing equipment	HCFC-22 to R-410A and R-407C	Conversion completed
	Eko Elektro Frigo RAC Central Systems Cold storage chamber for fruit Condensing Units	HCFC-22 to R-404A, R-507 and HFC-134A Ammonia only eventually	Procurement on-going
	Sena Industrial refrigeration systems	HCFC-22 to R-404A and R-410A Ammonia only eventually	Equipment delayed at custom warehouse due to issue about VAT
	Soko Commercial refrigeration	HCFC-22 to R-407C,	Conversion completed

Country	Enterprise Visited	Conversion	Status
	central systems for supermarkets Air handling units Cold storage rooms Chillers and industrial refrigeration systems on special request	R-404A and R-410A Ammonia only eventually	
Thailand	Bitwise Group Residential, commercial and industrial AC products, under their own brand name as well as producing products for York, Daikin, Panasonic and LG	HCFC-22 to HFC-32	Project started May 2016. Not completed. Actual production may not be able to commence due to the unavailability of HFC-32 compressors with capacities over 30,000 BTU which accounts for 90 per cent of the air-conditioning split production
	UniAire Residential and commercial AC products such as ductless splits and roof top units and commercial water chillers	HCFC-22 to HFC-32	Project completed conversion project involved the production of small residential split a/c units only. Converted line will produce units only up to 36,000 BTU because of the unavailability of compressors over that capacity. HCFC-22 will still be used for the larger capacity products until larger capacity compressors are available. The manufacturer had also indicated that there was a great demand by the consumer for HFC-32 products as a result of the advertising campaign conducted by Daikin
	Eminent Aire Residential, commercial and industrial air-conditioning products up to 60,000 BTU.	HCFC-22 to HFC-32	Project completed. Converted line will produce units up to a capacity of 24,000 BTU only because of unavailability of compressors capacities beyond that from their supplier. Unit production beyond the 24,000 BTU capacity will utilize R-410A until compressors become available for HFC-32. HCFC-22 will continue to be used for all commercial and industrial applications over the 60,000 BTU threshold
	Unico Consumer Products Residential and light commercial air-conditioning products up to 60,000 BTU	HCFC-22 to HFC-32	Project completed. Newly converted line will produce units up to a capacity of 24,000 BTU only because of the unavailability of compressor capacities beyond that from their supplier. Unit production beyond the 24,000 BTU capacity will utilize R-410A until compressors become available for HFC-32