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PAPER ON HOW HCFC PHASE-OUT AND HFC PHASE-DOWN ACTIVITIES SUPPORTED BY THE MULTILATERAL FUND MIGHT CONTRIBUTE TO SUSTAINABLE COOLING (DECISION 92/1(b))

Background

1. At the 92nd meeting, one Executive Committee member introduced a draft decision requesting the Secretariat to examine some of the national cooling action plans developed by countries and to prepare a document on how HCFC phase-out and HFC phase-down activities supported by the Multilateral Fund (MLF) could contribute to sustainable cooling and thermal comfort. The cooling requirement, he said, was a cross-sectoral issue that was essential to economic growth and presented both challenges and opportunities in terms of energy efficiency and refrigerant transition. A large share of the cross-sectoral cooling requirement had been met with refrigeration and air-conditioning (RAC) technologies using a refrigerant with ozone depleting potential (ODP) or global-warming-potential (GWP). Therefore, the MLF's key role in supporting Article 5 countries in transitioning to climate-friendly alternatives was particularly relevant. Following the discussions, the Executive Committee requested the Secretariat to prepare, for consideration by the Executive Committee at its 94th meeting, a paper on how HCFC phase-out and HFC phase-down activities supported by the Multilateral Fund might contribute to sustainable cooling (decision 92/1(b)).

2. In preparing the present paper, the Secretariat consulted technical experts on sustainable cooling technologies in refrigeration, air-conditioning and heat-pump (RACHP) applications. Further, for the purpose of analyzing how HFC phase-down might contribute to direct and indirect greenhouse gas (GHG) emissions in Article 5 countries,[2] the Secretariat analyzed the data in UNEP's Global Cooling Watch 2023 report;[3] reviewed national cooling plans including the summary of national cooling action plans (NCAPs)

[1] UNEP/OzL.Pro/ExCom/94/1
[2] Direct GHG emissions are estimated based on consumption of HFCs as done under the Montreal Protocol; indirect emissions are estimated based on the energy consumption levels of different equipment and the carbon intensity of the energy source supplying energy to these equipment.
[3] Global Cooling Watch 2023 | UNEP - UN Environment Programme, ("Keeping it chill - How to meet cooling demand, while cutting emissions")

supported by UNDP and similar country-level reports on cooling; and consulted the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee's 2022 assessment (RTOC – 2022 assessment). Finally, the Secretariat obtained inputs from bilateral and implementing agencies.

3. In addition to describing the aspects of sustainable cooling and the related sectors covered under MLF funding, the present document examines the impact of HCFC phase-out and HFC phase-down activities on achieving sustainable cooling, analyzes direct and indirect emissions as well as future trends resulting from cooling needs, and presents what might be done in relation to sustainable cooling under HCFC phase-out management plans (HPMPs) and Kigali HFC implementation plans (KIPs).

Aspects related to sustainable cooling[4]

4. Sustainable cooling relates to achieving comfort cooling and refrigeration in the cold chain, with minimum direct and indirect GHG emissions and other adverse environmental impacts, using technologies that are affordable, technically and economically feasible, and scalable. In general, the largest benefit from implementing sustainable cooling is reducing the energy consumption required to achieve the same cooling level, including "right-sizing" cooling needs. Sustainable cooling can also encompass interventions beyond the selection and use of cooling technologies and include responsible refrigerant disposal. Sustainable cooling contributes to Sustainable Development Goals (SDGs) 2, 3, 4, 8, 9, 10, 11 and 12.[5]

Sectors covered under Multilateral Fund funding in relation to sustainable cooling

5. Over more than three decades, ODS phase-out activities for different RACHP applications have been addressed with support from the MLF. These include domestic refrigerators, commercial, industrial and transport refrigeration, residential, commercial, industrial and mobile air-conditioning, and chillers. Projects mainly addressed refrigerant conversion and the conversion of insulation foam to alternative technologies.

6. HFC-based applications and HFC consumption in those applications have been rising. Furthermore, there will be new applications that could entail HFC consumption growth (e.g., data centres, tumbler dryers).[6] During HFC phase-down, these HFC-consuming applications will be addressed based on national industry structure and HFC consumption trends, as well as policies and guidelines approved by the Executive Committee. Conversion to alternative technologies is expected, and interventions could include avoiding growth in HFC consumption in these applications, as well as support to convert to alternatives.

