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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Eighty-second Meeting
Montreal, 3-7 December 2018

SUMMARY OF THE PARTIES' DELIBERATIONS AT THE 40TH MEETING OF THE OPEN-ENDED WORKING GROUP AND THE THIRTIETH MEETING OF THE PARTIES TO THE MONTREAL PROTOCOL IN RELATION TO THE TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL'S REPORT ON ISSUES RELATED TO ENERGY EFFICIENCY (DECISION 81/67(b))

Background

1. At its 81st meeting, in the context of agenda item 10(a) on Development of the cost guidelines for the phase-down of HFCs in Article 5 countries: Draft criteria for funding (decisions 78/3(i), 79/44(b) and 80/76(b)), the Executive Committee considered document UNEP/OzL.Pro/ExCom/81/53, and agreed to establish a contact group to discuss the matter further.

2. In regard to the element of energy efficiency of decision XXVIII/2,[1] the Secretariat was requested to provide to the 82nd meeting the summary of the Parties' deliberations at the 40th meeting of the Open-ended Working Group of the Parties (OEWG) to the Montreal Protocol and the Thirtieth Meeting of the Parties to the Montreal Protocol in relation to the report by the Technology and Economic Assessment Panel (TEAP) on issues related to energy efficiency in response to decision XXIX/10[2] (decision 81/67(b)).

3. The Secretariat has prepared the present document in response to decision 81/67(b). The document briefly presents the actions that have been taken in response to decision XXIX/10, particularly regarding

[1] Decision related to the amendment of phasing down HFCs.

[2] Decision XXIX/10 requested, in relation to maintaining and/or enhancing energy efficiency in the refrigeration and air-conditioning and heat-pump (RACHP) sectors, an assessment of: technology options and requirements including challenges for their uptake, and their long-term sustainable performance and viability, their environmental benefits in terms of CO_2-eq; capacity building and servicing sector requirements in the RACHP sectors; related capital and operating costs. It also requested TEAP to provide an overview of the activities and funding provided by other relevant institutions addressing energy efficiency in the RACHP sectors in relation to maintaining and/or enhancing energy efficiency while phasing down HFCs under the Kigali Amendment. Further, it requested the Ozone Secretariat to organise a workshop on energy efficiency opportunities while phasing-down HFCs at the 40th meeting of the OEWG, and, thereafter, for TEAP to prepare an updated final report for the Thirtieth Meeting of the Parties, taking into consideration the outcome of the workshop.

the report by the TEAP on issues related to energy efficiency, and the workshop on energy efficiency opportunities while phasing down HFCs held in the margins of the 40th meeting of the OEWG[3]. It further presents the discussions at the meeting of the OEWG in relation to the report by the TEAP and the workshop, and transcribes the general discussion in the OEWG on the issue of energy efficiency while phasing down HFCs. It also contains a recommendation.

4. To facilitate the work of the Executive Committee, the present document includes the following three attachments:

Attachment I: Summary of the workshop on energy efficiency opportunities while phasing down HFCs[4]

Attachment II: Access of Parties operating under paragraph 1 of Article 5 of the Montreal Protocol to energy-efficient technologies in the refrigeration, air-conditioning and heat pump sectors (Submission by Rwanda on behalf of the African Group for consideration at the Thirtieth Meeting of the Parties). Draft decision forwarded to the Thirtieth Meeting of the Parties by the 40th meeting of the OEWG[5]

Attachment III: Executive Summary, TEAP Report, September 2018, Volume 5: Decision XXIX/10 Task Force report on issues related to energy efficiency while phasing down HFCs (updated final report)

Actions taken in response to decision XXIX/10

5. In response to decision XXIX/10, TEAP established the Decision XXIX/10 Task Force (Task Force), which included TEAP and Technical Options Committees members, and outside experts who provided information from their own research and their organisations. The Task Force presented its report as Volume 5 of the Report of the TEAP, May 2018 and submitted it to the 40th meeting of the OEWG.

6. In response to paragraph 4 of decision XXIX/10, the Ozone Secretariat organized a one-and-a-half-day workshop on energy efficiency opportunities while phasing down HFCs[6] in the margins of the 40th meeting of the OEWG.

Discussions during the 40th meeting of the OEWG

7. The 40th meeting of the OEWG discussed under agenda item 6 on Issues related to energy efficiency while phasing down HFCs (decision XXIX/10), the report by the TEAP on energy efficiency in the refrigeration, air-conditioning and heat pump sectors (agenda item 6(a)); and the outcome of the workshop on energy efficiency opportunities while phasing down HFCs (agenda item 6(b)).

Report of the Task Force

8. Under agenda item 6(a), the Task Force presented its report to the OEWG[7]. In the ensuing discussion, all the representatives who spoke expressed appreciation to the Task Force for the quality of its report, which had been prepared in an extremely short period of time. During the discussion, the members

[3] Vienna, 9-10 July 2018.
[4] UNEP/OzL.Pro.WG.1/40/6/Rev.1
[5] UNEP/OzL.Pro.WG.1/40/7, annex I, section B
[6] Three briefing notes on energy efficiency issues were distributed by the Ozone Secretariat in advance of the workshop.
[7] Section C of annex II of document UNEP/OzL.Pro.WG.1/40/7

of the Task Force responded to questions raised by the Parties as detailed in paragraphs 97 to 104 of the report of the 40th meeting of the OEWG.[8]

Report on the workshop on energy efficiency opportunities while phasing down HFCs

9. Under agenda item 6(b), the co-chair of the OEWG invited one of the rapporteurs of the workshop to present the workshop report.[9] The rapporteur said that the workshop had dealt mainly with the topic of energy efficiency in the design of new and existing refrigeration and air-conditioning equipment and systems, but there had been many other relevant elements in the presentations, including, for example, the relative thermo-dynamic efficiency of various refrigerants and the impact of that on the overall energy efficiency of a system. The rapporteur highlighted one of the outcomes of the workshop, namely that although refrigerant choice was an important consideration in the overall energy efficiency of a system, it was not the dominant feature. For ease of reference, the summary of the workshop is contained in Attachment I to the present document. Additional points discussed relating to the workshop are contained in paragraphs 107 to 111 of the report of the 40th meeting of the OEWG.

