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Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer
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Bangkok, 12–16 July 2021
Item 12 of the provisional agenda*

Energy-efficient and low-global-warming-potential technologies (decision XXXI/7)

Issues for discussion by and information for the attention of the Open-ended Working Group of the Parties to the Montreal Protocol at its forty-third meeting

Note by the Secretariat

Energy efficiency

I. Introduction

1. By its decision XXXI/7, on continued provision of information on energy-efficient and low-global-warming-potential technologies, the Thirty-First Meeting of the Parties requested the Technology and Economic Assessment Panel to prepare a report for consideration by the Thirty-Second Meeting of the Parties addressing any new developments with respect to best practices, availability, accessibility and cost of energy-efficient technologies in the refrigeration, air-conditioning and heat-pump sectors as regards the implementation of the Kigali Amendment to the Montreal Protocol.

2. In response to decision XXXI/7, the Technology and Economic Assessment Panel established a task force with a view to preparing the above-mentioned report in time for its consideration by the Thirty-Second Meeting of the Parties in 2020. Owing to the coronavirus (COVID-19) pandemic, it was decided that the Thirty-Second Meeting of the Parties would be convened online, with a reduced agenda, and that issues related to energy efficiency would instead be included in the agenda of the forty-third meeting of the Open-ended Working Group of the Parties to the Montreal Protocol, scheduled to be held in Bangkok from 12 to 16 July 2021.

3. Notwithstanding the situation, the Panel's task force prepared its report as had originally been planned in order to provide the parties with ample time to consider its findings before their formal discussions in July 2021. The report is set out in volume 2 of the September 2020 report of the Technology and Economic Assessment Panel and is available on the meeting portal of the forty-third meeting of the Open-ended Working Group.[1] The executive summary of the report, which consists of the report's key messages, is set out in the annex to the present note as received by the Secretariat,

* UNEP/OzL.Pro.WG.1/43/1.

[1] https://ozone.unep.org/sites/default/files/assessment_panels/TEAP_dec-XXXI-7-TFEE-report-september2020.pdf.

without formal editing. A summary of the information provided in the report is set out in section II of the present note.

4. Should significant new information become available, the task force intends to provide relevant updates as appropriate.

II. Summary of issues for discussion by the Open-ended Working Group at its forty-third meeting

A. Energy-efficient technologies in the refrigeration, air-conditioning and heat-pump sectors for the implementation of the Kigali Amendment to the Montreal Protocol (decision XXXI/7)

5. The report on the continued provision of information on energy-efficient and low-global-warming-potential technologies, set out in volume 2 of the Technology and Economic Assessment Panel's September 2020 report, is the fourth in a series of reports prepared by the Panel in response to decisions of the Meeting of the Parties since the adoption of the Kigali Amendment to the Montreal Protocol in 2016, addressing issues related to energy efficiency while phasing down hydrofluorocarbons (HFCs) and the cost and availability of low-global-warming-potential (GWP) technologies and equipment that maintain or enhance energy efficiency. As it has done for previous reports, the task force has restricted the scope of the document mainly to room air conditioners and self-contained commercial refrigeration equipment.

6. Introducing its report, the task force provides a summary of the key findings of the previous reports, including the importance of harnessing energy efficiency solutions during the HFC phase-down as these would double the climate benefit derived from the timely implementation of the Kigali Amendment; and the importance of access to cooling in meeting many of the Sustainable Development Goals. In addition, previous reports had shown that many energy-efficient technical innovations in refrigeration and air conditioning using lower-GWP refrigerants were available and being implemented, and that it was possible and beneficial for parties to leapfrog from HCFCs directly to lower-GWP refrigerants and higher energy efficiency. Furthermore, minimum energy performance standards, already introduced in some parties operating under paragraph 1 of Article 5 (Article 5 parties), would need to take into account the transition to lower-GWP refrigerants. Combined finance from multilateral organizations could drive best practice in delivering energy efficiency gains during the HFC phase-down in those parties.

7. The task force also highlights the progress made in the operationalization of the Kigali Amendment, noting the number of parties that had ratified the Amendment by the time of preparation of the report (104 by 30 September 2020), and the support provided under the Multilateral Fund for the Implementation of the Montreal Protocol by 2020 in that regard, including funding of $26 million for enabling activities; 10 project preparation activities and 6 investment projects to inform the ongoing discussions on the HFC cost guidelines.

8. The salient aspects of a number of useful recent reports are also provided, highlighting the environmental and development benefits of energy-efficient and climate-friendly cooling.

