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**Open-ended Working Group of the Parties to  
the Montreal Protocol on Substances that  
Deplete the Ozone Layer  
Forty-first meeting  
Bangkok, 1–5 July 2019**

## **Report of the forty-first meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer**

### **I. Opening of the meeting**

1. The forty-first meeting of the Open-ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer was held at the United Nations Conference Centre, Bangkok, from 1 to 5 July 2019. The meeting was co-chaired by Mr. Alain Wilmart (Belgium) and Ms. Laura-Juliana Arciniegas (Colombia).
2. The meeting was opened at 10 a.m. on Monday, 1 July 2019 by Ms. Arciniegas. Opening statements were delivered by Mr. Apichin Jotikasthira, Deputy Permanent Secretary, Ministry of Industry, Thailand; Ms. Dechen Tsering, Director of the United Nations Environment Programme (UNEP) regional office for Asia and the Pacific; and Ms. Tina Birmpili, Executive Secretary of the Ozone Secretariat.
3. Mr. Jotikasthira welcomed the participants to Thailand, saying that the meeting's success would help pave the way for important decisions to be made by the Thirty-First Meeting of the Parties later in the year. He noted that all parties had fulfilled their obligations under the Protocol thus far, although challenges remained, with the deadline for a 35 per cent reduction in consumption of hydrochlorofluorocarbons (HCFCs) only six months away. He wished to congratulate the 73 parties that had ratified the Kigali Amendment to the Montreal Protocol to phase down hydrofluorocarbons (HFCs), allowing it to come into effect on 1 January 2019. Phasing down the use of HFCs was critical for protecting the global climate and ensuring a decrease of up to 0.4°C in global temperatures, with even greater climate benefits possible if the phase-down were combined with improved energy efficiency. In Thailand, for instance, the support of the Multilateral Fund for Implementation of the Montreal Protocol and its implementing agencies had enabled the air-conditioning industry to replace ozone-depleting substances that had high global warming potential with lower-global-warming potential HFCs and simultaneously improve energy performance by 8 to 10 per cent on average. The Kigali Cooling Efficiency Program was supporting steps to enhance the energy performance of air-conditioning equipment by another 20 to 30 per cent. However, despite those positive steps, challenges ranging from alternative technologies to financing needed to be tackled if full compliance with the Kigali Amendment were to be achieved while maintaining the momentum of the HCFC phase-out. He thanked the participants for coming together in Bangkok to address and resolve those challenges.
4. Ms. Tsering applauded the parties' achievements under the Montreal Protocol, which she herself had witnessed in the Asia-Pacific region. She wished to join Mr. Jotikasthira in congratulating the parties that had ratified the Kigali Amendment, noting its importance for achieving the objective of the Paris Agreement on Climate Change. In September 2019, the Secretary-General of the

United Nations would host the Climate Action Summit, where he would call upon leaders to ratify and implement the Kigali Amendment as a means of enhancing climate action. In the Asia-Pacific region, air-conditioning was an important sector, with space cooling making up 37 per cent of total building energy use. As incomes in the region grew and temperatures rose, energy-efficient cooling technologies were expected to generate huge savings in terms of energy costs and investment in infrastructure. In addition to providing a roadmap for the HFC phase-down, the Kigali Amendment was thus driving innovation, creating new economic opportunities and making the air-conditioning sector more sustainable. Many countries were examining the sector more systematically and had integrated it into the formulation of their nationally determined contributions under the Paris Agreement, a trend that was expected to rise. Urging countries to ratify the Kigali Amendment as early as possible, she expressed hope that, despite the emerging challenges such as recently reported increases in emissions of trichlorofluoromethane (CFC-11), the open, cooperative and supportive spirit that had always prevailed under the Montreal Protocol would enable parties, with the capable backing of the assessment panels, to strengthen the Protocol's monitoring, reporting, verification and enforcement mechanisms.

5. Ms. Birmpili in her remarks stressed the progress made by parties in overcoming the threat that ozone-depleting substances presented to human health and economies – progress demonstrated by the three assessment reports to be discussed at the meeting. While those reports confirmed that the world was on a promising path towards the recovery of the ozone layer, the recent detection of an unexpected increase in CFC-11 emissions underscored the need for continued vigilance. The CFC-11 issue had been highlighted in research by Montzka and others (2018),<sup>1</sup> and recently published findings by Rigby and others (2019)<sup>2</sup> had identified two regions in eastern China as the source of approximately half the emissions in question. Though the source of the remaining emissions had yet to be found, it was clear that more precise estimates of emission rates and their changes would aid location efforts.

6. On the positive side, parties were aware of the problem and its seriousness. They had immediately vowed to take strong action to identify and address the unexpected emissions and were discussing the relevant processes of the institutions of the Montreal Protocol, including the Multilateral Fund and the institutions of the Vienna Convention for the Protection of the Ozone Layer. The Government of China had shown commitment and ongoing cooperation and had taken firm steps to address the issue through inspections and monitoring plans. Still, more needed to be done. Countries needed actionable science-based information so that they could take effective steps, and vigilance to prevent illegal actions at the national level. Parties needed to enforce the rules they themselves had set in order to sustain the results achieved thus far, to complete the transition to non-ozone-depleting substances and restore the ozone layer. All parties were responsible for sustaining the phase-out of ozone-depleting substances and ensuring that the institutions of the Protocol were able to address new, unforeseen issues. The success of the Protocol rested on the parties' ability to adapt to new information and decide on appropriate, commensurate responses. Science was essential to that effort, but the measurements needed to ensure compliance were lacking and capability needed to be enhanced, including through the establishment of a greater number of stations that were more strategically distributed and suitably equipped. In addition, the Ozone Secretariat, together with the Multilateral Fund secretariat, had prepared a document including some observations on policy areas where the provisions of the Protocol might be strengthened.

7. Meanwhile, implementation of the Kigali Amendment had begun, with 73 parties having ratified the amendment to date. Universal ratification would bring the full power of the Montreal Protocol to bear on the important issue of HFCs.

## II. Organizational matters

### A. Attendance

8. The following parties to the Montreal Protocol were represented: Afghanistan, Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Benin, Bhutan, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cambodia, Canada, Chad, Chile, China, Colombia, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Czechia, Democratic People's Republic of Korea, Djibouti, Dominican Republic,

<sup>1</sup> S. A. Montzka and others, "An unexpected and persistent increase in global emissions of ozone-depleting CFC-11", *Nature*, vol. 557 (17 May 2018).

<sup>2</sup> M. Rigby and others, "Increase in CFC-11 emissions from eastern China based on atmospheric observations", *Nature*, vol. 569 (23 May 2019).

Ecuador, Egypt, Eritrea, Estonia, Eswatini, Ethiopia, European Union, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Grenada, Guatemala, Guinea, Guinea Bissau, Haiti, Hungary, India, Indonesia, Iran (Islamic Republic of), Iraq, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Latvia, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands, Mauritius, Mexico, Micronesia (Federated States of), Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Paraguay, Poland, Portugal, Republic of Korea, Qatar, Romania, Russian Federation, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Slovakia, Solomon Islands, Sri Lanka, State of Palestine, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Timor-Leste, Togo, Tonga, Tunisia, Turkey, Tuvalu, Uganda, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United Republic of Tanzania, United States of America, Uruguay, Uzbekistan, Vanuatu, Viet Nam, Zambia, Zimbabwe.

9. The following United Nations entities, organizations and specialized agencies were represented: secretariat of the Multilateral Fund for the Implementation of the Montreal Protocol, United Nations Development Programme, United Nations Environment Programme, United Nations Industrial Development Organization (UNIDO), World Bank. The Montreal Protocol assessment panels were also represented.

10. The following intergovernmental, non-governmental and industry bodies and organizations were represented as observers: ADC3R; Alliance for Responsible Atmospheric Policy; Blue Star Ltd.; California Citrus Quality Council; Centre for Science and Environment; CLASP; Climalife; Council on Energy, Environment and Water; Daikin; Daikin Industries Ltd.; Environmental Investigation Agency; European Partnership for Energy and the Environment; Gujarat Fluorochemicals Ltd.; ICF International; Indian Chemical Council; Industrial Technology Research Institute; Institute for Governance and Sustainable Development; International Pharmaceutical Aerosol Consortium; Japan Fluorocarbon Manufacturers Association; Japan Refrigeration and Air-Conditioning Industry Association; Kigali Cooling Efficiency Program; Kulthorn Group; Lawrence Berkeley National Laboratory; Lennox International; MEBROM; Natural Resources Defence Council; New Energy and Industrial Technology Development Organization; Nolan Sherry and Associates Ltd.; Oak Ridge National Laboratory; Ökorecherche; Peking University; Petra Engineering Industries Co.; Refrigerant Gas Manufacturers Association; Refrigerant Reclaim Australia; Refrigerants Australia; Refrigeration and Air-Conditioning Manufacturers Association; Shaffie Law and Policy LLC; Shecco; Sun Vat Sen University; Sustainable Energy for All; The Energy and Resources Institute; Toshiba Carrier Corporation; United Technologies Climate, Controls and Security; United Technologies Corporation; University of São Paulo; University of Southern California; Wagner Consulting International.

## **B. Adoption of the agenda**

11. The Working Group adopted the following agenda on the basis of the provisional agenda set out in document UNEP/OzL.Pro.WG.1/41/1/Rev.1:

1. Opening of the meeting.
2. Organizational matters:
  - (a) Adoption of the agenda;
  - (b) Organization of work.
3. Unexpected emissions of trichlorofluoromethane (CFC-11) (decision XXX/3).
4. Terms of reference for the study on the 2021–2023 replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol.
5. Quadrennial assessment of the Montreal Protocol for 2018 and potential areas of focus for the 2022 assessment:
  - (a) Ongoing reported emissions of carbon tetrachloride (UNEP/OzL.Pro.30/11, para. 225);
  - (b) Relationship between stratospheric ozone and proposed solar radiation management strategies (UNEP/OzL.Pro.30/11, para. 214);
  - (c) Any other issues arising from the reports of the assessment panels.