General discussion on the issue of energy efficiency while phasing down HFCs

10. The general discussion on energy efficiency taking into account agenda items 6(a) and (b) of the 40th meeting of the OEWG is transcribed below:[10]

> "112. The Co-Chair then invited representatives to participate in a general discussion on the issue of energy efficiency while phasing down HFCs.
>
> 113. Representatives thanked the Technology and Economic Assessment Panel for its hard work in producing its report, and stressed the importance of the topic, given the impact on climate change not only of the refrigerants used in equipment but of the energy consumed during its operation. That was true in particular for space cooling, the demand for which was anticipated to rise steeply in the future. Implementing improvements in energy efficiency had implications for the design of equipment, its manufacture and its maintenance and servicing, and had the potential to deliver significant benefits, including not only a reduction in emissions but also lower costs to consumers and lower peak loads on electricity grids.
>
> 114. One representative observed that improvements in energy efficiency had always been one of the co-benefits of actions taken under the Montreal Protocol, as new technology adopted under successive transitions away from ozone-depleting substances had always been more efficient than the equipment it replaced, although that had not been the central purpose of the phase-out. It was clear that parties needed to look much more deeply into the topic, but that they should do so in the awareness that considerable amounts of expertise, resources and activities lay outside the institutions of the Montreal Protocol. It would be important, therefore, for parties to establish contacts with the relevant regulatory bodies in their own countries, and for the Protocol as a whole to avoid duplicating the work of other bodies or attempting to exercise influence over policy decisions that lay outside its jurisdiction. The Montreal Protocol should stick to its areas of core competence and experience.
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> 115. Questions relating to the costs of equipment were critical. As had been pointed out in the Panel's presentation, it was important to consider the full life-cycle cost of the equipment; equipment with a high initial capital cost often had a lower life cycle cost.

[8] UNEP/OzL.Pro.WG.1/40/7
[9] UNEP/OzL.Pro.WG.1/40/6/Rev.1
[10] UNEP/OzL.Pro.WG.1/40/7

116. Many representatives highlighted the need for assistance to Article 5 parties to ensure they were able to realize the potential gains of energy efficiency measures. That assistance included institutional strengthening activities, support for regional networks, training and capacity-building, in particular for technicians responsible for maintaining and servicing equipment, and technology transfer.

117. Representatives asked in particular for assistance with accessing sources of finance and support for capacity-building. Some recalled the commitment of the World Bank to provide $1 billion in lending for energy efficiency investments in urban areas, as part of its Climate Change Action Plan, and indicated that they would welcome further information on that topic at a future meeting. One representative observed that the Executive Committee was currently unable to approve funds for energy efficiency improvements because that lay outside the definition of incremental costs approved by meetings of the parties. At the same time, parties were often unable to access funding for those improvements from other institutions because the Montreal Protocol already possessed its own financial mechanism. It was important for parties to discuss how energy efficiency improvements could be financed under the Protocol.

118. Several representatives asked the Panel to provide more information in its updated report, including on the performance of low-global-warming-potential refrigerants (including information on their flammability and performance in different environments); possible policy measures that could be adopted, such as minimum energy performance standards, and countries that were already employing them; heat pumps; the barriers to the adoption of energy efficiency measures, and means of removing them; and estimates for the length of time needed to introduce alternatives.

119. Several representatives, highlighting the large volume of information available from various sources, suggested that the Technology and Economic Assessment Panel could help the parties by presenting key issues in a concise way, including information on new substances and technologies and their performance and management. Representatives requested the Panel to compile a concise list of all sources of funding available to support energy efficiency activities connected to the HFC phase-down.

120. One representative, however, felt that the Panel had not fulfilled the mandate given to it by decision XXIX/10 of the Twenty-Ninth Meeting of the Parties. Whereas that decision had requested the Panel to provide information related to maintaining and/or enhancing energy efficiency in the refrigeration, air-conditioning and heat-pump sectors while phasing down HFCs, in fact the Panel had provided information on energy efficiency issues more generally. In particular, it had not taken into account the relative performance of alternative substances. He requested the Panel to include in its updated report clear and concise information on technology options; requirements for uptake, capacity-building and servicing (including in particular servicing with flammable refrigerants), and the related incremental capital and operating costs; the concept of the “cost hump”, related to the high upfront costs of energy efficient equipment, along with the importance of financial measures to overcome it; and the estimated costs of the technical interventions mentioned in the Panel’s report.

121. Another representative agreed, arguing that both the Panel’s report and the workshop should have been more focused. Topics such as minimum energy performance standards fell outside the remit of the Montreal Protocol. Issues related to climate change should be discussed in the context of the United Nations Framework Convention on Climate Change, and parties to the Montreal Protocol should discuss only issues related directly to the replacement of refrigerants.

122. Several representatives requested the Secretariat to arrange an informal group in which parties could discuss with the Panel the issues they would like to see included in its updated report for the Thirtieth Meeting of the Parties.

123. Subsequently, the representative of Rwanda introduced a conference room paper, containing a draft decision relating to sub-items 6 (a) and (b) of the agenda, on behalf of the African Group.

124. The Working Group agreed to establish a contact group, co-chaired by Mr. Leslie Smith (Grenada) and Mr. Patrick McInerney (Australia) to discuss the draft decision.

125. Reporting back, the co-chair of the contact group said that the group had developed additional guidance on energy efficiency for the Technology and Economic Assessment Panel, which had been posted on the meeting portal. The additional guidance to the Panel is reproduced in annex III to [document UNEP/OzL.Pro.WG.1/40/7], without formal editing. Members of the Panel had said that, although they had only four more weeks in which to finalize the Panel's report, they would do their best to address both the additional guidance and the interventions made by parties at the present meeting.

126. The contact group had discussed the conference room paper submitted by Rwanda on behalf of the African Group. A number of elements had been seen as useful, but it had been agreed that further consideration was needed with regard to how they fitted into the framework of the Montreal Protocol and how they related to decision XXVIII/2, particularly paragraphs 16 and 22, and to the ongoing work of the Executive Committee. Further discussion of how the proponents foresaw the implementation of those elements was also required.