[4] In the Global Cooling Watch 2023 report, sustainable cooling is defined as cooling technologies and approaches that are accessible, affordable and scalable but that minimize the impacts on people and the planet, including through large reductions in GHG emissions. Sustainable cooling can go beyond the direct emissions of refrigerants and the energy consumption associated with operating cooling equipment. This can include minimum natural resource use in building construction, sustainable building materials and other such interventions. For the purposes of the present document, such interventions are not further considered due to the lack of nexus with Montreal Protocol implementation.

[5] **SDG2**: End hunger, achieve food security and improved nutrition and promote sustainable agriculture; **SDG3**: Ensure healthy lives and promote well-being for all at all ages; **SDG4**: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; **SDG8**: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; **SDG9**: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; **SDG10**: Reduce inequality within and among countries; **SDG11**: Make cities and human settlements inclusive, safe, resilient and sustainable; **SDG12**: Ensure sustainable consumption and production patterns.

[6] The growth in consumption of HFCs is subject to technical, market and regulatory factors; hence, the extent of growth cannot be clearly determined at this stage though it appears that consumption in these applications would grow.

Impact of HCFC phase-out and HFC phase-down activities on achieving sustainable cooling

7. For more than three decades, the Multilateral Fund has supported interventions in the RAC and foam sectors that have enabled the transition to more environmentally friendly cooling technologies. Such activities not only resulted in industry conversions to ozone-friendly alternatives, but also helped industry, particularly small- and medium-sized enterprises (SMEs) and those in the RAC servicing sector, manage their transition to alternatives in a manner that was safe while ensuring business continuity. Further, information outreach and awareness activities targeted at different stakeholders supported by the MLF enabled the adoption of environmentally friendly technologies.

8. A summary of important observations based on the experience gained from implementing HPMPs is given below.

<u>Manufacturing related</u>

(a) Under HPMPs and other ODS phase-out projects, the approach focused on achieving compliance targets[7] defined for those substances. The implementation plans were broken down into annual targets over different timeframes (e.g., stage I of HPMPs for non-low-volume-consuming (LVC) countries focused on achieving the 2015 phase-out target). While long-term plans for achieving HCFC phase-out were taken into account when developing a country's overarching phase-out strategy, the consumption reduction and compliance targets for each of the specified timeframes were the basis for providing project funding support.

(b) The priority area during HPMP implementation, in terms of substance, was phasing out HCFC-141b used as a solvent and foam blowing agent. This was because it had a higher ODP compared to HCFC-22 and because other HCFCs, and low-GWP alternatives were available as alternatives to HCFC-141b in almost all applications. Less than 1 per cent of HCFC-141b phase-out projects were for conversion to high-GWP foam blowing agents.

(c) Air-conditioner manufacturers were one of the largest consumers of HCFC-22. Initially, the MLF supported conversions to R-410A, taking into consideration the technical feasibility, economic viability, and country strategy at that point in time. After the 68th meeting, with the increasing availability of low- and lower-GWP alternatives, the Executive Committee ceased to provide funding for projects for conversion to R-410A in air-conditioning applications given the high GWP of the substance. Manufacturers that were not supported by the MLF for their conversion are believed to have largely converted to R-410A, making a full conversion to low- or lower-GWP alternatives in these applications challenging. That being said, in one large Article 5 country, it appears that the dominant technology has been replaced with HFC-32 notwithstanding that support for that transition was not provided by the MLF.

(d) While the Multilateral Fund has supported air conditioner (AC) conversions to R-290, to date the manufacturing of such equipment on the converted lines has been limited, particularly for AC units with a cooling capacity greater than 1 tonne of refrigeration (TR). While a variety of challenges (e.g., non-availability of compressors, lack of regulations for market adoption of HC-based air-conditioners, longer time required for installation of split units) may have contributed to the limited manufacturing, competition from products using

[7] In certain instances, depending upon the national strategy, support for activities beyond compliance targets were considered and approved by the Executive Committee.

other refrigerants that were considered more market friendly and safer was likely a determining factor.