6. Technology and Economic Assessment Panel 2019 report, including issues relating to:
  - (a) Nominations for critical-use exemptions for methyl bromide for 2020 and 2021;
  - (b) Stocks of methyl bromide (UNEP/OzL.Pro.30/11, paras. 73 and 77);
  - (c) Development and availability of laboratory and analytical procedures that can be performed without using controlled substances under the Protocol (UNEP/OzL.Pro.30/11, paras. 83 and 127);
  - (d) Process agents (decision XXIX/7 and UNEP/OzL.Pro.30/11, para. 86);
  - (e) Any other issues.
7. 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 (decision XXX/5).
8. Linkages between hydrochlorofluorocarbons and hydrofluorocarbons in transitioning to low-global-warming-potential alternatives (UNEP/OzL.Pro.30/11, para. 89).
9. Safety standards (UNEP/OzL.Pro.30/11, para. 199).
10. Review of the terms of reference, composition, balance, fields of expertise and workload of the Technology and Economic Assessment Panel (decision XXX/15).
11. Membership of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol (UNEP/OzL.Pro.30/11, para. 177).
12. Request by Azerbaijan to be included among the parties to which the phase-down schedule for hydrofluorocarbons, as set out in paragraphs 2 and 4 of Article 2J of the Montreal Protocol, applies.
13. Risk of non-compliance with hydrochlorofluorocarbon production and consumption reduction targets by the Democratic People's Republic of Korea.
14. Other matters.
15. Adoption of the report.
16. Closure of the meeting.

12. The Working Group agreed to consider, under agenda item 14, on other matters, a proposal by the European Union for a "Rome Declaration" to be presented for adoption by the Thirty-First Meeting of the Parties, to be held in Rome in November 2019.

13. One representative said that he wished to discuss short-lived substances and banks of ozone-depleting substances and hydrofluorocarbons under agenda item 5 (c).

### **C. Organization of work**

14. The Working Group agreed to the organization of work proposed by the Co-Chair, namely to establish contact and informal groups as necessary; to avoid holding contact group meetings in parallel with each other or with plenary meetings; and to avoid, to the extent possible, the holding of simultaneous meetings of informal groups. Morning sessions would run from 10 a.m. to 1 p.m. and afternoon sessions from 3 to 6 p.m.

## **III. Unexpected emissions of trichlorofluoromethane (CFC-11) (decision XXX/3)**

15. Introducing the item, the Co-Chair recalled that the issue of the unexpected increase in emissions of CFC-11 had been discussed extensively at the fortieth meeting of the Open-ended Working Group and at the Thirtieth Meeting of the Parties, at which the parties had adopted decision XXX/3. By that decision, the Scientific Assessment Panel had been requested to provide a summary report on the matter, including atmospheric modelling and underlying assumptions for consideration by the Thirty-Second Meeting of the Parties. A preliminary summary report, prepared for the present meeting, included a summary of the proceedings of an international symposium on the unexpected increase in emissions of CFC-11 held in Vienna in March 2019. The present meeting would also consider a preliminary report by the Technology and Economic Assessment Panel on potential sources of emissions of CFC-11 and related controlled substances, while a final report would be prepared for

the Thirty-First Meeting of the Parties. The task force on CFC-11 established by the Panel had attended the symposium. The meeting also had before it a report by the Secretariat on unexpected emissions of CFC-11 (UNEP/OzL.Pro.WG.1/41/3 and its addendum).

16. The summary report of the Scientific Assessment Panel was presented by Mr. Paul A. Newman, co-chair of the Panel. The summary report of the Technology and Economic Assessment Panel was presented by Ms. Helen Tope and Ms. Helen Walter-Terrinoni, co-chairs of the Panel's task force. Summaries of the presentations by Mr. Newman, Ms. Tope and Ms. Walter-Terrinoni, as prepared by the presenters, are set out in section I of annex III to the present report, without formal editing.

17. The representative of China presented information on the production and consumption of carbon tetrachloride (CTC), a feedstock for CFC-11, in China, noting that her country did not have the ozone-depleting-substance-monitoring capacity to provide monitoring data for related scientific research. The party had, as requested by decision XXX/3, submitted a report to the Secretariat on CFC-11 emissions, and had also reported relevant data on production of polyurethane foams and foam blowing agents, which had indicated that in reality there was no market for CFC-11 as a foam blowing agent in China, nor sufficient availability of CTC as a feedstock.

18. Regarding production and consumption of HCFC-22, an annual quota system applied to all enterprises, and data on production, consumption and uses had to be made publicly accessible. Routine monitoring by the environmental authorities was in place, and quarterly reporting to the relevant authorities was required. The Ministry of Ecology and Environment of China also maintained records of production, consumption and use, and cross-checking was carried out to verify the data. To receive funding from the Multilateral Fund, all HCFC-22 production plants were required to monitor a range of data on site, including actual production of HCFC-22, consumption of feedstock and production ratios of facilities. Conversion to CFC-11 production in an HCFC-22-producing enterprise would require stopping production, cleaning the machinery, and replacing the catalyst and other materials, which would be a complex and time-consuming process. Verification in recent years by the implementing agencies for projects under the Multilateral Fund and by other experts had not found any evidence that facilities producing HCFC-22 were being used illegally to produce CFC-11.

19. She invited experts from the Scientific Assessment Panel and the Technology and Economic Assessment Panel and other interested parties to visit the enterprises producing HCFC-22 in China to obtain a better understanding of HCFC-22 production and consumption in the country and expressed the hope that the academic and scientific communities would continue research to better understand the unexpected emissions of CFC-11 and take appropriate and timely action.

20. Members of the two panels responded to questions raised by representatives about the presentations.

21. Mr. Newman answered questions about the summary report of the Scientific Assessment Panel. Referring to recent research indicating that 40 to 60 per cent of the recent emission increases originated in eastern China and the rest elsewhere, he said that there were not enough monitoring stations to clearly identify other regional sources, though some regions could be excluded. Updates on emissions from Europe and the United States of America indicated that those regions were not sources, though a full analysis of the data was yet to be undertaken. Application of an inter-hemisphere gradient had shown that the increase in emissions was concentrated in the northern hemisphere. In short, while knowledge about the matter was available on a global scale, by hemisphere and for a few regional locations, more monitoring stations were needed to fill in the gaps, and a study was needed to indicate the best locations for those stations to achieve effective regional monitoring. Flask sampling could provide anecdotal evidence of emissions in remote areas but did not provide enough data for precise measurements. Regarding other possible sources of CFC-11, including natural sources, he said that evidence indicated that the increase was anthropogenic. For example, the substance was not found in historical ice or firn records and had only been identified in the atmosphere after its widespread use.

22. Regarding the accuracy of the monitoring process in identifying the source of the emissions, he said that multiple measurements were made of gas plumes, which included other chlorine gases in addition to CFC-11, indicating that the source was very likely industrial. A study of that methodology would soon be published, and further information would be included in the November 2020 report of the Scientific Assessment Panel. Regarding emissions of CFC-12, he said that the assessment had not found an increase in global emissions of that substance or any marked global increase in CTC comparable to the increase in CFC-11 emissions. He stressed that identifying such an increase in emissions required years of data collection and analysis, as well as peer review to check the robustness

of the methodology used. If the emission increases remained at current levels, they could threaten the recovery of the ozone layer in the long term.

23. Mr. Nick Campbell, a member of the task force, said that the task force had tried to keep an open mind about possible sources of emissions and had evaluated both the technical and economic aspects of more than 20 processes. The atmospheric levels reported by the Scientific Assessment Panel meant that it was unlikely that the increased emissions originated solely from microscale production plants, which were more likely to produce a few hundred tonnes of CFC-11, and that alone. As the chemicals involved were very hazardous and therefore dangerous to transport, processing sites were generally quite static. The increased emissions were therefore most likely to be from a combination of some microscale plants and some larger plants swung from production of HCFC-22 to CFC-11. Regarding the tightness of the supply chain, he said that as CTC tended to be moved around in large containers such as tankers or rail cars, producers were probably well aware of the destination of a shipment, although later stages of the supply chain were less easily defined. Replying to a question about using CFC-12 as a feedstock for HFC-32 production, he said that he did not know of any plants performing that process.

24. Ms. Walter-Terrinoni responded to some questions addressed to the Technology and Economic Assessment Panel. She said that since the paper by Rigby and others had not been available when the Panel had completed its report, the report did not explore any possible reasons for the paper's finding that most emissions emanated from eastern China. On the matter of shipment of CFC-11 contained in pre-blended polyols, she said that it would be difficult to know whether such shipments were taking place. The product could be detected with a handheld device or other methods at the place of import, but no international data were available on that matter. There was no evidence to indicate large-scale transboundary movements of CTC or CFC-11. Prices could be obtained from various sources - for example, online advertisements - though they were evidence only of the product's availability and not of actual sales. However, the prices available indicated that the price of CFC-11 on the market was lower than that of other liquid blowing agents. While the phase-out of and decline in the supply of HCFC-141b had been identified as a potential driver of an increase in the use of CFC-11, no actual instances of that occurring had been found.