127. The Working Group agreed to forward the draft decision, as set out in section B of annex I to the present report, to the Thirtieth Meeting of the Parties for further consideration."

11. For ease of reference, the draft decision on access of parties operating under paragraph 1 of Article 5 of the Montreal Protocol to energy-efficient technologies in the refrigeration, air-conditioning and heat-pump sectors, submitted by Rwanda on behalf of the African Group, is contained in Attachment II to the present document.

Outcome of the Thirtieth Meeting of the Parties

12. Based on the guidance provided by the 40th meeting of the OEWG, the Task Force prepared a revised report under "Volume 5 of the Report of the TEAP, updated final report (September 2018)", and submitted for consideration by the Thirtieth Meeting of the Parties. The Executive Summary of the updated final report of the Task Force along with additional guidance on energy efficiency for the TEAP, is contained in Attachment III to the present document.

13. The Executive Committee may wish to note that the Thirtieth Meeting of the Parties will continue discussing under agenda item 8 on Issues related to energy efficiency while phasing down HFCs (decision XXIX/10): the updated final Report by the TEAP on energy efficiency in the refrigeration, air-conditioning and heat-pump sectors, issued on September 2018 (agenda item 8(a)); and access of parties operating under paragraph 1 of Article 5 of the Montreal Protocol to energy-efficient technologies in the refrigeration, air-conditioning and heat pump sectors (agenda item 8(b)).

14. Prior to the 82nd meeting, the Secretariat will issue an addendum to the present document summarizing the outcomes of the discussions of the Thirtieth Meeting of the Parties on issues related to energy efficiency while phasing down HFCs.

Recommendation

Pending outcomes on energy efficiency of the Thirtieth Meeting of the Parties.

Attachment I[1]

Annex

Summary of the workshop on energy efficiency opportunities while phasing down hydrofluorocarbons (Vienna, 9 and 10 July 2018)

Introduction

1. Under the Kigali Amendment to the Montreal Protocol, parties recognized the importance of maintaining and/or enhancing energy efficiency while transitioning away from high-global-warming-potential (GWP) hydrofluorocarbons (HFCs) to low-GWP alternatives in the refrigeration, air-conditioning and heat-pump sectors. Parties also recognized that maintaining and/or enhancing energy efficiency could have significant climate benefits.

2. A one-and-a-half-day workshop on energy efficiency opportunities while phasing down HFCs was convened in accordance with decision XXIX/10 (para. 4) taken by the parties to the Montreal Protocol on Substances that Deplete the Ozone Layer at their twenty-ninth Meeting, held jointly with the eleventh meeting of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer, in Montreal (20–24 November 2017).

3. The objectives of the workshop were to provide an opportunity for parties and other stakeholders to discuss in depth:

(a) The types of technical opportunities that can be adopted to improve the energy efficiency of both new and existing refrigeration, air-conditioning and heat-pump (RACHP) equipment, as well as improvements to building design

(b) The barriers to these opportunities and the ways in which barriers can be overcome through appropriate policy measures and investments

(c) The connections between Montreal Protocol activities to phase down HFCs and other activities that are addressing energy efficiency issues in the RACHP sectors.

4. The workshop involved 34 speakers, supported by six session facilitators and seven rapporteurs. The more than 450 participants came from governments, industry and industry associations, international and non-governmental organizations, academic institutions, consulting firms and other organizations. Sessions included presentations and panel discussions, with opportunities for all participants to contribute through questions and statements addressed to the speakers, including through a smartphone application that allowed questions to be submitted electronically.

5. The three main sections of the workshop addressed:

(a) The overall context of energy efficiency in the refrigeration, air-conditioning and heat-pump sectors

(b) Technical opportunities for improving RACHP energy efficiency

(c) Investment, financial and policy measures that encourage improved cooling efficiency, and the potential relationship between energy efficiency policies and the Kigali Amendment.

6. Three briefing notes distributed by the Ozone Secretariat in advance of the workshop helped participants better understand energy efficiency issues.

[1] UNEP/OzL.Pro.WG.1/40/6/Rev.1

7. The present document summarizes the key issues raised in each session of the workshop, including those raised in presentations and in subsequent question-and-answer sessions with participants.

A. Background to energy efficiency in the refrigeration, air-conditioning and heat-pump sectors

8. The objective of the session was to set the scene by examining overarching issues and challenges to improving energy efficiency in the RACHP sectors.

9. RACHP use in Article 5 countries is expected to more than double by 2030 and more than triple by 2050. Currently, refrigerant emissions and energy use in the RACHP sectors both contribute to global warming, with energy use accounting for more than 80 per cent of the sectors' combined carbon footprint. As a consequence, various interventions will be required to avoid a very large increase in energy demand from the use of RACHP equipment. According to the International Energy Agency, almost half of the near-term reductions in emissions required to meet the goals of the Paris Agreement can be achieved by adopting cost-effective energy efficiency measures, including in the RACHP sector. Global energy efficiency improved by 13 per cent overall between 2000 and 2016, but progress has since slowed because of a reduction in the number of energy efficiency policies enacted and a decrease in energy prices.

10. There is significant technical potential to reduce RACHP energy consumption by reducing cooling loads; minimizing the temperature lift; accounting for variable operating conditions; selecting the most efficient refrigeration cycle, refrigerant and components; designing effective control systems; monitoring operating performance; and correcting faults.

11. Despite the excellent potential that exists, uptake of energy efficiency measures is slow owing to a lack of understanding of how to improve energy efficiency, poor design and selection of equipment, a lack of monitoring and analysis of performance, and narrow financial analysis that does not value the multiple benefits of energy efficiency improvements.

12. As an example of the benefits and challenges of improving energy efficiency, several presentations highlighted the fact that requiring all new air-conditioning units to be very efficient would cut growth in demand for cooling energy by half. If combined with efficient building design, this would completely eliminate growth in the use of energy for space cooling. The average energy efficiency of air conditioners currently on the market is less than half that of efficient products available in most markets, and one third that of the best available technology. Consumers tend to buy the least expensive units even though the extra capital cost of a more energy-efficient unit is usually recovered within one to three years from the resulting energy savings.