(e) A limited number of projects were approved for conversion from HCFC-22 to alternatives in the manufacturing of refrigeration applications, mainly commercial refrigeration applications as the consumption of HCFC-22 was relatively low in the manufacturing of refrigeration equipment. It was also known that most of the enterprises manufacturing commercial refrigeration equipment were using low-cost HFCs (e.g., R-404A which has a GWP of 3,922).[8] This was not monitored and reported as HFCs were not controlled under the Montreal Protocol prior to the ratification and implementation of the Kigali Amendment and there were no mechanisms available to have a holistic sectoral technology assessment during project implementation.

(f) SMEs were provided additional support for implementing conversion projects. Through decisions 60/44 and 74/50,[9] additional funding was available for SME conversion projects to low-GWP refrigeration technologies. In addition, technical assistance was also provided to SMEs to increase their awareness of low-GWP refrigerant technologies and to facilitate their adoption of those technologies. It must be noted that SMEs, particularly in commercial refrigeration manufacturing/assembly, needed special assistance for conversion due to lack of technical and financial capabilities to adopt the low-GWP refrigerant technologies.

<u>Support for the servicing sector and capacity building</u>

(g) Support for the servicing sector included *inter alia* training and certification of refrigeration technicians in good servicing practices;[10] supplying basic tools and equipment to technicians and to technical institutions that provide training to technicians; extending certification to servicing enterprises involved in the installation, servicing, maintenance and decommissioning of refrigeration equipment; providing regulatory support promoting technician certification, support in the development and adoption of standards and codes of practice for the servicing sector, continued strengthening of RAC associations and their involvement in the promotion or implementation of Montreal Protocol-related activities; and establishing refrigerant recovery and recycling schemes as well as reclamation centres, including regulatory support for refrigerant recovery and recycling where feasible.[11]

(h) The servicing sector activities facilitated good servicing practices including promoting the proper installation and maintenance of different RACHP equipment, recovery and reuse of HCFC-22, safe servicing practices using alternatives including low-GWP refrigerants, infrastructure support for training institutions as well as capacity building of RACHP

[8] Enterprises manufacturing commercial refrigeration equipment that were not covered under the HPMP due to ineligibility and other reasons continued to operate and grow with HFC-based refrigerants; further, albeit to a limited extent, low-GWP refrigerants such as R-290, R-600a, and CO_2 were used in a limited number of manufacturing enterprises.

[9] Under these decisions, up to 25 per cent additional funding was provided for conversion to low-GWP alternatives and in the case of SMEs consuming less than 20 mt per annum, up to 40 percent additional funding was provided.

[10] This includes containment of controlled substances through preventive maintenance, enhancing installation quality, maintaining/improving the energy efficiency of equipment through appropriate control settings, proper cleaning of equipment including heat exchangers, training on the safe handling of flammable refrigerants and specialized training of specific target audiences, such as on the use of CO_2-based equipment in supermarkets.

[11] Under decisions 89/6 and 91/65, additional support is currently available to Article 5 countries for including activities relating to energy efficiency in existing and future HPMPs for LVC countries and in the context of HFC phase-down; the impact of these activities will be known over the next few years.

associations for ongoing training support, which indirectly resulted in the adoption of low-GWP technologies in different RACHP applications.[12]

(i) During the implementation of HPMPs, it was reported that in several Article 5 countries hydrocarbons (HCs) were being used for retrofitting, operating and/or filling HCFC-22-based equipment. Concerns were raised regarding the safe use of flammable refrigerants in these systems that are designed for non-flammable refrigerants and the associated risks for technicians and end users. In response to this practice, the Executive Committee noted that, if the country engaged in retrofitting HCFC-based RAC equipment to flammable or toxic refrigerants and associated servicing with assistance from the Fund, the country did so on the understanding that it assumed all associated responsibilities and risks and that such retrofitting should be done only in accordance with the relevant standards and protocols (decisions 72/17 and 73/34).[13]

(j) At the 92nd meeting, the Executive Committee considered a report on end-user incentive schemes funded under the approved HPMPs.[14] Further to its discussions of the report, the Executive Committee *inter alia* requested Article 5 countries and bilateral and implementing agencies, when designing end-user incentive schemes, to consider factors that would contribute to the sustainability and scalability of the adoption of low-GWP alternatives by end users, such as potential energy-efficiency gains and opportunities for additional modalities and sources of funding, whenever possible and on a voluntary basis (decision 92/36(e)).