25. Regarding alternative sources of CFC-11 emissions, she said that the emission rate from landfills was probably very low. While that facet of the issue would be further explored, it was likely that emissions from landfills formed only part of the background emissions. Further analysis of banks by region or market sector would be useful, but more data were needed from parties on that matter. Responding to a query on shredding and reuse of foams for lightweight bricks as a possible source of emissions, she said that, while it was difficult to estimate how much foam in banks was still in buildings or landfills, it seemed unlikely that banks could produce emissions on the scale observed.

26. Ms. Tope responded to other questions directed to the Technology and Economic Assessment Panel. She explained that CFC-12 was never used as a feedstock and that there was no commercial reason for such use. As for the matter of switching production from one substance to another, the task force considered it relatively easy to alternate between producing CFC-11, CFC-12 and HCFC-22. A change of feedstock was needed, and the plant needed to be closed for a few weeks for cleaning and other adjustments, but no change in physical equipment was required. As the analysis had shown, 100 per cent CFC-12 production could be achieved relatively easily, while 100 per cent CFC-11 production was more difficult to achieve, although nearly 100 per cent CFC-11 production was possible in microscale plants designed and operated solely for that purpose.

27. Before opening the floor for discussion, the Co-Chair recalled that in decision XXX/3 the parties had requested the Ozone Secretariat, in consultation with the secretariat of the Multilateral Fund, to provide an overview outlining the procedures under the Protocol and the Multilateral Fund by which the parties reviewed, and ensured continuing compliance with, Protocol obligations and the terms of their agreements under the Fund, including with regard to monitoring, reporting and verification. That overview was contained in document UNEP/OzL.Pro/OEWG/41/3, which also contained brief observations by the Ozone Secretariat. An updated version would be prepared for the Thirty-First Meeting of the Parties.

28. Furthermore, at the eighty-third meeting of the Executive Committee, held in May 2019, in its decision 83/60, members had requested the Fund Secretariat to forward to the Ozone Secretariat, as a separate submission, document UNEP/OzL.Pro/ExCom/83/38, discussed at that meeting, which gave an overview of prevailing monitoring, reporting, verification and enforceable licensing and quota systems. The submission had been posted on the online portal of the present meeting as a background document for consideration by the parties.

29. The representative of China, saying that her Government attached great importance to monitoring and verification mechanisms, described the measures that it had taken since the Thirtieth Meeting of the Parties to address weaknesses in its systems and outlined its further plans to help ensure the effective operation of the Protocol.
30. Pursuant to decision XXX/3, China had submitted to the Technology and Economic Assessment Panel data on production of polyurethane foam and the market use of blowing agents. In March 2019, the Government had held, in Beijing, a seminar on capacity-building for compliance and had invited representatives of the Ozone and Multilateral Fund secretariats, the implementing agencies and other interested parties from various countries to discuss the potential causes of the unexpected emissions of CFC-11 and other relevant issues, such as policy regulation and imports and exports.
31. China had begun research into atmospheric monitoring of ozone-depleting substances and planned to start establishing monitoring stations, including for chlorofluorocarbons (CFCs), HCFCs and HFCs, in 2021. The country would work harder to carry out inspections of relevant enterprises. Provinces and municipalities encouraged the use of an environmental hotline to report illegal production and consumption, and a relevant industry had launched an initiative for reporting, offering its own reward for such reporting. With regard to the country's inadequate capacity for carrying out testing in relation to products containing ozone-depleting substances, she said that the Government planned to establish six more laboratories in order to enhance its law enforcement capacity.
32. It had also begun amending legislation governing the management of ozone-depleting substances. They were listed as harmful substances, and all illegal dumping, emissions and processing would be subject to criminal proceedings. In addition, controls on the raw materials required to produce CFC-11 had been tightened. The Government was establishing a system in the country's 16 chloromethane-producing enterprises to measure production, storage, conversion and sales through the management of data on CTC. Such a system had already been installed in eight of the enterprises.
33. Her Government remained committed to cooperating with the other parties to address the unexpected emissions of CFC-11 and maintain the results achieved to date by the Montreal Protocol.
34. In the ensuing discussion, much appreciation was expressed for the information and documentation provided by the Ozone and Multilateral Fund secretariats, the Technology and Economic Assessment Panel, the Scientific Assessment Panel, the Government of China and other contributing parties, all of which was said to aid understanding of the issue. Some representatives also commended the Government of China for its cooperation and the actions that it was taking.
35. Several representatives noted that more information and further clarification of a number of issues were required, although the submitted documents formed a good basis for further discussions on the way forward, including on how to ensure the sustainability of reductions in production and consumption and of the phasing out of ozone-depleting substances through the strengthening of monitoring, reporting and verification under the Protocol.
36. A number of representatives expressed deep concern that such a situation, which undermined the hard work and dedication of the global community and jeopardized the recovery of the ozone layer, had occurred. Some stressed the need, while focusing on the future, also to understand the past: what had happened, how and why, and its implications. The representative of a party that was a major donor to the Multilateral Fund emphasized that until the source of the CFC-11 emissions was known and the cause addressed, it would be difficult for his Government to maintain its contributions to the Multilateral Fund in view of its responsibility to its taxpayers. Another representative expressed similar concerns regarding accountability to his country's taxpayers.
37. While the source of some of the emissions appeared to have been established, one representative recalled that according to the report of the Technology and Economic Assessment Panel emissions from other regions could not be ruled out because monitoring and observation around the globe were incomplete. Several representatives called for comprehensive monitoring of atmospheric emissions, and some referred to remaining stocks of CFCs. One representative suggested that the General Trust Fund for Financing Activities on Research and Systematic Observations Relevant to the Vienna Convention could play a role in that respect. Others proposed that monitoring capacities, including satellite- and ground-based monitoring, and related gaps, could also be examined at the eleventh meeting of the ozone research managers, to be held in 2020, and the conclusions presented at the Twelfth Conference of the Parties to the Vienna Convention, also in 2020.
38. Several representatives stressed that all parties should be treated equally, both in terms of globally comprehensive monitoring and in terms of any future obligations. There was some discussion of the focus on parties operating under paragraph 1 of Article 5 of the Montreal Protocol (Article 5 parties) in relation to reporting, monitoring and verification under the Multilateral Fund. It was

proposed that any additional monitoring obligations, including, for example, in relation to the proposals for novel mechanisms to ensure sustained compliance contained in the background document prepared by the Multilateral Fund Secretariat, should apply to Article 5 parties and non-Article parties alike. One representative proposed that the Technology and Economic Assessment Panel look into how to implement such an approach. Another stressed the need to take measures that were proportionate to the financial resources available, especially in Article 5 parties.

39. Several representatives cited the need to address illegal trade as part of the response to the unexpected emissions and of the strengthening of monitoring, reporting and verification more generally. One of them, expressing the view that reporting on illegal trade to the Ozone Secretariat in line with decision XIV/7 should be extended to all illegal activities, including production, urged all parties to do so as soon as they became aware of an issue. He asked the Technology and Economic Assessment Panel to consider the matter before finalizing its report for the Thirty-First Meeting of the Parties. Another representative underlined the importance of ensuring that there were no barriers or deterrents in relation to the reporting of illegal trade, as such information was crucial for addressing the issue. A third proposed a review of the reporting procedure, including to ensure that the reporting of illegal trade did not automatically lead to a situation of non-compliance. Another representative, saying that her Government had shared with the Ozone Secretariat information about its prevention of the illegal import of 200 kilograms of carbon tetrachloride in 2017, called upon parties to strengthen cooperation among their respective customs services. One representative, noting that the borders in a number of Article 5 parties were porous, expressed the need for capacity-building to enable the monitoring of CFC-11 contained in blends.

40. In a discussion of additional country-level issues, such as reporting, enforcement, compliance, licensing issues, atmospheric trends and monitoring, sustained aggregate reductions, and prevention of and reporting on illegal trade and other illegal activities, several representatives said that the time was ripe for a review of institutional processes and mechanisms under the Vienna Convention and the Montreal Protocol, including whether they were working effectively and could serve the parties adequately over the coming decades.

41. In addition to considering the suggestions for further analysis and data collection made by the Technology and Economic Assessment Panel and the proposals for novel mechanisms to ensure sustained compliance made by the Multilateral Fund Secretariat, participants recalled that the report of the international symposium on CFC-11 contained suggestions for short-term and longer-term actions. It was proposed that those suggestions also be considered, with the involvement of both panels.

42. The Working Group agreed to establish a contact group, to be co-chaired by Ms. Annie Gabriel (Australia) and Mr. Osvaldo Álvarez-Pérez (Chile), to consider further (a) technical and scientific issues related to the unexpected emissions of CFC-11 with a view to identifying the information that needed to be enhanced, and (b) institutional matters and processes under the Vienna Convention and the Montreal Protocol, including monitoring, reporting and verification, compliance, licensing and illegal trade. Additional matters to be addressed could be added to the mandate of the group if necessary.

43. Subsequently the co-chairs of the contact group, reporting on the group's work, presented an oral report on its discussions in order to inform further deliberations on the matter during the Thirty-First Meeting of the Parties. The report is set out in annex II to the present report.

44. The Working Group agreed to defer further discussion of the matter to the Thirty-First Meeting of the Parties.

#### **IV. Terms of reference for the study on the 2021–2023 replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol**

45. Introducing the agenda item, the Co-Chair recalled that the Multilateral Fund operated with three-year funding cycles. He said that, in preparation for a decision by the parties on the replenishment of the Fund for the next replenishment period, 2021–2023, the Working Group should develop terms of reference for a study to estimate the funds that would be required to enable Article 5 parties to achieve compliance with their obligations under the Protocol during that period. Noting that the study was usually prepared by a task force of the Technology and Economic Assessment Panel established for that purpose, he invited the Working Group to consider as a basis for discussion the terms of reference for the study on the replenishment of the Multilateral Fund for the period 2018–2020, set out in decision XXVIII/5 and reproduced in annex I to the note by the Secretariat on

issues for discussion by and information for the attention of the Open-ended Working Group at its forty-first meeting (UNEP/OzL.Pro.WG.1/41/2).