13. The introduction of high-energy-efficiency technologies often creates an initial "price hump" that can make them less competitive than conventional technologies. The size and duration of this hump can be reduced through appropriate policies and financial interventions, such as minimum energy performance standards (MEPS), grants and low-cost loans, and bulk procurement programmes. Presenters and some participants advocated for an integrated approach that links efficiency with the refrigerant transition.

14. Given its many benefits, energy efficiency is best seen as an enabler of sustainable development; RACHP goes far beyond comfort and has positive impacts on food safety, health and many other elements of the Sustainable Development Goals.

B. The technical potential for improving energy efficiency in the refrigeration, air-conditioning and heat-pump sectors

15. Two workshop sessions aimed to outline the technical potential for improving the energy efficiency of new RACHP products (session 2) and existing RACHP products (session 3).

1. New products

16. Presentations highlighted the wide range of new RACHP products that have large energy efficiency improvements compared to older designs; energy savings of well over 50 per cent were illustrated through a number of presentations. Some examples described were:

(a) Reductions in cooling demand through such measures as ventilation cooling, improved building design, doors on retail display cases, and LED lighting

(b) Improved thermodynamic performance of certain refrigeration cycles and refrigerants, including CO_2 trans-critical systems for retail applications and R-290 for movable room air conditioners

(c) Improved system components, such as inverter-driven compressors, electronic expansion valves, ejectors and new heat exchanger designs

(d) Improved control systems at the product, system and building automation system levels.

17. Refrigerant selection is an important design consideration for RACHP equipment. The properties of alternative refrigerants relevant for refrigerant selection included energy efficiency, flammability, toxicity and so on. The direct impact of refrigerant selection on overall energy efficiency is typically in the plus or minus 5 to 10 per cent range. Reducing leaks through proper installation practices and good design – for example, by minimizing joints and using brazed rather than mechanical connections – reduces refrigerant emissions and helps maintain energy efficiency over the life of the equipment.

18. MEPS drive the market for energy-efficient equipment. The use of MEPS has yielded positive results in countries around the world, including those with high ambient temperatures. The design of equipment to be used in high-ambient-temperature settings must take into account the high heat loads and very high condensing temperatures.

19. The benefits of a holistic approach and the need to look at building envelope and insulation technologies as well as effective service and refrigerant management were emphasized.

20. Finally, improving energy efficiency in the cold chain helps reduce food waste.

2. Existing products

21. Examples were given of a wide range of opportunities for improving the performance of existing equipment through better control and monitoring and improved maintenance. Several presenters described savings in the 10 to 30 per cent range, with a few examples given of even higher savings. Improving efficiency typically also extends the operating life of equipment. Some key techniques described by presenters included:

(a) Improved metering that identifies poorly performing equipment and maintenance issues

(b) Cleaning of heat exchangers and filters

(c) Ensuring good airflow around heat exchangers

(d) Monitoring and repairing refrigerant leaks.

22. Many presentations stressed the importance of training service technicians to ensure that they understand their role in improving the energy efficiency of RACHP equipment. Experience shows that training is most effective when it includes both theoretical and practical assessments. Refresher training and requalification for new equipment and refrigerants should be incorporated into training requirements. Training should cover leak detection and repairs, equipment cleaning, equipment and control settings, and safety considerations. The provision of information on basic system maintenance to customers and end users can also be important.

23. The discussions highlighted the need for more information comparing the energy efficiency of low-GWP refrigerants to that of hydrochlorofluorocarbons (HCFCs) and HFCs. It was also noted

that energy efficiency issues related to maintenance seemed to be common to all types of refrigerants. That view was echoed by the panel members.

C. Investment and financing opportunities

24. The objective of this session was to give an overview of opportunities, experiences and challenges relating to the funding of energy efficiency projects in the RACHP sectors.

25. Governments and development banks have climate targets that can be drivers for increasing energy efficiency. Energy efficiency would improve more rapidly, however, if it were seen as a means to an end. More emphasis should be put on the services that people desire and are willing to pay for, and that financial institutions will therefore support. For example, governments are particularly interested in energy security, industry in productivity, hospitals in safe vaccines, and schools in improving students' performance.

26. While it is often difficult to commoditize energy efficiency projects because different types of projects require different approaches and tailored financial mechanisms, standardization and certification schemes can help by providing greater certainty in terms of performance and creating larger markets for products and services. These developments in turn create business opportunities for equipment suppliers and energy service companies. While such companies have not been universally successful, driven by the notion that "where there is a margin there is a market", they have delivered large-scale energy efficiency investments in China and India; lessons learned from these countries could benefit others. Energy service companies can facilitate financial flows by identifying solutions for overcoming barriers, taking on technical risks, and aggregating large numbers of small projects in order to reduce transaction costs for banks, as has been done successfully by Energy Efficiency Services Limited of India.

27. Energy efficiency projects often have difficulty attracting financing. They are often relatively small, and the benefits accrue not only to the investor, in terms of energy cost savings, but to the broader economy and society – for example, by reducing the need to invest in supply infrastructure or by reducing CO_2 emissions. In other words, even though both public and private stakeholders benefit from improvements in energy efficiency, the up-front costs are not shared.

28. Perceived risks need to be addressed, and real risks need to be managed. There is some evidence that local financial institutions do not take international energy efficiency programmes seriously.

29. It is generally held that, while sufficient funds are available, these do not always flow effectively in the case of energy efficiency projects. It was suggested that a catalogue of funding opportunities be developed as an information source for parties.

D. Policies for improving the energy efficiency of refrigeration, air-conditioning and heat-pumping appliances and systems

30. Two sessions explored policy measures that encourage the uptake of higher-efficiency RACHP products. The first dealt with policies governing domestic appliances and the second with those for larger systems.

31. For domestic appliances, the presentations described three main policy mechanisms: MEPS, energy-labelling programmes and demand response strategies.