(k) Enterprises engaged in local installation and assembly were provided support under the HPMPs in accordance with the policy guidelines for the servicing sector. As the amount of HCFCs used in these applications was not high, limited additional support was requested and, therefore, provided for these enterprises under the HPMPs.[15]

(l) Project implementation and monitoring of activities were undertaken not only to achieve timely cost-effective completion of projects, but also to reduce consumption in accordance with the compliance targets. The impact of the conversion activities on the growth in HFC consumption was in general not monitored or reported as, during the period prior to October 2016, those substances were not controlled under the Montreal Protocol or under national regulations.

9. Notwithstanding support provided to Article 5 countries for adopting low-GWP alternatives to HCFCs in different RACHP and foam applications, there was considerable uptake of HFC-based equipment and technologies in Article 5 countries given *inter alia* technology evolution levels that affected the market availability of mature technologies at competitive prices; the caution exercised by industry in adopting low-GWP technologies; and market and regulatory factors. This was especially pronounced in the residential air-conditioning sector where energy-efficient high-GWP HFC-based technologies (e.g., energy-efficient R-410A-based ACs) were frequently adopted, particularly early in the HCFC phase-out. That transition helped countries achieve HCFC phase-out faster. However, this also increased the stock of HFC-based technologies in applications that had previously been using HCFCs.

[12] UNEP/OzL.Pro/ExCom/82/64

[13] The Secretariat is aware that HCs were in use in domestic refrigeration applications for more than two decades and that HFC-based domestic refrigerators may have been retrofitted with HCs; while not a safe practice, the small refrigerant charge likely limits the risk associated with such retrofits.

[14] UNEP/OzL.Pro/ExCom/92/43

[15] Applications where local installation and assembly enterprises were active mainly used HFCs, both in refrigeration and in air-conditioning.

10. The adoption of the Kigali Amendment in 2016 has led to a broad increase in awareness levels regarding the climate impact of using HFC-based technologies in RACHP applications, and of the need to phase down HFC-based technologies. As of the 93rd meeting, 106 countries have received funding for the preparation of KIPs, 24 countries have received funding for KIPs, and 14 countries have had HFC phase-down stand-alone investment projects approved. Furthermore, KIPs for additional countries are expected to be submitted over the next 24 months, including those Article 5 countries that are expected to ratify the Kigali Amendment in the near future. Since approved KIPs are in very early stages of implementation, it is difficult to assess their impact on the rate of adoption of low-GWP technologies and the consumption trends of those technologies. It must be noted that several of the domestic and commercial stand-alone refrigeration manufacturers assisted through HFC investment projects have completed their conversions to low-GWP alternatives.

11. Following the adoption of the Kigali Amendment, the Executive Committee is continuing to discuss different policy aspects aimed at providing support to maintain and/or enhance energy efficiency while adopting alternative technologies in the context of HCFC phase-out/HFC phase-down.

12. Currently, support is available for pilot projects relating to energy efficiency in the context of HFC phase-down (decision 91/65) and for activities relating to energy efficiency in the servicing sector for LVC countries when adopting low-GWP technologies while phasing out HCFCs (decision 89/6). The Executive Committee is continuing its consultations relating to activities to maintain and/or enhance energy efficiency while phasing down HFCs in document UNEP/OzL.Pro/ExCom/94/61.

Direct and indirect emission analysis and future trends resulting from cooling needs

13. The Global Cooling Watch 2023 report presents information on the direct and indirect emission trends up to 2050, including different scenarios depending upon the rate of adoption of technologies that could reduce direct emissions (e.g., faster HFC phase-down compared to Kigali Amendment targets) and indirect emissions (e.g., the impact of an increase in energy efficiency or the adoption of passive cooling). It must be noted that the analysis of the findings presented below do not prejudge any policy decisions relating to sustainable cooling; rather, it presents a summary of various possible interventions and the impact of those interventions. Further, the estimates of emissions are based on modelling of direct and indirect emissions undertaken with inputs from experts on technology trends in different cooling applications and in electricity generation.