46. In the ensuing discussion, many representatives, including one speaking on behalf of a group of parties, expressed support for requesting the Technology and Economic Assessment Panel to prepare the replenishment study and for using as a basis for the terms of reference for the study those set out in decision XXVIII/5.

47. Several representatives mentioned topics that they wished to see included in the terms of reference. Topics cited by one or more representatives included estimating the costs associated with implementing stage III of the HCFC phase-out management plans and achieving a 67.5 per cent reduction of HCFCs by 2025; continuation of activities in the servicing sector using low-global-warming-potential substances; stage I of the HFC phase-down, including the development of national plans to implement the phase-down and the cost of safety systems associated with conversions from HFCs to hydrocarbons and other flammable substances; energy efficiency measures, such as the installation of energy-efficient refrigeration and air-conditioning systems in plant conversions; strengthening of national ozone units to deal with additional workloads; and dealing with compliance challenges highlighted in the 2018 quadrennial assessment of the Technology and Economic Assessment Panel.

48. Many other representatives, including one speaking on behalf of a group of parties, expressed support for the inclusion in the replenishment study of indicative figures for the two subsequent replenishment periods, following past practice. They added that the terms of reference should focus on estimating the costs of compliance by Article 5 parties with their core obligations under the Montreal Protocol during the replenishment period 2021–2023, taking into account all the relevant decisions by the Meetings of the Parties and the Executive Committee of the Multilateral Fund related to compliance with the Protocol's control measures. One representative said that the terms of reference should be simple and not too prescriptive in order to enable the Technology and Economic Assessment Panel to decide how it would estimate the costs associated with obligations for the next replenishment periods, including those related to compliance with the Kigali Amendment.

49. Following the discussion, the Working Group agreed to establish a contact group, to be co-chaired by Mr. Agustín Sánchez (Mexico) and Mr. Ralph Brieskorn (Netherlands), to discuss the terms of reference.

50. Subsequently, the co-chair of the contact group, reporting on the group's work, said that the group had reviewed nearly all of the text of the previous decision on the terms of reference and had managed to reach agreement on certain aspects and eliminate some repetitive text. The resulting version had been posted on the meeting portal by the contact group, with some sections remaining in brackets.

51. The Working Group agreed to forward the draft decision, as set out in section A of annex I to the present report, to the Thirty-First Meeting of the Parties for further consideration.

## **V. Quadrennial assessment of the Montreal Protocol for 2018 and potential areas of focus for the 2022 assessment**

52. Introducing the agenda item, the Co-Chair drew attention to the note by the Secretariat on issues for discussion by and information for the attention of the Open-ended Working Group at its forty-first meeting (UNEP/OzL.Pro.WG.1/41/2) and the addendum thereto, which summarized the highlights of the 2018 quadrennial assessment reports prepared by the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel and its technical options committees.

53. The Working Group then heard presentations on the main findings and conclusions of the 2018 quadrennial assessment reports, as well as suggestions for potential areas of focus for the 2022 quadrennial assessment. Mr. David Fahey, co-chair of the Scientific Assessment Panel, described the Panel's main findings. He was followed by Ms. Janet F. Bornman and Mr. Nigel Duncan Paul, co-chairs of the Environmental Effects Assessment Panel, who presented the results of the Panel's investigations. Summaries of the presentations by Mr. Fahey, Ms. Bornman and Mr. Paul, as prepared by the presenters, are set out in section II of annex III to the present report, without formal editing.

54. Mr. Ashley Woodcock, co-chair of the Technology and Economic Assessment Panel, then gave an overview of the Panel's assessment report, including its key messages, after which co-chairs of the Panel and its technical options committees summarized the findings of the report as follows: Mr. Paulo Altoe – Flexible and Rigid Foams Technical Options Committee; Mr. Adam Chattaway –

Halons Technical Options Committee; Ms. Marta Pizano – Methyl Bromide Technical Options Committee; Mr. Keiichi Ohnishi – Medical and Chemicals Technical Options Committee; and Mr. Fabio Polonara – Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee. Lastly, Mr. Woodcock summarized the panel’s findings on the impact of the phase-out of ozone-depleting substances on sustainable development. Summaries of the presentations, as prepared by the presenters, are set out in section II of annex III to the present report, without formal editing.

55. Following their presentations, the panel members answered questions from representatives while also indicating their willingness to engage in bilateral discussions with individual parties as needed. In several of their replies, the panel members reassured the Working Group that the various panels and technical committees communicated with each other regularly on the results of their work and shared information and data in preparing their assessments.

56. Ms. Pizano, co-chair of the Methyl Bromide Technical Options Committee, responding to a question about research on alternatives to the use of methyl bromide as a fumigant, said that there was extensive experience to draw on in both research and direct adoption of alternatives and offered to expand on the matter in bilateral discussions. She encouraged parties to consult the current and previous assessment reports, which were a rich source of information. Mr. Ian Porter, co-chair of the Methyl Bromide Technical Options Committee, addressed a question on charcoal rot in strawberry plants, which appeared to be increasing in specific regions, countries, growing conditions and varieties. The most promising solution was the development of resistant varieties, as chemical alternatives did not seem to be performing well. Asked why quarantine and pre-shipment uses were increasing in some countries but not in others, he said that the issue was difficult to explain but was related to bilateral trade agreements between countries, and that it could involve increased trade in a particular commodity, or a pest affecting that commodity in a specific country, or regulations imposed by the importing country on the exporter. While the Committee went to great lengths to try to understand the many reasons behind the increases, bilateral trade issues were beyond the purview of its work and needed to be discussed from an international trade perspective. He noted, however, that a trend had been observed in which countries whose national legislation prohibited the use of methyl bromide were required, under bilateral trade arrangements, to use the chemical in quarantine and pre-shipment applications offshore.

57. A representative of the Secretariat, responding to a question about the classification of methyl bromide mixtures, drew attention to an information note issued for the consideration of the Thirtieth Meeting of the Parties that set out new proposed classification codes for HFCs. The note included a proposal by the World Customs Organization to reclassify methyl bromide from chapter 38 of the Harmonized System, on miscellaneous chemical products, to chapter 29, on organic chemicals, effective as of 1 January 2022. If that proposal was implemented then the main component reported on would be methyl bromide, regardless of the mixture.

58. Mr. Polonara, responding to questions on behalf of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, said that there were many refrigeration and air-conditioning subsectors in which technology had progressed and low-global-warming-potential alternatives were readily available, including the domestic and commercial refrigeration subsectors, but that much work remained to be done in the air-conditioning subsector. In terms of training and leak detection programmes, the European Union’s F-gas regulation was very advanced and could be considered an example for others to follow. Regarding the use of perfluorocarbons (PFCs) in equipment, he said that the Technology and Economic Assessment Panel had no information on the matter but could investigate. Mr. Chattaway added that PFCs had initially been used as a first-generation replacement for halons but that their use had been relatively short-lived.

59. Asked to elaborate on low-global-warming-potential alternatives for air-to-air air conditioners, Mr. Polonara said that most alternatives were in the category of R-290 (propane), HFC-32 and hydrofluoroolefin (HFO) blends. The Committee was aware that some chemical companies were developing new fluids containing iodine, but it had considered those too new to mention in the 2018 assessment report.

60. Asked about research being carried out under high-ambient-temperature conditions, Mr. Polonara noted that such queries would largely be addressed by the report of the task force on decision XXX/5, on energy efficiency, to be presented under agenda item 7. He nevertheless drew attention to evaporative cooling, an effective, low-global-warming-potential, not-in-kind technology mentioned in the assessment report that was of interest for arid, high-ambient-temperature regions. The energy-efficient, refrigerant-free technology was being rapidly commercialized and was expected to spread quickly in such regions.