32. Many countries around the world are successfully using MEPS to drive markets for more efficient appliances, often in combination with labelling programmes. Mandatory MEPS have been successful both in countries that manufacture energy-using products and in those that import most of their products. It is widely held that mandatory MEPS are the most effective policy measures for removing the least efficient products from the market.

33. Energy labels are voluntary or mandatory mechanisms for encouraging purchases of appliances with performance exceeding the minimum standard. Mandatory comparative labels such as those used in China, Ghana and the European Union and in many other countries help consumers choose more efficient products, while voluntary endorsement labels like the Energy Star label used

in the United States of America help consumers choose the most efficient products and drive the market towards higher-efficiency products. Trust in brands is an important aspect of any labelling programme. Market surveillance is important for guaranteeing the success of such programmes. Standards and labels need to be regularly reviewed and updated.

34. Some appliances, such as air conditioners, can be remotely controlled through smartphone applications to reduce or shift periods of peak demand. This is particularly useful when variable renewable energy resources are being integrated into electricity grids. In Australia, for example, one in four houses has rooftop solar panels, and consumers are given incentives to reduce peak demand for power. While these systems are in early stages of development, they could make major contributions to reducing peak energy demand for cooling.

35. For larger equipment, utility demand-side management programmes can overcome some of the barriers to investment in energy efficiency. Utility companies can provide both technical expertise and financing and monetize the financial benefits of reducing peak demand on the electricity grid.

36. Bulk procurement was described as a mechanism that can reduce the size of the capital cost "hump" that occurs when innovative highly energy efficient products reach the market. A bulk procurement business model can work with both domestic appliances and larger RACHP equipment.

37. A presentation on cold chains described how, in some regions, up to 40 per cent of food produced is lost owing to the lack of an integrated cold chain that connects producers to markets and consumers. According to a recent United Nations report, only one in three fish caught ever reaches a plate. The use of small diesel engines on refrigerated lorries creates localized air pollution as well as CO_2 emissions. Alternative approaches to transport refrigeration can overcome some of these issues.

38. District cooling uses economies of scale to save significant amounts of energy, especially in high-ambient-temperature locations, where 70 per cent of electricity consumption goes towards cooling. When district cooling is used in appropriate circumstances, efficiency improvements of over 40 per cent can be achieved.

Attachment II

B. Access of parties operating under paragraph 1 of Article 5 of the Montreal Protocol to energy-efficient technologies in the refrigeration, air-conditioning and heat-pump sectors

Submission by Rwanda on behalf of the African Group

Noting the imminent entry into force of the Kigali Amendment to the Montreal Protocol,

Recognizing the role of all United Nations bodies in supporting the global response to the threat of climate change and its increasing impacts worldwide,

Acknowledging that the effective implementation of the Kigali Amendment will require additional efforts to reduce greenhouse gases and will give rise to the opportunity to address energy efficiency concerns and contribute to the reduction of indirect emissions of greenhouse gases,

Cognizant that developing countries face the challenge posed by the pervasive entrance of inefficient, outdated and/or obsolete technologies into their markets,

Recognizing the opportunities cited by the Technology and Economic Assessment Panel in volume 5 of its May 2018 report, where it is noted that several categories of enabling activities can potentially serve to bridge activities related to enhancing or maintaining energy efficiency with hydrofluorocarbon phase-down activities,

1. To request financial support for parties operating under paragraph 1 of Article 5 for the development and enforcement of policies and regulations to avoid the assembling and manufacturing of energy-inefficient refrigeration, air-conditioning and heat pump equipment as well as its import and penetration into their markets;

2. To approve a window for funding demonstration projects in parties operating under paragraph 1 of Article 5 that can provide information on costs and cost-effectiveness as well as practical experience to inform discussions and decisions on maintaining energy efficiency in the servicing sector;

3. To request the Executive Committee of the Multilateral Fund to develop guidelines for bulk procurement processes that will allow aggregation of demands for equipment with high energy efficiency and lower global warming potential at affordable prices;

4. To request the Technology and Economic Assessment Panel to include in its annual reports updates on the cost and availability of lower-global-warming-potential refrigerants and energy-efficient equipment applicable to all, including high-ambient-temperature countries;

5. To request implementing agencies to facilitate the provision of targeted training on certification, safety and standards, awareness-raising and capacity-building that will assist parties operating under paragraph 1 of Article 5 in maintaining and enhancing the energy efficiency of refrigeration, air-conditioning and heat-pump equipment.

Attachment III

EXECUTIVE SUMMARY OF TEAP DECISION XXIX/10 TASK FORCE REPORT ON ISSUES RELATED TO ENERGY EFFICIENCY WHILE PHASING DOWN HFCs
Updated final report issued in September 2018

Background

1. In response to decision XXIX/10, TEAP established the Decision XXIX/10 Task Force (Task Force), which included TEAP and Technical Options Committees members, and outside experts. The Task Force presented its report under Volume 5 of the Report of the TEAP, May 2018 and submitted it to the 40th meeting of the Open-ended Working Group (OEWG).

2. Under agenda item 6(a)[1] the Task Force presented its report to the OEWG. Subsequent to discussions in plenary where members of the Task Force responded to questions raised by the Parties, the Parties agreed to establish a contact group to further discuss the matter. Reporting back to plenary, the co-chair of the contact group said that the group had developed additional guidance on energy efficiency for the Task Force. For ease of reference, the additional guidance provided by the OEWG of the Parties is presented at the end of this annexure.

3. The Executive Summary extracted from the updated final report is presented below. The highlighted text relates to changes introduced by the Task Force to its report issued in May 2018.