B. Update for 2020 on new refrigerants

9. With regard to new refrigerants, the task force notes that since the publication of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee 2018 assessment report,[2] one new single-component refrigerant (iodofluorocarbon IFC-13I1) and eight new refrigerant blends have received a designation or classification from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) of Standard 34 and/or from the International Organization for Standardization of (ISO) 817. Research into the chemical stability and the (low) chronic toxicity of IFC-13I1 is ongoing.

[2] https://ozone.unep.org/sites/default/files/2019-04/RTOC-assessment-report-2018_0.pdf.

10. Most of the lower-GWP alternatives available on the market have different degrees of flammability ranging from lower to higher flammability. Experts have worked together to address this challenge by developing new safety standards requirements.[3] These new revised safety standards will enable increased equipment refrigerant charge size for flammable refrigerants. Numerous research activities are under way to pave the way for the safe use of flammable refrigerants.

11. In room air conditioning, both natural and lower-GWP fluorinated refrigerants are now widely available to replace most high-GWP refrigerants, and it is possible to leapfrog to lower-GWP options in many regions. While more than 50 per cent of the globally produced air-conditioning units now use refrigerants with no ozone-depleting potential, in Article 5 parties locally produced room air conditioners predominately use HCFC-22 and remain relatively inefficient. The lack of high performance HCFC-22 compressors combined with more stringent minimum energy performance standards in some Article 5 parties is starting to favour the move towards the use of HFC technologies. However, where minimum energy performance standards have not yet integrated the future HFC phase-down schedule, the switch tends to be towards high-GWP refrigerants, in particular R-410A.

12. Lower-GWP refrigerants comprise: HFC-32, with a GWP of 675, already introduced in many countries around the world as an energy-efficient lower-GWP refrigerant; blends involving low-GWP HFCs, hydrofluoroolefins (HFOs), hydrochlorofluoroolefins (HCFOs) or iodofluorocarbon (IFC), with GWPs ranging from 100 to 2000 and varying degrees of flammability; and hydrocarbons, with GWP ranging from 1 to 20, such as HC-290 which is currently limited to small-capacity room air conditioners and portable or window air conditioners due to its higher flammability. Mitigation factors enabling the use of flammable refrigerants such as HC-290 involve the employment of qualified installers trained in the safe use of such refrigerants and the update of relevant safety standards.

13. In commercial refrigeration installations, low-charge and low-leak designs are already being used as alternatives to larger central systems in several countries and regions, operating with low-GWP refrigerants such as R-744, HC-600a and HC-290, while lower-GWP HFO blends are being applied in smaller charge commercial systems.

C. Refrigerant cost considerations

14. The cost of the refrigerant is typically 1 to 3 per cent of the cost of the air-conditioning equipment. However, the servicing costs of top-up refrigerant can be a substantial and recurrent hidden cost.

15. For typical room air-conditioning applications, when all factors pertaining to system design and refrigerant charge are taken into consideration, the use of HFC-32 is currently more cost effective than both R-410A and HC-290. However, in several regions the single component HFC-32 price is significantly higher than that of R-410A, and this price differential has been cited as a barrier to more widespread introduction of HFC-32 equipment. The price of HFC-32 will probably come down over time. Lessons learned from previous refrigerant transitions have shown that whereas upfront production costs tend to increase, these are offset by improved product efficiency, production process improvements and economies of scale.

16. The market penetration of HC-290 in room air-conditioning applications has been limited owing to concerns regarding safety and the lack of qualified servicing technicians, and due to restrictive standards and regulations, such as local building codes; consumer acceptability; liability issues and cost. Ambitious national legislation to phase down HFCs would provide a financial incentive for manufacturers to market HC-290 as a refrigerant. The skills of technicians for safe installation and servicing would also need to be developed, which represents a significant additional cost compared to less flammable refrigerants. In general, positive market signals enable manufacturers to scale up their production, which results in lower prices, and increased experience with and confidence in the technology at hand, therefore driving the adoption of the technology.

[3] With regard to International Electrotechnical Commission (IEC) standards, IEC 60335-2-89 has recently increased the charge levels for flammable refrigerants and this is expected to have a positive impact on the use of all lower-GWP flammable refrigerants; IEC 60335-2-40 is under revision and a committee draft for vote includes provisions for increased flammable refrigerant charge.

D. Update for 2020 on energy-efficient technologies for room air conditioning and self-contained commercial refrigeration

17. The task force report elaborates on the latest developments in energy-efficient technologies for room air conditioning and self-contained commercial refrigeration, including providing summary tables outlining the impact that various technological improvements can have on improving maximum potential energy efficiency and the associated incremental operating and capital costs.