61. Mr. Chattaway, responding to questions on behalf of the Halons Technical Options Committee, began by addressing a question on 2-bromo-3,3,3-trifluoroprop-1-ene (2-BTP). He said that it was only being used as a halon-1211 replacement for portable extinguishers on aircraft newly produced from existing designs, although it was very likely that it would also be used on newly designed aircraft. While the substance was not currently being considered for use in aircraft engine nacelles, nevertheless, as he had said in his presentation, research was being spearheaded by two aviation industry consortiums, one looking at aircraft engine nacelle fire protection and the other at aircraft cargo compartment fire protection. Those interested in the maintenance and storage of residual halons might wish to consult a technical note on best practices for emission reduction and emission reduction strategies that had been updated by the committee in 2018 and was posted on the Secretariat's website.
62. Responding to questions on behalf of the Flexible and Rigid Foams Technical Options Committee, Ms. Walter-Terrinoni informed the Working Group that the availability of HFOs in the foam industry was growing, as was shown by the recent start-up of two plants, including a large-scale one, that used HFO-1233zd. The Committee was aware of the demonstration projects being funded by the Multilateral Fund and believed that such projects, once further commercialized, would provide options for small and medium-sized enterprises and other market segments where the transition to the use of alternative technologies had been technically and economically challenging.
63. Mr. Paul responded on behalf of the Environmental Effects Assessment Panel to two questions regarding the potential threat presented by trifluoroacetic acid (TFA), produced by atmospheric degradation of HFOs. There was still a large gap between environmental concentrations of TFA, generally measured or predicted in nanograms or micrograms, and concentrations known to be toxic to organisms, which were typically in the milligram range. While that indicated that TFA was not a problem, more information on it would be welcome. There was little research available on its effects on terrestrial plants and soil microorganisms, for instance, as TFA was expected to accumulate in water and the research to date had therefore tended to focus on aquatic organisms. Furthermore, very little new research had been done in the previous four years on the overall environmental impact of TFA. As for the potential effects of other substitutes for ozone-depleting substances, ammonia could be an air pollutant, and propane and other hydrocarbons could act as volatile organic compounds that could contribute to the production of ozone, but those compounds were produced by many sources other than the substitutes, and releases attributable to refrigeration would be small by comparison.
64. On the subject of TFA, Mr. Polonara drew attention to a possible inconsistency between the Committee's assessment report and the report of the Environmental Effects Assessment Panel. Any inconsistency could result from current information gaps on the topic, but he would ensure that the two bodies liaised on the question so that the information provided to parties was consistent.
65. Mr. Paul, addressing a question about the availability of global estimates of the incidence of skin cancers avoided owing to the implementation of the Protocol, said that, while in the past many papers had looked at global skin cancer incidence in the absence of the Protocol, they lacked the rigour and detail of United States Environmental Protection Agency estimates for that country, which were exemplary tools for understanding the effects that would have been seen in the absence of the Protocol.
66. Mr. Paul Newman, a co-chair of the Scientific Assessment Panel, replying to a number of questions on behalf of that panel, said that the additional four years of data available for the 2018 quadrennial assessment had bolstered confidence in the scientific community that upper stratospheric ozone was increasing. Ozone levels above the Antarctic region were also increasing, and the hole in the ozone layer was expected to close around 2060. That said, there had been a decline in the number of ozone measurements around the world over the past two decades owing to closures of surface measurement stations. The satellite observation system was strong, however. Those with questions about the interaction between the ozone layer and climate were advised to consult the chapter on the subject in the assessment report.
67. Turning to a question on carbon tetrachloride (CTC), he began by noting that the gap between bottom-up emissions of CTC and top-down, atmosphere-derived emissions had narrowed considerably. The identified sources of the bottom-up emissions were chloromethane plants and perchloroethylene plants, although the panel had not visited the plants themselves to see how they were emitting CTC.
68. Ms. Tope addressed a related question on whether CTC emissions were perhaps due to small emissions from a large number of facilities rather than high emissions from individual facilities, saying that a recent paper detailed some of the estimations of the bottom-up, industry-sourced emissions of CTC from chloromethane plants. The estimates were by region rather than for individual plants,

however; the paper indicated a regional range of CTC emissions from chloromethane plants of 0.4 to 0.9 per cent, or 0.5 per cent for the global average, as a proportion of chloromethane produced.

69. Mr. Fahey, replying on behalf of the Scientific Assessment Panel to two questions related to short-lived and very short-lived substances, which were largely not controlled by the Protocol, and their impact on the ozone layer, drew attention to a table in appendix A of the assessment listing all the synthetic compounds that the Working Group might consider. The Panel was aware that not all short-lived compounds had been assigned ozone-depleting potential figures, but it lacked the tools to determine them. It was important to note that the ozone-depleting potentials for such compounds were largely dependent on the latitude at which a given compound was emitted, which determined whether it was convected into the stratosphere or remained in the troposphere. The Panel considered short-lived substances to be a potential area of focus for the 2022 quadrennial assessment.

70. Finally, in response to a question on how 2016 emissions of CFCs, HCFCs, halons, CTC and methyl chloroform, at approximately 1.7 gigatonnes when expressed in CO<sub>2</sub>eq, compared to 2016 emissions of other greenhouse gases such as HFCs and methane, Mr. Stephen Montzka, a member of the Scientific Assessment Panel, said that he estimated the CO<sub>2</sub>eq of methane to be around 10 gigatonnes and that of HFCs to be 1 gigatonne, but referred those interested to the Scientific Assessment Panel's report, which contained the precise 2016 emission figures in CO<sub>2</sub>eq.

#### **A. Ongoing reported emissions of carbon tetrachloride (UNEP/OzL.Pro.30/11, para. 225)**

71. Introducing the sub-item, the Co-Chair recalled that at the Thirtieth Meeting of the Parties the Scientific Assessment Panel had highlighted, in a presentation on key issues emerging from its 2018 quadrennial assessment, new findings on the sources of significant CTC emissions. The parties had consequently requested that the issue be considered further at the current meeting. Background information was provided in a note by the Secretariat (UNEP/OzL.Pro.WG.1/41/2, paras. 19–22).

72. One representative said that he appreciated the work of the assessment panels to provide further information on and analysis of the ongoing reported emissions of CTC, which was both an ozone-depleting substance and a potent greenhouse gas. While the matter of CTC emissions had linkages with the discussion of CFC-11 and synergies in that regard should be explored, it merited separate consideration, as emission sources were not limited to production of CFC-11. As for possible action, extending atmospheric monitoring to those regions for which information was scant would assist in building knowledge of the global patterns of emissions and atmospheric movement. Mitigation measures were needed for emission sources that had been identified or would be identified in the future, and guidance was needed from the assessment panels to orient research on the matter.

73. Another representative, speaking on behalf of a group of parties, said that the apparent reduction in the discrepancy between top-down and bottom-up estimates of CTC emissions was encouraging. Higher emissions from industrial production had been identified as the likeliest source of the increase in emissions. It was of concern that a significant quantity of atmospheric CTC was associated with feedstock uses, rather than being absorbed into the system during production. A third representative also expressed concern that uncontrolled and unregulated industrial sources, emitting CTC as a by-product or as fugitive emissions, had been identified as the probable main source of the increased emissions. Further research and analysis were needed to quantify emissions from industrial facilities, and to more closely pinpoint geographical sources of emissions.

74. Subsequently, the representative of Switzerland introduced a conference room paper containing a proposed draft decision on the matter. The proposal had, he said, been motivated by the new findings on emissions of CTC, which had contributed to a better understanding of the discrepancy between the top-down and bottom-up estimations of emission levels, as well as by new information on the characteristics of potential CTC emission sources. He was therefore presenting a comprehensive list of possible actions to guide the way forward on the matter.

75. In the ensuing discussion, a number of views were expressed on the possible scope and direction of any future action on CTC emissions, and on what responses were appropriate or feasible within the mandate of the Montreal Protocol. Some representatives said that the proposed scope was broader than they had envisioned, and that it could be useful to concentrate on a few key activities. The view was voiced that possible action by the Technology and Economic Assessment Panel or the Scientific Assessment Panel should take into account the workloads and mandates of those bodies and the fact that the topic was of major concern to a limited number of parties. It was noted that securing funding for an extension of the currently operating network of atmospheric monitoring stations would be challenging. One representative, speaking on behalf of a group of parties, favoured an approach to the matter that took account of its multifaceted nature and its relevance to a number of related issues,

including CFC-11 emissions, feedstock use and atmospheric monitoring systems. Another spoke in favour of a step-by-step approach, starting with discussion among interested parties and members of the assessment panels to define the scope of the issue, the information required to address it, and possible action under the Montreal Protocol.

76. Following the discussion, the working group agreed to establish a contact group, to be co-chaired by Mr. Patrick McInerney (Australia) and Mr. Leslie Smith (Grenada), to further consider CTC emissions and related issues.

77. Subsequently, the co-chair of the contact group said that, given the limited time available, the contact group had agreed that any further work on the matter should take place within the mandate and control obligations of the Montreal Protocol and should take account of the workloads of the assessment panels. Clarity was needed about which knowledge gaps needed to be closed and what work the panels and the parties could undertake to close those gaps.

78. The Working Group agreed to forward the draft decision, as set out in section B of annex I to the present report, to the Thirty-First Meeting of the Parties for further consideration.

## **B. Relationship between stratospheric ozone and proposed solar radiation management strategies (UNEP/OzL.Pro.30/11, para. 214)**

79. Introducing the sub-item, the Co-Chair recalled that some general discussion of the relationship between stratospheric ozone and proposed solar radiation management strategies had taken place at the Thirtieth Meeting of the Parties, which had agreed to defer further consideration of the matter to the current meeting. The issue had been discussed in the 2018 reports of the Scientific Assessment Panel and the Environmental Effects Assessment Panel. Background information was provided in a note by the Secretariat (UNEP/OzL.Pro.WG.1/41/2, paras. 23–26).

80. One representative said that the potential damage to the ozone layer arising from geo-engineering applications that increased stratospheric aerosols with the aim of mitigating global warming was an example of the complex interconnections involved in efforts to resolve environmental and other challenges. Such interconnections demonstrated the need for continued diligence to ensure that the benefits of action in one area were not outweighed by negative consequences in other areas. While solar radiation management was still at a nascent stage, the issue was worthy of consideration in the 2022 quadrennial report of the Scientific Assessment Panel in order to further knowledge of its potential impacts.

81. A number of representatives, including one speaking on behalf of a group of parties, agreed that further information was needed on the possible effects of solar radiation management on the ozone layer, and that the quadrennial report of the Scientific Assessment Panel constituted an appropriate context for providing such information. Several representatives said that, given the early stage of development of solar radiation management projects, the focus of the Montreal Protocol should for the moment be on monitoring any developments, building knowledge, and raising awareness of the possible future implications of such activities. Some representatives noted that the issue was being considered from a general perspective in other forums such as the United Nations Environment Assembly, and in the preparatory work for the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, where relevant scientific information was assessed under the distinct categories of solar radiation management and greenhouse gas removal techniques. Some representatives said that the bodies of the Montreal Protocol needed to ensure that their consideration of the matter remained within the mandate of the Protocol with regard to protection of the stratospheric ozone layer.