Executive Summary of the updated Decision XXIX/10 Task Force report

At their 29th Meeting, parties requested the Technology and Economic Assessment Panel (TEAP) to report to the 40th Open-ended Working Group (OEWG-40) on issues related to energy efficiency (EE) while phasing down hydrofluorocarbons (HFCs), as outlined in Decision XXIX/10. Decision XXIX/10 requests, in relation to maintaining and/or enhancing energy efficiency in the refrigeration and air-conditioning and heat-pump (RACHP) sectors, an assessment of:

- Technology options and requirements including
  - Challenges for their uptake;
  - Their long-term sustainable performance and viability; and
  - Their environmental benefits in terms of CO_2eq;
  - Capacity-building and servicing sector requirements in the refrigeration and air-conditioning and heat-pump sectors;
- Related costs including capital and operating costs;

The decision also requested TEAP to provide an overview of the activities and funding provided by other relevant institutions addressing EE in the RACHP sectors in relation to maintaining and/or enhancing energy efficiency while phasing down HFCs under the Kigali Amendment.

Finally, Decision XXIX/10 requested the Secretariat to organise a workshop on EE opportunities while phasing-down HFCs at hydrofluorocarbons at OEWG-40, and, thereafter, for TEAP to prepare an updated final report for the 30th Meeting of the Parties (MOP-30) to the Montreal Protocol, taking into consideration the outcome of the workshop.

In response to Decision XXIX/10, TEAP established the Decision XXIX/10 Task Force, which included TEAP and Technical Options Committees members as well as outside experts. EE is a broad topic of major importance for the environment, economics and health, and there is an enormous amount of published

[1] Issues related to energy efficiency while phasing down hydrofluorocarbons (decision XXIX/10): Report by the TEAP on energy efficiency in the refrigeration, air-conditioning and heat pump sectors.

literature and reviews. In preparing its response to the decision, the Task Force referenced information provided in earlier TEAP reports (e.g., Decision XXVIII/3 Working Group Report – October 2017) and examined updated, available research and studies. Outside expert members of the Task Force provided relevant information from their own research and of work done by their colleagues and organisations for consideration in this report.

This report is organised, following the format requested in Decision XXIX/10, into an introduction and two main chapters. Chapter 2 deals with the technology opportunities related to maintaining or enhancing EE during the phasedown of HFCs. Various aspects of the EE opportunities in the RACHP sector were considered. Chapter 2 also considered the other topics requested from the decision including the long-term sustainability and viability of the technology opportunities, consideration of high ambient temperature conditions, climate benefits from adopting the RACHP EE measures, and consideration of related capital and operating costs. Chapter 3 examines other financial institutions where these may intersect with support for realizing EE goals in the RACHP sectors during the phasedown of HFCs. Contained in two annexes are information about the different challenges to the technology uptake in the RACHP sectors and examples of relevant projects funding or financing. Two additional annexes provide a summary of the workshop organised by the Secretariat and the guidance to the TEAP from the OEWG-40 contact group for consideration in the updated final report to MOP-30. For ease of reference, updates to the May 2018 Decision XXIX/10 Task Force Report are highlighted in grey throughout this updated September 2018 final report.

Below are summaries of the various sections of the report.

Energy efficiency in RACHP sectors in the context of refrigerant transition

Low GWP refrigerants are expected to have an impact on the system efficiency, which is likely to be within ±5% of the baseline refrigerant(s) in terms of energy performance. Refrigerant blends can be valuable in optimising system performance, balancing between coefficient of performance (COP), volumetric capacity, flammability, and GWP.

The large majority of the improvement in EE in newly designed RACHP systems can be achieved through the optimisation and use of new and advanced components, particularly compressor, heat exchanger and controls

The Kigali Amendment to the Montreal protocol focused primarily on developing a timeline to phase down high global warming HFCs to avoid direct contribution of up to 0.5°C of total global warming by 2100. However, the direct benefits of the reduction of high GWP refrigerants during the phase down might be offset by the use of less energy-efficient equipment. On the contrary, if this amendment resulted in the use of more energy-efficient equipment, the total reduction of greenhouse gases emissions both from direct and indirect sources, could double that.

Technology opportunities and challenges to maintain and/or enhance energy efficiency of new RACHP equipment

Technology research and development, and the studies to assess those technologies, are progressing to support compliance with the Kigali amendment.

By using a rigorous integrated approach to RACHP equipment design and selection, the opportunities to improve EE or reduce energy use can be maximised. This approach includes:

- Ensuring minimisation of cooling/heating loads;
- Selection of appropriate refrigerant;
- Use of high efficiency components and system design;
- Ensuring proper install, optimised control and operation, under all common operating conditions;
- Designing features that will support servicing and maintenance.

While the benefits of higher EE, such as savings in energy, operating cost to the consumer, peak load and GHG emissions are widely recognised, many barriers to the uptake of more efficient equipment continue to persist. There are a number of common challenges that apply to all types of RACHP equipment. There are also certain market and sector-specific issues that are presented in further detail. Broadly, these barriers can be classified into the following categories: financial, market, information, institutional and regulatory, technical, service competency and others. Ways to overcome the barriers, and estimates of the length of time needed to introduce alternatives are presented.

Technologies resulting in efficiency improvement opportunities available for high-GWP refrigerants may be applicable to low-GWP refrigerants as well.
The largest potential for EE improvement comes from improvements in total system design and components, which can yield efficiency improvements (compared to a baseline design) that can range from 10% to 70% (for a "best in class" unit). On the other hand, the impact of refrigerant choice on the EE of the units is usually relatively small – typically ranging from +/- 5 to 10%. Furthermore, there are also a wide variety of co-benefits of EE in addition to avoided peak load. Various examples cited the following benefits: avoided mortality caused by energy poverty, avoided morbidity caused by energy poverty, reduced days of illness, comfort benefits, avoided SOx, NOx and particulate matter emissions, and avoided CO_2 emissions in addition to direct economic benefits, such that these additional co-benefits were 75%-350% of the direct energy-savings benefits of energy efficiency in the cases reviewed.

Long-term sustainable performance and viability

In assessing consideration of long-term sustainable performance and viability (of technology options and requirements in the context of maintaining or exceeding energy performance), it was necessary for the Task Force to define the terms and timeframes for this assessment. The Task Force interpreted the term "long-term" for RAHCP technologies to mean for a period of up to 15 years, which is consistent with previous assessments of this term used and reported by the TEAP.