18. In room air conditioning, technological improvements for various components (e.g., compressors, heat exchangers, sensors and controls, condenser precooling) may individually lead to a maximum potential energy efficiency improvement of up to 35 per cent, but can reach 50 per cent in some cases when specific improvements are applied synergistically. However, several technical barriers continue to slow the adoption of such energy efficiency measures, including a lack of technical know-how and of manufacturing capacity.

19. In self-contained commercial refrigeration, energy efficiency gains of up to 33 per cent can be achieved through improvements in various energy efficiency technology options, such as high-performance insulated glazing units for doors, and the use of high efficiency compressors and smart controllers.

20. Incremental operating and capital costs for these technologies may vary widely. Such costs are provided in the task force report for the specific technology options for both air conditioning and commercial refrigeration.

E. Availability and accessibility

21. Addressing the availability of high-energy-efficiency products with lower-GWP refrigerants for manufacturers, the task force notes, among other things, that such technology is available for both room air conditioning and self-contained commercial refrigeration. The main challenge is how to build capacity in Article 5 parties to exploit these improvements, and make them accessible and affordable. This involves giving local manufacturers time to absorb the technology, while developing a common framework of reference standards that includes both energy efficiency and HFC phase-down; building a national regulatory and verification infrastructure framework; and developing local technician training programmes.

22. The accessibility of high-energy-efficiency products with lower-GWP refrigerants for end-users can vary between regions, adjacent countries and even between districts within a country. It is influenced by multiple factors including the local supply chain; the regulatory environment (e.g., minimum energy performance standards, energy labels, safety and flammability standards, building codes); consumer affordability and return on investment; and servicing, including the availability of spare parts and refrigerants, trained technicians, quality and reliability of power supply, and logistics pertaining to transport, storage and handling of equipment.

23. According to the task force, harmonizing and implementing ambitious minimum energy performance standards and combining them with HFC phase-down is the single most important method for improving accessibility for high energy efficiency/low-GWP equipment in Article 5 parties. Accessibility for technology receivers can be improved by increasing technology awareness, contractor training and affordability, kick-starting market interest, ensuring the enforcement of standards through inspection and penalties; and removing electricity subsidies to make consumers aware of the importance of energy efficiency and the burden on the government of inefficiency. Significant technology producers with large export markets could be encouraged to produce high energy efficiency/low-GWP equipment by giving them advance warning that their export markets are introducing challenging minimum energy performance standards or similar market transformation policies requiring a combination of high energy efficiency and low-GWP HFCs. Market forces will ensure that such producers automatically respond and position themselves to supply the best available technology for local use and export.

24. Working with the electricity supply industry is also deemed by the task force to be important in helping consumers to recognize the benefits of high energy efficiency/low-GWP equipment, which include a reduction in lifetime energy consumption and cost; a reduction both in direct carbon dioxide (CO_2) emissions through the use of a lower-GWP refrigerants and in indirect CO_2 emissions through reduced energy use; and a reduction in electrical peak demand.

F. Case studies on best practices

25. The task force report presents recent case studies to illustrate best practices related to phasing down high-GWP refrigerants and increasing energy efficiency in the refrigeration, air-conditioning and heat pump sector. In so doing, the report elaborates on the institutional arrangements, capacities and capabilities, and regulatory environments needed to facilitate such a transition. These case studies confirm that the continued transition to low-GWP and higher-energy-efficiency equipment would be expedited by the coordinated adoption of refrigerant policies with the revision of minimum energy performance standards and labels. Countries that primarily import refrigeration, air-conditioning and heat-pump equipment have an opportunity to build capacity to quickly prioritize imports of more energy-efficient products alongside the HCFC phase-out and in preparation for the HFC phase-down.

G. Next steps

26. In terms of the way forward, the task force suggests that individual parties consider adopting a "fast mover" approach, with ambitious integrated regulations for the HCFC phase-out and HFC phase-down and with progressive energy efficiency improvement.

27. Recognizing that improved understanding of the combined impacts of HFC phase-down and higher energy efficiency requires better modelling of the whole stock of refrigeration, air-conditioning and heat-pump equipment both in specific countries and globally, the task force notes that it is making additional efforts on integrated modelling. It also reiterates its plan to provide updates in 2021 if significant new information becomes available.

28. Finally, the task force suggests that the parties may wish to consider requesting the Technology and Economic Assessment Panel to assess the potential options, costs and benefits of different phase-down schedules for HFCs under the Kigali Amendment, taking into account the benefits of the synchronized improvement in energy efficiency.