82. The Working Group agreed to consider the issue further under sub-item 5 (c), particularly with regard to the development of terms of reference for the quadrennial report of the Scientific Assessment Panel.

## **C. Any other issues arising from the reports of the assessment panels**

83. Introducing the sub-item, the Co-Chair suggested that the discussion take into consideration the findings of the assessment panels, the proposal made during the adoption of the meeting agenda that short-lived substances and banks of ozone-depleting substances and hydrofluorocarbons be discussed under the sub-item, and the development of terms of reference for the work of the assessment panels for the coming quadrennium.

84. Several representatives highlighted the urgent need to turn attention to banks and short-lived substances, either in the context of the quadrennial report of the Scientific Assessment Panel or

through provision of more immediate information via annual assessment panel reports. One representative, speaking on behalf of a group of parties, said that it was apparent from the 2018 report of the Scientific Assessment Panel that banks of ozone-depleting substances could be managed more effectively, and that best available techniques should be applied to ensure that the destruction methods adopted minimized venting of those substances. With regard to short-lived substances, such as dichloromethane, the report of the Scientific Assessment Panel had shown that their impact on the ozone layer could be significant in the coming decades, but the lack of current information made it difficult to predict their effects or to develop techniques to mitigate those effects. Academia and the research community should share any relevant information with the assessment panels to assist them in reporting on the matter. One representative said that the issue of destruction of banks should encompass not only technical options but also political options for action at the national level, supported by demonstration projects.

85. One representative said that, while short-lived substances accounted for a relatively small proportion of the total chlorine in the stratosphere and were not controlled under the Montreal Protocol, their impact should not be ignored. The information provided on dichloromethane in the 2018 report of the Medical and Chemicals Technical Options Committee, including the analysis of the supply of and demand for the substance, provided useful knowledge. The scientific community should continue monitoring short-lived substances to reduce the levels of uncertainty surrounding their impact. Regular updates on the uses, quantities and emissions of short-lived substances, and on possible alternatives to such substances, would help the assessment panels provide the parties with more comprehensive information on the matter. His Government might be interested in having further discussions on the issue at the next Meeting of the Parties.

86. Regarding the terms of reference for the Scientific Assessment Panel, one representative said that the list of potential areas of focus for the 2022 report provided by the co-chair of the Panel at the current meeting was a good starting point for discussion of the work to be undertaken during the next assessment period. Continuing review of emissions of CFCs should be a component of that work, supported by a consideration of possible methodologies for enhancing atmospheric monitoring capabilities for ozone-depleting substances.

87. Subsequently, the representative of the European Union introduced a conference room paper setting out a proposed draft decision on potential areas of focus for the 2022 quadrennial reports of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel. The proposed text was intended as a review of possible actions that could form a basis for further discussion at the Thirty-First Meeting of the Parties.

88. Two representatives said that the draft decision as it stood had not been subject to the usual discussion processes of the Open-ended Working Group, and that it was important to ensure that a full exchange of ideas on the issues raised took place during the Meeting of the Parties.

89. The Working Group agreed to forward the draft decision, as set out in section C of annex I to the present report, to the Thirty-First Meeting of the Parties for further consideration.

## **VI. Technology and Economic Assessment Panel 2019 report**

90. The Co-Chair, introducing the agenda item, drew attention to volumes 1 and 2 of the 2019 report of the Technology and Economic Assessment Panel, which contained information related to the five sub-items.

91. Following an introduction by the co-chair of the Panel, Ms. Bella Maranion, who highlighted continuing administrative challenges faced by the Panel, members of the Panel and its technical options committees summarized the findings of volumes 1 and 2 of the 2019 Panel report as follows: Ms. Helen Walter-Terrinoni – Flexible and Rigid Foams Technical Options Committee; Mr. Daniel P. Verdonik – Halons Technical Options Committee; Mr. Fabio Polonara – Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee; Ms. Helen Tope – Medical and Chemicals Technical Options Committee; and Mr. Ian Porter and Ms. Marta Pizano – Methyl Bromide Technical Options Committee. Summaries of the presentations, as prepared by the presenters, are set out in section III of annex III to the present report, without formal editing.

92. In the ensuing discussion, Panel members answered questions and expressed their willingness to discuss the issues in more detail bilaterally with representatives.

93. Mr. Polonara, responding to a question about how the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee was managing its workload, said that in the previous two years six new members had been appointed to the Committee, including four women and three

members from high-ambient-temperature countries. The Committee was seeking to maintain its current membership of 42 individuals, which was larger than the membership of the other technical options committees and adequate for managing its workload. In response to another question, he said that the increase in charge limits for flammable refrigerants in commercial appliances could have enormous implications for the entire commercial refrigeration sector because many appliances that could not work with a charge below 150 grams could work with 500 or, in the case of A2L refrigerants, even up to 1,200 grams of charge.

94. Ms. Tope, answering a question about the increase in production of controlled substances for feedstock uses in 2017 compared to 1990, said that 50 per cent of the increase could be attributed to the increased use of HCFC-22 in the production of tetrafluoroethylene, which was used to make fluoropolymers. Fluoropolymers had many applications, and the fluoropolymer industry was driving the growth in the use of HCFC-22 as a feedstock.

95. Mr. Verdonik, replying to a question about the existence of comprehensive data on halon banks in Article 5 parties, said that, with the single exception outlined in the 2018 report of the Halons Technical Options Committee, no such information existed at the country or regional level, and that the Committee hoped to address the situation through increased engagement with national ozone units.

96. Ms. Maranion, answering a question related to the very low representation of the African region on the Panel and its technical options committees, said that she could not pinpoint the cause of such underrepresentation and looked to the parties to nominate relevant experts. In the current and previous matrices of needed expertise the Panel had requested members with expertise in Africa and other regions. Addressing another question, she said that, in view of the expected decision by the parties to request a task force of the Panel to conduct the study on the 2021–2023 replenishment of the Multilateral Fund, the Panel was expected to require additional expertise in economics or a similar field to carry out such work.

97. Mr. Porter, responding to the clarification provided by a representative that methyl bromide was not being used in China to treat plastic and other waste, as was reported in section 4.5.2 of volume 1 of the 2019 Panel report, thanked the representative for the information. Ms. Pizano, responding to the concern expressed by another representative that the Methyl Bromide Technical Options Committee had based one of its recommendations regarding the critical use nomination submitted by one party on the potential future regulatory approval of an alternative to methyl bromide in that party, said that the Committee had simply intended to support the management strategy presented to it by the nominating party. In reply to another question, she said that the statement in volume 1 of the Panel's 2019 report, that one party had banned the use of methyl bromide as a pest control fumigant in 2019 even though it had not reported any controlled uses of methyl bromide since 2004 and had never reported any quarantine or pre-shipment uses of the chemical, had been used to show that there seemed to be some confusion among the parties regarding the difference between controlled and non-controlled uses of methyl bromide.

98. Ms. Walter-Terrinoni, responding to a question about the use of HCFO-1224yd, said that the chemical was available in very small quantities in Japan for use in centrifugal chillers and as a foam blowing agent.

## **A. Nominations for critical-use exemptions for methyl bromide for 2020 and 2021**

99. Introducing the sub-item, the Co-Chair of the Working Group referred representatives to the interim recommendations of the Methyl Bromide Technical Options Committee on the critical-use nominations put forward by parties, which had been included in the Panel's presentation and were contained in volume 2 of the Panel's 2019 report and summarized in document UNEP/OzL.Pro.WG.1/41/2/Add.1 (paras. 21–24).

100. The representative of Australia, thanking the Committee for its work, said that he was nevertheless perplexed by the Committee's interim recommendation on Australia's nomination for 2021. After many years of research and hard work on possible alternatives to methyl bromide, Australia had recently concluded that the registration and use of one alternative, methyl iodide, would be the best way forward. Industry was working with the registration authorities to provide all the data needed for registration of methyl iodide by late 2020, and trial production of the chemical had taken place, but, because the registration authority was an independent body that would conduct a robust risk assessment of the chemical, the Government could not predict the outcome of the registration process. For that reason, Australia had indicated in its nomination for 2021 that, should methyl iodide be registered and become available, Australia would only issue permits for the required amounts of the methyl bromide requested for 2021, as part of the transition period from methyl bromide to methyl

iodide. Despite that, the Committee had recommended that Australia be granted only half of the amount requested for 2021, on the basis that methyl iodide would be registered in 2020 and become available for use in 2021, in accordance with the country's proposed transition plan. He also wished to clarify that Australia had applied for the critical-use exemption for 2021 because fumigation in the country started early in the calendar year, so obtaining an exemption in late 2020 to fumigate in early 2021 would not give growers and industry enough time to ensure that the necessary amounts of methyl bromide were formulated and shipped.

101. The representative of Canada, thanking the Committee for its work on all the nominations presented, said that it was nevertheless inappropriate for the Committee to prejudge the outcome of the registration of a pesticide when making recommendations. With regard to the Committee's consideration of Canada's nomination, he was very pleased with the Committee's recognition that no chemical alternatives to methyl bromide were available for strawberry runners on Prince Edward Island and that only technical solutions were available to reduce and eventually phase out the use of methyl bromide on the island. Canada remained committed to working towards reducing and eventually phasing out the use of methyl bromide and had clearly said that it could reduce such use through the use of technical solutions including soilless production systems. However, it was facing considerable challenges with its soilless production system trials, which had yielded disastrous results in 2017 but more positive results in 2018. The 2018 results were nevertheless offset considerably by the production of slower plant growth than plant growth in fumigated soils. That reduction in plant growth had negative economic consequences for farmers. The 2019 results were jeopardized owing to plant damage caused by bird attacks. In his Government's view, positive soilless production system trial results would need to be achieved for two to three years, and two or three additional years would be needed to optimize the systems. With regard to the Committee's interim recommendations, he would like the Committee to clarify its rationale for reducing Canada's nomination by 4.6 per cent, which would have real consequences for farmers.