For the phrase " sustainable performance and viability" (over the 15-year "long-term" timeframe), the Task Force looked to assess whether or not the options and requirements for technology that are commercially available today and being commercially developed for the nearer term (which include zero or low-GWP refrigerants - single chemicals and blends, and compatible equipment/hardware), would be anticipated to at least meet EE needs (i.e., would be viable) and whether or not they would remain viable over the next 15 years, including considerations for servicing.

Therefore, the relevant aspects that will impact the long-term sustainment of performance are expected to be as follows:

- Technological environment,
- Minimum Energy Performance Standards (MEPS) and labelling programmes.

While the challenge of researching and finding sound, technical solutions is important, in some cases it may be even more important to ensure engagement with the customer and the industry and consideration of issues of the whole supply chain in order to ensure that the process of putting those technologies to practical use is not jeopardized.

District cooling and Green Building Codes are additional ways to realise EE improvements.

High ambient temperature (HAT) considerations

A HAT environment imposes an additional set of challenges on the selection of refrigerants, system design, and potential EE enhancement opportunities.
At HAT, system designs which maintain energy efficiency are affected by the refrigerant choice due to thermodynamic properties, safety requirements due to the increased charge, and component availability and cost.

Research at HAT conditions done so far has shown the viability of some low-GWP alternatives to deliver comparable EE results to existing technologies. Further financed research, as well as private sector efforts, continue to focus on the optimisation of design to achieve targeted efficiencies for those alternatives.

The rise of outdoor temperatures due to climate change pose specific challenges for refrigeration and air conditioning (RAC) equipment, especially in HAT conditions

Environmental benefits in terms of CO_2eq

Over 80% of the global warming impact of RACHP systems is associated with the indirect emissions generated during the production of the electricity used to operate the equipment (indirect), with a lower proportion coming from the use/release (direct emissions) of GHG refrigerants where used.

The environmental impact of improving system efficiency is a factor of the type of equipment, how many hours and when it is used (influenced by ambient temperature and humidity conditions), and the emissions associated with generating power, which vary by country.

Climate and development goals are driving governments to adopt policies to improve the EE of equipment. In the RACHP sector, a holistic approach is important for reducing equipment energy consumption. Reducing cooling/heating loads present the best opportunity to reduce both indirect emission through lower consumption of electricity and direct emissions through the reduction of the refrigerant charge associated with the load.

For the purposes of this report, the approach and examples presented consider only the indirect CO_2eq environmental benefit from energy efficient technologies in the RACHP applications related to a single unit of equipment.

Servicing sector requirements

The present concern in most Article 5 countries in the HCFC phase-out process is to train technicians on the use of new refrigerants. EE aspects require additional training and further awareness.

Some EE degradation over the life time of equipment is inevitable; however, there are ways to limit the degradation through improved design and improved servicing which include both installation and maintenance.

The impact of proper installation, maintenance, and servicing on the efficiency of equipment and systems is considerable over the life time of these systems while the additional cost is minimal.

The benefits of proper maintenance are considerable. Appropriate maintenance and servicing practices can curtail up to 50% reduction in performance and maintain the rated performance over the lifetime.

Other benefits include reduced energy cost, improved safety by eliminating risks, better temperature control and occupant comfort, and compliance with regulations.

Capacity-building requirements

There are enabling activities such as capacity building, institutional strengthening, demonstration projects, and national strategies and plans that help to bridge Montreal Protocol activities under the Kigali Amendment and EE. A number of enabling activities supported by the other funds, such as the Kigali Cooling Efficiency Programme and the Global Environment Facility, have advanced both ozone depletion and EE goals.

Additional enabling activities under the Kigali Amendment can bridge the current Montreal Protocol activities with those destined towards EE and serve as examples of potential synergy between HFC phasedown and EE opportunities.

In the servicing sector, the use of low-GWP refrigerants requires capacity building and training initiatives to address the specific issues related to installation, operation and maintenance of low-GWP refrigerant based equipment.

Costs related to technology options for energy efficiency

EE can bring multiple economic benefits. The most frequently cited benefits of EE are energy, cost and greenhouse gas (GHG) saving and, for space cooling, peak load reduction. In addition, there is a reduction in the morbidity and mortality caused by energy poverty, reduced days of illness, improved comfort, reduced pollution and avoided CO_2 emissions.

A summary is presented of methods developed by various countries with established market transformation programs for promoting EE including MEPS programs and labelling programs.

It should be noted that the presented methodology offers a "snapshot" of the cost of efficiency improvement at any given time and will tend to provide a conservative (i.e. higher) estimate of the cost of efficiency improvement. In actual practice, the prices of higher efficiency equipment have been found to decline over time in various markets as higher efficiency equipment begins to be produced at scale. This applies especially for small mass-produced equipment where manufacturers quickly absorb the initial development costs and try to get to certain "price points" that help them sell their equipment.

Retail price of products is not an adequate indicator for the costs of maintaining or enhancing EE in new equipment due to:

- bundling of various non-energy related features with higher efficiency equipment,
- variation of manufacturer's skills and know-how,
- variation in manufacturer's pricing, marketing and branding strategies, and
- the idea that efficiency can be marketed as a "premium" feature.

Rigorous cost analysis may be needed to fully understand the impact of EE improvements. These types of analyses are relevant when setting MEPS as several EE levels need to be evaluated compared with the baseline. These studies can take more than 1 year to conclude for a single product category. As such, in this report we would like to refer parties to the corresponding methodologies and present simplified examples based on products already introduced on the market.

A matrix of possible technical interventions aimed at improving EE and associated costs is provided.

Global market for EE and funding

The market for energy efficiency is growing, with global investment in EE increased by 9% to US$ 231 billion in 2016.

Among end users, buildings still dominate global EE investments accounting for 58% in 2016.

EE investment in the building sector increased by 12% in 2016 with US$ 68 billion in incremental EE investment in the building envelope in 2016, US$ 22 billion in heating, ventilation and air conditioning (HVAC), US$ 28 billion in lighting, and US$ 2 billion in appliances.

The majority of large multilateral climate funds operate in sectors other than RACHP, such as energy access, renewable energy transmissions and other related investment projects.