Cooling demand and greenhouse gas emissions

14. The cooling demand in terms of terawatt (TW) of installed cooling capacity in Article 5 countries is expected to grow from 10.1 TW in 2022 to 39.4 TW in 2050 under a business-as-usual (BAU) scenario. The BAU scenario takes into account *inter alia* population forecasts based on UN mid-growth estimates; gross domestic product forecasts based on the United Nations Framework Convention on Climate Change – Shared Socio-economic Pathway 2 (UNFCCC SSP2) (“Middle of the road”);[16] and other macro-economic parameters such as access to electricity, number of households and number of vehicles.

15. Under an improved access (IA) scenario that considers additional equipment (i.e., access to a domestic refrigerator and a small AC for the poorest 1 billion households),[17] the cooling demand in Article 5 countries in 2050 is estimated at 43.2 TW. This translates to a growth in per capita cooling demand from 1.5 kW in 2022 to 4.8 kW in 2050. The growth multiplier (i.e., ratio of cooling demand in 2050 (BAU) compared to 2022) is expected to be the highest in countries in Africa and the Asia Pacific region followed by the Latin American and Caribbean and Eastern Europe regions.

[16] SSP2 is a scenario with medium challenges to mitigation and adaptation.
[17] This 1 billion households’ access is not included in the BAU scenario explained above.

16. The annual GHG emissions from cooling equipment used in Article 5 countries is expected to grow from 2.70 billion CO_2-equivalent (CO_2-eq) tonnes in 2022 to 7.47 billion CO_2-eq tonnes and 8.15 billion CO_2-eq tonnes in 2050 under BAU and IA growth scenarios, respectively.

Possible interventions to reduce greenhouse gas emissions

17. The Global Cooling Watch 2023 report includes estimates of the impact of different interventions on GHG emission levels in 2050 from all countries. Table 1 presents information on the estimates of the impact on emissions from different policies on Article 5 countries. The estimates presented in the report show that various interventions have the potential to reduce cooling-related direct and indirect GHG emissions in 2050 from 8.15 billion CO_2-eq tonnes to 2.11 billion CO_2-eq tonnes.[18]

Table 1. Impact of interventions in Article 5 countries to achieve sustainable cooling on direct and indirect emissions in 2050[19] under the IA growth scenario

Interventions	Total emissions in 2050	Direct refrigerant emissions	Indirect energy emissions
	Billion CO_2-eq tonnes		
No policy measures	8.15	1.22	6.93
Kigali Amendment Compliance	7.22	0.29	6.93
BAU energy-efficiency gain[20]	5.49	0.29	5.20
Load reduction[21]	4.32	0.24	4.08
Best energy efficiency gain[22]	2.25	0.24	2.01
Rapid HFC phase-down[23]	2.11	0.10	2.01

Reductions in direct emissions in different applications

18. Table 2 presents an assessment of cumulative direct emissions from cooling (i.e., emissions from the refrigerants used in different applications) under the "Kigali compliant scenario" in six application clusters, namely, residential space cooling, residential cold chain, non-residential space cooling, non-residential cold chain, transport space cooling and transport cold chain. It also shows the indirect emission reduction resulting from lower energy consumption, as well as the corresponding CO_2-eq tonnes emission decrease under "BAU energy efficiency gain" and "Best energy efficiency gain" scenarios. Residential space cooling, non-residential space cooling, non-residential cold chain and transport space cooling contribute to the highest estimated cumulative direct HFC emissions. The three space cooling sectors represent a significant proportion of the installed cooling capacity.