Annex

Report by the Technology and Economic Assessment Panel (September 2020) Volume 2

Decision XXXI/7: Continued provision of information on energy-efficient and low-global-warming-potential technologies

EXECUTIVE SUMMARY

Key Messages

1. Climate change is accelerating. Cooling demand is also increasing rapidly, and if unmanaged will result in a vicious circle, increasing global warming through greater energy consumption combined with the use of higher GWP refrigerants.

2. Addressing access to cooling and its adverse impacts has been a low priority historically, although this is rapidly changing. Cooling is included in all five themes at UNFCCC COP-26. The importance of a combined strategy to improve energy efficiency of cooling equipment while phasing down HFC refrigerants under the Kigali Amendment to the Montreal Protocol is increasingly being recognized as one of the biggest climate mitigation opportunities available today.

3. Reports from TEAP, UNEP, International Energy Agency (IEA), Kigali Cooling Efficiency Program (K-CEP), Clean Air and Climate Coalition (CCAC) and other institutions all emphasise the climate mitigation opportunity. New initiatives such as, the Cool Coalition, Twinning Training for senior energy and environment officials from A5 parties, and government leadership on developing national cooling plans, are all creating more visibility for these issues.

4. The coordination of energy efficiency with the implementation of HCFC phase out and HFC phasedown enables industry to explore the synergies in redesigning equipment and retooling manufacturing lines, in which the MLF and the implementing agencies have great experience. The EETF has confirmed that it is possible to leapfrog from HCFCs directly to lower GWP options in many sectors in different regions.

5. The 2019 EETF assessment of availability showed that low efficiency cooling equipment generally used higher GWP refrigerants, while equipment using lower GWP alternatives was generally of higher efficiency.

6. The further transition to low GWP and higher EE equipment would be expedited by the coordinated adoption of refrigerant policies with the revision of minimum energy performance standards (MEPS) and labels. In contrast, ambitious MEPS alone can undermine the HFC phasedown by encouraging improved EE of AC equipment, but with the use of high GWP refrigerants especially R-410A, especially in countries that are primarily technology receivers.

7. A5 parties developing a large installed base of low EE equipment, will be economically disadvantaged as valuable electricity capacity is lost from other uses, and because of the need to build more generating capacity. The economic disadvantage could last for decades due to the long product lifetimes of cooling equipment.

8. Since the 2019 EETF Report, the EETF identified additional technical improvements such as sensors, controls and condenser precooling.

9. Availability[1]: Technology and refrigerants are now widely available to replace most high GWP HFCs, with both natural and lower GWP fluorinated refrigerants options covering key sectors. This is supported by the best practice case studies in this report.

[1] "Availability" is the ability of the industry to manufacture products with new technologies of lower-GWP refrigerants and higher efficiency. Availability is controlled by the manufacturers and is related to technology. The factors affecting availability of products that are manufactured locally are summarized as:

- The ability of the industry in a country to absorb new technologies;
- Technical capabilities needed to implement the technology;
- Scalability of operations; and
- Technology barriers such as Intellectual Property Rights (IPR) and patents.

10. Accessibility[2]: Whilst there is good availability of high EE / low GWP products in some regions, the accessibility to these technologies is low in many A5 parties and even in some non-A5 parties. Improved accessibility to high EE/lower GWP AC in A5 parties could be achieved sooner by:

(a) early signalling from the Montreal Protocol to the air conditioning and refrigeration industry

(b) supporting policy designed to improve accessibility e.g. tackling market barriers affecting the end consumer;

(c) adopting ambitious and progressive energy performance standards across regions that are appropriately harmonized and coordinated with HFC phasedown strategies (e.g., U4E model regulations);

(d) coordinating multi-agency funding for A5 enterprise conversions for both high EE and low GWP refrigerants.

11. Progressive legislation, such as the EU F-gas regulation, has enabled a faster implementation of lower GWP refrigerants.

12. Individual parties could consider adopting a fast mover status, with ambitious integrated regulation for the HCFC and HFC phasedown with progressive EE improvement.

13. Parties could consider asking TEAP to assess options for simplified and harmonised emissions reductions, including costs and benefits of the ongoing HCFC phase out and the HFC phasedown of high GWP refrigerants, taking into account the potential benefits from the synchronised improvement in energy efficiency.

[2] "Accessibility" on the other hand is focussed on the consumer and varies with location within a region, country, or even district within a country. Some of the factors which affect accessibility include:

- Supply chain; Importers/Suppliers for parts, refrigerant;
- Presence of local manufacturing and/or assembly;
- Regulations affecting energy efficiency and safety; Collaboration with Energy Departments on integrated MEPS
- Service sector capacity and quality;
- Electricity quality, reliability and price;
- Affordability;
- Acceptability and preferences; and
- Presence or absence of laboratories and certification/verification bodies.