102. The representative of Argentina said that her country supported the Committee's interim recommendations on Argentina's nomination even though the recent devaluation of the country's currency had led to an increase in the cost of production of alternatives to methyl bromide that would require a greater effort by the Government to support the production sector. Argentina was committed to an accelerated phase-out of methyl bromide in the coming years.

103. Following the discussion, the Co-Chair encouraged all interested parties to arrange bilateral meetings with the Committee in the margins of the current meeting to discuss its interim recommendations in more detail.

## **B. Stocks of methyl bromide (UNEP/OzL.Pro.30/11, paras. 73 and 77)**

104. Introducing the sub-item, the Co-Chair drew attention to the information provided in document UNEP/OzL.Pro.WG.1/41/2 (paras. 34–37) and the addendum thereto (UNEP/OzL.Pro.WG.1/41/2/Add.1, paras. 25–30) and in volume 2 of the Technology and Economic Assessment Panel's 2019 report.

105. The representative of the European Union announced that he would submit for consideration by the Working Group a conference room paper on the issue of stocks, which would consist of two parts. Part 1 would invite the parties to provide information on their stocks of methyl bromide, and part 2 would request the Technology and Economic Assessment Panel to further clarify, through specific examples, what constituted an exempted use or quarantine and pre-shipment application of methyl bromide, and what constituted a controlled use of the chemical. Drawing attention to the conclusion on page 48 of the executive summary of the quadrennial report of the Scientific Assessment Panel that the elimination of future production of methyl bromide for quarantine and pre-shipment applications, which were not controlled by the Montreal Protocol, would accelerate the return of mid-latitude equivalent effective stratospheric chlorine to 1980 levels by about one year, he said that by dealing with the exempt uses of methyl bromide the parties could accelerate the healing of the hole in the ozone layer, which was in the interest of all parties. Accordingly, to better understand the amounts of methyl bromide being used by the parties for both controlled and non-controlled purposes, it would be a good idea to determine the amount of methyl bromide stocks, which the Methyl Bromide Technical Options Committee estimated to be 1,500 tonnes, and how such stocks were distributed, and to ensure that all parties fully understood the difference between exempt uses and controlled uses of methyl bromide.

106. In the ensuing discussion, two representatives, while expressing appreciation to the European Union for bringing the issue of stocks to the attention of the parties, added that the Scientific Assessment Panel had indicated that annual methyl bromide emissions from quarantine and

pre-shipment applications by the parties totalled 8 to 10 gigagrams, which was a minuscule amount compared to the 75 to 110 gigagrams of methyl bromide emissions from natural sources. One of the representatives suggested that quarantine and pre-shipment applications were exempted from the Montreal Protocol because they enabled countries to trade in valuable commodities while preventing the movement of invasive pests, and questioned the need to address the issue of stocks, while nevertheless expressing willingness to engage with the European Union on its proposal. The other expressed the hope that the proposal to be submitted by the European Union would present a solution commensurate with the problem identified and consider the resources that each party would need to fulfil any requirements resulting from the proposal.

107. A third representative expressed support for the proposal to address the issue of stocks, especially in view of the information provided by the Methyl Bromide Technical Options Committee that alternatives to methyl bromide were available for about 40 per cent of quarantine and pre-shipment application uses.

108. Subsequently, the representative of the European Union introduced a conference room paper co-sponsored by Norway and containing a draft decision and expressed the hope that the matter could be discussed further in a contact group.

109. One representative questioned the purpose of the draft decision. He stressed that each country defined "quarantine" nationally, implemented quarantine and pre-shipment exemptions domestically and negotiated the required treatment methods bilaterally with other countries, a process in which the Methyl Bromide Technical Options Committee had no role. A national ozone unit that was unclear about the quarantine needs for methyl bromide should contact its national plant protection organizations or the secretariat of the International Plant Protection Convention. The Multilateral Fund and UNEP had assisted several countries in developing databases to identify quarantine uses of methyl bromide and ensure that imported quantities of the substance were only used for quarantine purposes. As for stocks, only countries requesting exemptions were required to report their stocks, and the Methyl Bromide Technical Options Committee did not take into account information on stocks when recommending critical-use exemptions. Stocks created prior to the phase-out did not need to be reported, and it was unclear why they would need to be identified. Furthermore, stocks were owned by private interests, not governments, and it was not apparent that governments had the authority to identify who held stocks of methyl bromide. Consequently, the applicability of the provisions in the proposed draft decision was not apparent.

110. The representative of Norway, taking the floor as a proponent of the proposal to provide additional information about the intention behind it, said that the proponents considered the Methyl Bromide Technical Options Committee to be the appropriate body to provide the parties with relevant information about stocks of methyl bromide and how they were used globally. The proponents also wished to increase awareness of, and encourage the use of, the sustainable alternatives to the use of methyl bromide indicated by the Committee for quarantine and pre-shipment purposes.

111. One representative said that he had initially questioned the value of the proposal but after discussing it with one of the proponents had recognized that a number of parties would have an interest in the information it aimed to provide. He thus supported it in principle, although he wished to propose some amendments. A number of other representatives were also in favour of learning more about the intent behind the draft decision and discussing it further, although some acknowledged the validity of the concerns raised regarding it.

112. The Working Group agreed to continue discussion of the matter in an informal group with Ms. Shontelle Wellington (Barbados) and Ms. Jessica Escaip (New Zealand) as co-facilitators.

113. Subsequently, the co-facilitator of the informal group reported that, having discussed the proposed draft decision, including its purpose, intention and scope, the group had agreed that it should not be forwarded to the Thirty-First Meeting of the Parties, but that the issue should be included on the agenda of the Meeting.

114. The Working Group agreed to defer further consideration of the item to the Thirty-First Meeting of the Parties.

### **C. Development and availability of laboratory and analytical procedures that can be performed without using controlled substances under the Protocol (UNEP/OzL.Pro.30/11, paras. 83 and 127)**

115. The Co-Chair, introducing the sub-item, recalled that at the Thirtieth Meeting of the Parties the Medical and Chemicals Technical Options Committee had presented a report, prepared in response to

decision XXVI/5, on the development and availability of laboratory and analytical procedures that could be performed without using controlled substances. More details could be found in documents UNEP/OzL.Pro.WG.1/41/2 (paras. 38–41) and UNEP/OzL.Pro.WG.1/41/2/Add.1 (paras. 31–34); in section 5.1 of volume 1 of the May 2019 progress report of the Technology and Economic Assessment Panel; and in volume 4 of the Panel's September 2018 report.

116. In its report, the Committee had analysed available alternatives to laboratory and analytical procedures that used controlled substances and were still part of the global exemption for laboratory and analytical uses. It had also considered alternatives to HCFCs, but had not looked at HFC uses. The Committee had estimated in the report that 151 tonnes of ozone-depleting substances had been produced for laboratory and analytical uses in 2016. In the 2019 progress report of the Technology and Economic Assessment Panel, the Committee had reported that that production had increased slightly. The Committee recommended the removal of nine specific laboratory and analytical procedures using methyl bromide, carbon tetrachloride and 1,1,1-trichloroethane from the global essential-use exemption.

117. The Co-Chair also recalled that the Thirtieth Meeting of the Parties had adopted decision XXX/8, by which it had included HCFCs in the global laboratory and analytical-use exemption. It had agreed that the question of laboratory and analytical uses should be looked at in a more comprehensive manner at the current meeting.

118. In the ensuing discussion, one representative recalled that, during the discussions held by the Thirtieth Meeting of the Parties on the proposed removal of procedures from the list of laboratory and analytical uses, a number of parties had suggested moving to a simplified approach. The current practice of removing procedures from the list on a chemical-by-chemical basis was onerous, especially given the small quantities of substances concerned, in terms of both the administrative work required by the Technology and Economic Assessment Panel and the parties and the effort needed from parties at the domestic level to determine that they no longer needed ozone-depleting substances for specific laboratory and analytical uses. The overall effort required was not deemed commensurate with the associated environmental benefits. Furthermore, the fact that the list was not exhaustive could create confusion.

119. Any future approach needed, therefore, to be clear and to avoid overly complicated measures. The current global exemption would last until 2021, so there was no need to rush to decide on an approach, but it could be useful to begin considering the matter at the current meeting and at the Thirty-First Meeting of the Parties. A possible approach might be to extend the global exemption indefinitely and ask the Secretariat to continue posting on its website information on the total quantities of ozone-depleting substances for laboratory and analytical uses and alert the parties about any significant upward trend for their review. In addition, parties could be requested not to approve the use of ozone-depleting substances for laboratory and analytical methods that had been removed from the list approved by the parties, and could be encouraged or urged to further reduce their use of ozone-depleting substances for specific laboratory and analytic uses and facilitate the introduction of standards that did not require the use of such substances. The Technology and Economic Assessment Panel could be asked to periodically provide information on alternatives to ozone-depleting substances for certain procedures, essentially through its quadrennial reports.