[18] Table 1 does not include any emission reductions linked to decarbonization of the electricity grid. Electricity decarbonization will provide further emission reductions, but in general it will not be influenced by cooling-sector stakeholders.
[19] Table 1 presents the GHG emission estimates in 2050 and not the cumulative impact from 2024.
[20] A BAU energy-efficiency-gain scenario is estimated based on the expected energy-efficiency gains that would be achieved under the BAU scenario for different applications over the period 2024 to 2040 with the assumption that equipment manufacturers will slowly introduce energy-efficiency improvements even without further policy measures, but that this rate of efficiency improvement is much slower than is technically feasible with stronger policy measures.
[21] Passive cooling measures that would result in a load reduction of around 25 per cent in 2050.
[22] A best energy efficiency gain scenario relates to the rapid introduction of energy-efficient technologies with the assumption of a rapid uptake of currently available high-efficiency equipment and ongoing efficiency improvements based on new technical developments.
[23] In the rapid HFC phase-down scenario, the use of very-high-GWP HFCs is avoided as soon as practicable (leapfrogging). Where an ultra-low-GWP option is already widely available (such as HCs for small, sealed equipment and HFO-1234yf for car air-conditioning) these options are modelled. Where the long-term technology choice is less clear (such as split air-conditioning), "lower GWP" options are introduced, with a transition to low-GWP alternatives during the 2030s.

Table 2. Cumulative direct cooling emissions from 2024 to 2050

Particulars[24]	**Kigali compliant**		**Cumulative energy consumption, 2024 to 2050 ('000 TWh)**		**Cumulative indirect emissions, 2024 to 2050 (million CO_2-eq tonnes)**	
	Billion tonnes CO_2-eq	**Percentage of total (%)**	**BAU energy efficiency gain scenario**	**Best energy efficiency gain scenario**	**BAU energy efficiency gain scenario**	**Best energy efficiency gain scenario**
Residential space cooling	8.31	32.1	68.635	39.345	41.54	20.62
Residential cold chain	0.15	0.6	14.816	8.992	7.53	4.46
Non-residential space cooling	4.98	19.2	24.411	15.306	14.83	7.81
Non-residential cold chain	8.85	34.2	32.002	20.683	18.03	10.32
Transport space cooling	3.36	13.0	24.616	17.768	8.27	4.92
Transport cold chain	0.25	1.0	3.349	2.108	0.99	0.53
Total	**25.90**	**100.0**	**167.829**	**104.202**	**91.20**	**48.66**

Reductions in peak power demand

19. The HFC Outlook Global Cooling Emissions Model provides estimates of the terawatt hours (TWh) per year electricity consumption. Average annual terawatt (TW) demand can be estimated by dividing the TWh figure by 8,760 (the number of hours in the year). However, this average is well below the peak demand, which would be higher due to the coincident load of air-conditioning equipment or, for example, electric cars that are getting charged. In light of the above, table 3 presents the estimates of peak demand in terawatts using a "peak demand factor"[25] of 2.3.

Table 3. Electricity consumption and peak demand under "BAU energy efficiency gain" and "Best energy efficiency gain" scenarios

Particulars	**2022**	**2030**	**2040**	**2050**
	TWh per year			
BAU efficiency gain	3,024	4,290	6,477	10,042
High efficiency gain	2,930	2,979	3,168	3,864
	Average annual TW demand (using 8,760 hours)			
BAU efficiency gain	0.35	0.49	0.74	1.15
High efficiency gain	0.33	0.34	0.36	0.44
	Peak demand TW, Peak demand factor 2.3			
BAU efficiency gain	0.79	1.13	1.70	2.64
High efficiency gain	0.77	0.78	0.83	1.01

Note: 1 TW is equal to 1 million MW; at an estimated investment cost of US $2 million per MW for power generation, the savings from avoided power plant investments is significant.

20. Energy-efficiency gains result in savings in capital investments into equipment infrastructure for power generation, transmission and distribution and can also contribute to direct savings in government expenditures when power consumption is subsidized.

21. Significant energy consumption reduction can be achieved through load reduction, which can be achieved through passive cooling measures; a cooling load at current levels of 43.2 TW can be reduced to about 33 TW by 2050 through such measures. For buildings, measures such as reflective surfaces, shading

[24] Residential space cooling relates to residential air-conditioners; residential cold chain relates to domestic refrigeration; non-residential space cooling relates to commercial and industrial air-conditioning; non-residential cold chain relates to commercial and industrial refrigeration; transport space cooling relates to transport air-conditioning, including mobile air-conditioning; and transport cold chain relates to transport refrigeration.