Multilateral funds have a key role in providing grant funding to fill gaps in public finance.

At this point, most large multilateral climate related funds such as the Global Environment Facility (GEF), Climate Investment Fund (CIF), and Green Climate Fund (GCF), focus on energy access and renewable energy sectors and not on RACHP.

Less than 0.1 percent of Official Development Assistance (ODA)[1] projects in 2014 and 2015 are focusing on cooling, indicating that there is extremely low international focus on cooling relative to other development topics.

In spite of the low level of funding for cooling/RACHP sectors, there are numerous financial resources for project implementation in the field of EE in general. In addition to funding institutions that provide resources in the form of directed grants, there are financing institutions that provide project funding support through mechanisms, such as, loans, green bonds or other instruments. Moreover, private capital is an additional source through companies who might be interested to finance project implementation against investment payback.

Broad consideration of the various potential interested stakeholders, opportunities for partnerships with shared goals, and options for co-financing would be important to planning for potential projects related to EE in the RACHP sector while phasing down HFCs. To emphasise this issue, the Vienna EE Workshop finance panel report (para 29) [2] stated: "It is generally held that, while sufficient funds are available to support EE measures, *these do not flow effectively*. It was suggested that a catalogue of funding opportunities be developed as an information source for parties."

Taking into consideration the request from the EE Workshop, the Task Force prepared a catalogue of funding opportunities. However, based on preliminary analyses, the Task Force considers that this mapping exercise is insufficient alone, without some consideration of potential options for a new financial architecture by which resources for EE could flow more certainly and effectively.

There is a need to address the barriers against coordination with existing financial organisations (e.g., The GEF, GCF, CIF, etc.) with a view to having strategic focal areas introduced with earmarked financial windows/flows, and within a streamlined timeframe designed to meet MP targets and EE objectives in the phasedown of HFCs.

Given the significant financial resources potentially available related to EE in general and the currently low level of funding to projects specific to the RACHP sector, parties may wish to consider:

- Developing appropriate liaison with the main funding institutions with shared objectives, in order to investigate the potential for increasing the volume and improving the streamlining of processes that either currently don't exist or for which there are only low levels of funding being made available to the RACHP sector. The aim would be to enable timely access to funding for MP related projects and activities which integrate EE into the RACHP sector transitions, and the HFC phasedown.
- Investigating funding architectures that could build on and complement the current, familiar funding mechanisms under the MP and if deemed appropriate, establishing clear rules, regulations, and governance structures for any such new funding architecture that could enable the current MP funding processes to most effectively bridge to other financial resources.

[1] https://data.oecd.org/oda/net-oda.htm. Official development assistance (ODA) is defined as government aid designed to promote the economic development and welfare of developing countries. Loans and credits for military purposes are excluded.

[2] A Workshop Report was presented to OEWG 40 (UNEP/OzL.Pro.WG.1/40/6/Rev.1) (www.ozone.unep.org)

Additional guidance to TEAP as addressed in the updated final report on issues related to energy efficiency while phasing down HFCs

Additional guidance[1]	Addressed in section(s):
1. More information on the heat pump sector and CO_2 savings.	2.5.3
2. Tabular presentation of funding sources.	3.5
3. More information on opportunities/energy efficiency improvements in the mobile air-conditioning sector.	Annex A (A.4)
4. More information on lessons learned from previous transitions in terms of additional energy efficiency gains and resources.	2.1, 2.2.9
5. Information on additional gains from improved servicing.	2.6.2
6. Elaborate more on the design and criteria of RACHP units in particular with respect to safety, performance and the consequences of increasing the capacity of those units.	2.2.2, 2.4.2
7. Elaborate in a comprehensive way and provide clear comparison between HCFCs, HFCs and HFC alternatives with respect to performance, safety and costs.	2.1, 2.2.2
8. Focus on the energy efficiency of the equipment in the RACHP, avoiding duplication of work undertaken under other international entities such as the IPCC.	2.2.2
9. Look at measures taken at other regions (such as the EU) in recent years and address the particular challenges faced by HAT countries.	2.2.2, 2.4.3, 2.4.4
10. Request TEAP to reach out to the various regions to understand better their particular circumstances.	1.3, 2.3.2
11. Report on what research and development is occurring, and its progress and outcomes, to address high ambient temperature challenges.	2.4.5
12. For the TEAP to visit the regions to engage with stakeholders on the challenges of the regions in transitioning to higher energy efficiency refrigerants.	1.3
13. Calculate the lifecycle of equipment per country/region and associated climatic conditions.	2.5.2, 2.5.3
14. Provide more information on specific economic benefits in terms of savings to including to consumers, power plants, payback periods.	2.8.1
15. Reformulate TEAP's response to decision XXIX/10 to put in in the context of refrigerant transition.	2.1, 2.1.1
16. Provide further information on the following takeaway messages from the EE workshop: – The initial "price hump" in the introduction of high-energy-efficiency technologies; – How refrigerant selection needs to be made in terms of energy efficiency, flammability and other relevant factors; – Availability of funds that are, however, not easily flowing.	Annex C
17. Quantify the context/site-specific impacts of environmental benefits of EE equipment, as mentioned in the TEAP report.	2.5.3
18. Provide a matrix of technical interventions to EE and associated costs.	2.8.6
19. Elaborate on the criteria and methodologies of the relevant funding institutions noted in decision XXIX/10.	3.3.1, 3.3.2, 3.3.3, 3.4, 3.6

[1] "Annex III: Additional guidance to the Technology and Economic Assessment Panel on energy efficiency" UNEP/OzL.Pro.WG/1/40/7.

20. Elaborate on the capacity building and servicing requirements for low-GWP alternatives.	2.7.2
21. Explore the possibility of district cooling, green buildings code and hydrocarbons in commercial applications to be options for EE (as is demonstrated in UAE).	2.3.1, 2.3.3, Annex A (A.3)
22. Provide information on increased energy demand to produce the same amount of cooling in HAT countries due to the projected rise of temperature.	2.4.6
23. Consider visiting UAE to view the district cooling, green-cooling and hydrocarbon projects to inform its updated final report.	1.3