[25] Due to the complex nature of peak power demand assessment, "peak demand factor" is used for making estimates of peak power demand; the factor could vary depending on local conditions.

and improved insulation can significantly reduce cooling loads. For refrigeration applications, measures such as doors on retail displays, high-efficiency lighting in cold stores and variable speed evaporator fans can contribute to significant cooling-load reduction. These cooling-load reduction techniques are most cost effective for new systems, but many can also be applied to existing systems.

What might be done in relation to sustainable cooling in future under HCFC phase-out management plans and Kigali HFC implementation plans

22. Activities funded under the MLF play a key role in promoting the adoption of sustainable cooling technologies in RAC applications. The analysis above shows the considerable impact that HFC phase-down activities under the Kigali Amendment, the transition to high-energy-efficient equipment using low-GWP refrigerant technology, and efficient operation of the cooling equipment can have on sustainable cooling. Countries will benefit under both a BAU scenario in terms of people’s access to electricity and under an increased-access-to-equipment scenario.

23. In addition, the MLF is in a unique position to continue to implement activities to achieve sustainable cooling through: the national binding commitments for compliance with the Montreal Protocol targets; the networking of national ozone units (NOUs) with the industry; a country-driven approach to adopt sustainable technologies; a balanced approach that avoids supply-demand mismatch; and institutional strengthening. Furthermore, the MLF could work on sustainable cooling approaches and projects in collaboration with other institutions.

Strengthening data collection on sustainable cooling

24. *Strengthening data collection on cooling infrastructure relating to HFC consumption and energy efficiency along with patterns and trends is needed to understand barriers and interventions for achieving sustainable cooling.* An assessment of sector/industry structure and technology trends relating to comfort cooling and cold chains is critical to define specific action plans to promote sustainable cooling.[26] This would require country-specific approaches for data collection and analysis relating to cooling applications. The preparation and implementation of KIP activities can be used to collect information and engage stakeholders dealing with or using cooling applications when designing actions and policy interventions to reduce dependence on HFC-based equipment. In addition, activities with support from non-MLF funding sources could be used to collect information that could include sectoral data.

25. *Information on foam blowing agent technologies and other insulation solutions play an important role in reducing cooling loss and, therefore, need to be continuously monitored to strengthen the adoption of sustainable cooling technologies.* Adoption of sustainable cooling in different applications (e.g., building insulation, insulation of cold chain infrastructure to minimize cooling loss) should include the adoption of low-GWP sustainable insulation technologies, with a specific focus on SMEs involved in manufacturing insulation foam products. Data relating to insulation foam used in RACHP applications need to be continuously collected and analyzed with a view to ensuring energy-efficient operation of equipment.

Targeted programmes under HCFC phase-out management plans and Kigali HFC implementation plans for promoting sustainable cooling

26. *Activities under the HPMPs for the final HCFC phase-out could be implemented to avoid the adoption of high-GWP HFC-based replacement technologies.* Implementation of the remaining HPMP activities would necessitate a holistic approach with the existing and planned KIP activities that are being

[26] The data collection processes would be driven by main objectives for collecting this data. For interventions beyond KIP implementation, data collection (e.g., how cooling technologies are used at farm level and post-harvest operations prior to processing, issues faced in the context of access to cooling, need for interventions for behavioral changes among consumers) may need to be undertaken by other stakeholders with inputs from the NOU.

initiated, to avoid the adoption of high-GWP HFC-based replacement technologies and to promote the adoption of energy-efficient low-GWP refrigerant technologies.

27. *Sector/application-level strategy for comprehensive phase-out of HFCs along with the adoption of energy-efficient sustainable technologies could be considered as part of KIPs.* This can include single sectors or multiple sectors depending upon the national industry structure for achieving sustainable cooling solutions. During the implementation of HPMPs, some implementation plans included sector strategies that helped reduce HCFC consumption among all users of HCFCs in the sector and brought about a comprehensive policy and regulatory package to sustain HCFC phase-out. As a part of KIPs, for example, faster phase-out of HFC-134a and R-404A in the manufacturing of self-contained commercial refrigeration equipment at a sectoral level can result in reducing the long-term demand for HFCs in these applications. Sector strategies in adopting certain types of technologies (e.g., safe use of low-GWP flammable refrigerants) can have spill-over effects into other relevant applications/sectors and thus maximize benefits from this approach.

28. The following interventions can be considered during KIP implementation to achieve sustainable cooling, noting that these are not mutually exclusive.

(a) *Implementing energy-efficiency-related interventions while converting manufacturing from HFCs to alternatives.* This integrated approach of addressing refrigerant conversion and incorporating energy efficiency in equipment design would be a cost-effective solution to maximize positive climate impact.

(b) *Programmes for accelerated adoption of energy efficient low-GWP refrigerant-based RACHP equipment.* This would result in reduced energy consumption from RACHP equipment use both in countries that manufacture and import this equipment and would be beneficial to consumers and governments as there would be savings in energy consumption and energy needs resulting from RACHP equipment. This approach must include minimizing cooling demand in different end-user applications; right-sizing of RACHP equipment in terms of design and installation; ensuring good and safe practices for installation, maintenance and servicing of equipment including recovery and reuse of refrigerants; and conducting responsible end-of-life management. These activities should be complemented by appropriate targeted awareness and outreach programmes, capacity building of relevant national institutions and the promotion of innovative financing for the adoption of energy-efficient low-GWP refrigerant-based RACHP equipment.

(c) *End-user support programmes for reducing dependence on HFC-based equipment.* Reduced dependence on HFC-based equipment will reduce the demand for HFCs for initial charge and recharge and will speed up the adoption of alternatives to HFC-based equipment. This, in turn, will provide the market signals to equipment suppliers to promote those alternative technologies. While support is provided for projects involving the demonstration of low-GWP technologies and end-user incentives, they are limited in size and the scalability of the demonstrated technologies is also limited.

(d) *Efficient end-of-life management of equipment using HFCs.* This would require a combination of awareness raising and information outreach, training on recovery of refrigerant and the safe disposal of equipment at the end of its useful life, and the updating of associated codes of practice/regulations on safe end-of-life management. The recovered refrigerants that cannot be reused need to be safely disposed of, and innovative approaches for managing the logistics and funding of disposal and destruction need to be developed. This may involve a holistic approach to managing hazardous waste including refrigerant waste. In addition, given the high level of investment and the logistical processes involved, it may be useful to create regional centres that could reclaim refrigerant and operate destruction facilities.

(e) *Define mechanisms to achieve a holistic assessment HFC consumption in different applications.* This is critical for implementing policies and regulations to reduce use of controlled substances (e.g., sectoral approach for achieving results) which will be applicable to both MLF eligible enterprises and those not eligible for funding.

(f) *Integrated approach with strong institutional coordination for implementation of sustainable cooling activities.* Sustainable cooling requires the adoption of low-GWP refrigerant-based energy-efficient technologies and this necessitates an integrated approach involving MLF-funded projects with other relevant energy-related interventions. While the low-GWP refrigerant technology adoption is mainly addressed through the KIPs and other MLF-funded projects, energy-efficiency-related aspects need to be addressed through strong institutional coordination mechanisms with relevant energy-efficiency authorities. Given that NCAPs provide a holistic plan to address cooling needs at the national level and are prepared involving multiple stakeholders, integrating KIPs with the relevant components of NCAPs that address cold chain and comfort cooling applications can play an important role in supporting the adoption of sustainable cooling technologies. Countries could consider strengthening NOU coordination with the different stakeholders/institutional mechanisms involved in NCAP development/implementation (e.g., participating in coordination meetings, providing input into planning NCAP activities in order to maximize complementary approaches in adopting sustainable cooling technologies, and providing inputs during the review of the country's Nationally determined contribution (NDC) targets). Over time, depending on the evolution of NCAPs, the specific role of the NOU in the process could be adjusted. Similar approaches could be adopted in relation to other sector plans involving RACHP applications at the national level (e.g., tourism sector development plans, cold chain infrastructure strengthening).

RECOMMENDATION

29. The Executive Committee may wish to note the information contained in document UNEP/OzL.Pro/ExCom/94/63 on how HCFC phase-out and HFC phase-down activities supported by the Multilateral Fund might contribute to sustainable cooling.