120. A number of representatives expressed support for exploring ways of simplifying the procedure. One representative said that the quantities of ozone-depleting substances used in her country for laboratory and analytical procedures were in the microgram range and that resources should be directed where they were most required. Another agreed and said that the 151 tonnes of ozone-depleting substances produced for laboratory and analytical uses surpassed the quantity represented by all the requests for critical-use exemptions combined. In the past, restrictions governing the purity of substances for laboratory and analytical purposes and the size of the containers used had helped parties manage their use in a sensible manner. A third representative, speaking on behalf of a group of parties, said that those countries were wrapping up an evaluation of their domestic legislation and had found that one area for possible simplification related to laboratory and analytical uses of ozone-depleting substances. Any decision taken on the matter needed to take into account paragraph 4 of decision XXX/15 and paragraph 7 of document UNEP/OzL.Pro.WG.1/41/INF/6, according to which the Technology and Economic Assessment Panel was to provide a review of the laboratory and analytical uses of controlled substances if new compelling information were to become available. It was important to be sure how information provision would work under a simplified procedure.

121. The Working Group agreed that interested parties would hold informal consultations during the intersessional period and report to the Thirty-First Meeting of the Parties on any progress made.

**D. Process agents (decision XXIX/7 and UNEP/OzL.Pro.30/11, para. 86)**

122. The Co-Chair, introducing the sub-item, recalled that the Thirtieth Meeting of the Parties had considered the three recommendations on process-agent uses of ozone-depleting substances made by the Medical and Chemicals Technical Options Committee in the 2018 report of the Technology and Economic Assessment Panel. They included the removal from table A of decision X/14 of the use of CFC-113 in the preparation of perfluoropolyether diols; the updating of the same table by the removal of the reference to the European Union from under the application “recovery of chlorine by tail gas absorption from chlor-alkali production”; and the reduction of the quantities of “make-up or consumption” and “maximum emission” levels contained in table B of decision X/14 to take into account the process-agent uses and emissions currently reported. The parties had deferred consideration of the issues to the current meeting. The Working Group had before it the report by the Panel on the industrial application of any alternative technologies used by parties in the processes listed in table A of decision X/14 that had been prepared pursuant to decision XXIX/7. In that more recent report, the Panel had not changed its recommendations. Further information could be found in documents UNEP/OzL.Pro.WG.1/41/2 (paras. 42–44) and UNEP/OzL.Pro.WG.1/40/2/Add.1 (paras. 35–40) and in section 5.2 of volume 1 of the Panel’s May 2019 progress report.

123. One representative said that he was open to considering the recommendation relating to perfluoropolyether diols, as he believed that the company concerned was no longer using CFC-113 as a process agent. The situation regarding chlor-alkali production, however, was more complex, as could be seen in table 5.1 of section 5.2 of the Panel’s report. Further research was required before the countries could pronounce on that matter and on the recommendation relating to table B of decision X/14.

124. Another representative noted the parallel between the issue being discussed and the discussions under agenda item 6 (c) in terms of the ever smaller quantities being used for particular applications and the need to find a simple way to deal with related issues. In decision XXX/15, the Thirtieth Meeting of the Parties had requested the Technology and Economic Assessment Panel to provide its next review of process-agent uses of controlled substances no earlier than 2021, and every four years thereafter, if new compelling information were to become available. As that was not likely to happen, perhaps a revision to tables A and B of decision X/14 was warranted. Before any decision was taken, it would be important to consult with parties still using ozone-depleting substances for process-agent uses and understand their views on the recommendations made by the Panel.

125. A third representative recalled that the list of process-agent applications had at one time contained as many as 44 or 45 such applications, whereas there were currently only 11. Decision X/14 had aimed to ensure that substances were used in a way that minimized emissions. Given that the countries still using process agents managed their emissions well and manufactured valuable commodities, he wondered whether it was in fact necessary to change table B. He was, however, willing to engage in further discussions on the matter.

126. Following the discussion, the Working Group agreed that interested parties should hold informal consultations prior to the Thirty-First Meeting of the Parties in order to make specific proposals at that meeting regarding a possible decision on actions with regard to tables A and B of decision X/14 on process agents.

**E. Any other issues**

127. Although no other issues under the agenda item had been raised at the time of the adoption of the agenda, in response to the presentation by the Technology and Economic Assessment Panel on its 2019 report several representatives commented on the issue of nominations for positions on the Panel.

128. One representative said that she had noted the clear requirements for nominees that had been mentioned by the Panel in addition to the specific elements in the matrix of needed expertise, such as proficiency in English, computer skills and knowledge of electronic tools, and the ability to function within a structure that worked on the basis of consensus. She would take those elements into account when considering the nominations by parties.

129. Another representative stressed that the matrix was a tool that parties should use when choosing their nominees. Paragraph 8 of decision XXX/16 urged parties to follow the Panel’s terms of reference, consult the Panel co-chairs and refer to the matrix of needed expertise when making nominations for appointments to the Panel. He looked forward to receiving assurances that nominating parties had in fact taken those steps, and on that basis would be happy to discuss the future nominations.

130. A third representative, speaking on behalf of a group of parties, supported the points made by the previous speakers.

131. The Co-Chair recalled that, as was noted in document UNEP/OzL.Pro. WG.1/41/2/Add.1, two nominations had already been received by the Secretariat: the nomination by Algeria of a candidate to serve as a senior expert member on the Panel and the renomination by Japan of a co-chair of the Medical and Chemical Technical Options Committee. Annex 1 to volume 1 of the Panel's 2019 report provided the current status of the Panel membership, whereas table 5 and annex III of document UNEP/OzL.Pro.WG.1/41/2/Add.1 listed the members of the Panel and of the technical options committees whose terms expired at the end of 2019. The terms of reference of the Panel were posted on the meeting portal, and parties should keep in mind the procedures for nominating and appointing Panel members, including co-chairs of the technical options committees and senior expert members, whose appointment was subject to a decision by the Meeting of the Parties, and other members of the technical options committees, whose appointment did not require such a decision.

132. Parties intending to nominate experts or interested in the nominations should consult informally in the margins of the meeting with a view to preparing nominations in time for the Thirty-First Meeting of the Parties. They were also encouraged to consult with Panel members to ensure that nominations would meet the requirements of the Panel.

## **VII. 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 (decision XXX/5)**

133. Introducing the item, the Co-Chair recalled that in decision XXX/5, the Meeting of the Parties had requested the Technology and Economic Assessment Panel to prepare a report on the cost and availability of low-global-warming-potential technologies and equipment that maintained or enhanced energy efficiency. To respond to that request, the Panel had established a task force, the report of which had been issued as volume 4 of the 2019 report of the Panel. The executive summary of the report was presented in annex V to document UNEP/OzL.Pro.WG.1/41/2/Add.1.

134. A presentation summarizing the main findings of the report was introduced by Ms. Hélène Rochat, co-chair of the task force, with contributions from Mr. Bassam Elassaad, lead author for chapter 2; Mr. Omar Abdelaziz, lead author for chapter 3; and Ms. Gabrielle Dreyfus, lead author for chapter 4. A summary of the presentation, as prepared by the presenters, is set out in section IV of annex III to the present report, without formal editing.

135. Task force members then answered questions from representatives about the presentation.

136. Mr. Elassaad, responding to questions on availability, said that there was limited availability of compressors for high-ambient-temperature conditions with a cooling capacity of 2 tonnes or more that used HC-290 as a class A3 refrigerant. Regarding the availability of HC-290 for service purposes, he said that the task force had not considered that aspect, as its mandate related mainly to the availability of the technology and products, but that the issue might be dealt with at a later stage. Regarding the compatibility of alternatives for countries with high ambient temperatures, research from PRAHA and other projects had shown that viable alternatives were available, but they needed to be coupled with an optimized design. More information would be provided on that matter when the results of research became available. As for the energy-saving potential of variable-speed compressors, or inverters, he confirmed that, while the energy savings would not be large in high-ambient-temperature conditions with a small diurnal temperature range, they were still greater than for an on-off compressor, owing to the closer fit with the daily cooling load demand curve that could be achieved with inverters.

137. Evaporative cooling was an example of a not-in-kind cooling technology that had recently attracted attention, especially in countries with a moderate level of relative humidity. It had the potential to reduce the amount of energy consumed over the year by around 75 per cent. More information about it was available in chapter 12 of the 2018 Assessment Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee. It was worth noting that if changes in standards allowed larger quantities of refrigerants to be used in systems, and if improved component quality enabled the equipment to use lesser amounts of that refrigerant charge, then the capacity of the equipment would be enhanced.

138. He added that, while the presentation had mainly given a snapshot of the current situation, it was important to recognize trends over time, as research and development brought new products and technologies onto the market, and to be aware of opportunities to facilitate market transition to energy-efficient technologies once they became available.

139. Mr. Abdelaziz, responding to a question about capital costs for converting a production line for the manufacture of lower-global-warming-potential refrigeration and air-conditioning equipment with higher energy efficiency, confirmed that the costs presented were the incremental capital costs of conversion, not the total costs of a new manufacturing line. The range of \$1 million to \$1.5 million for the establishment of new production lines for microchannel heat exchangers referred to the cost of adding or producing the heat exchangers locally at the plant, while the option of procuring the microchannel heat exchangers would be less expensive. He said that low-volume-consuming countries typically imported equipment from China, so the in-country cost of purchase would be the purchasing cost plus shipping and import duties.

140. The intellectual property aspects of such conversion included considerations related to energy efficiency, such as how to build more efficient heat exchangers and how to integrate more energy-efficient components into systems. The importance of safety considerations when developing energy-efficient alternatives needed to be recognized. The cost of converting a production line for the manufacture of lower-global-warming-potential equipment, including safety costs, was not a significant barrier when calculated as unit costs.

141. Ms. Dreyfus, responding to a question about the relationship between price and energy efficiency, confirmed the finding that the two were only loosely correlated, reflecting the fact that firms' pricing strategies included consideration of factors other than the energy performance of a unit, such as brand reputation or the inclusion of additional features – for example, smart capabilities – demanded by clients.

142. Referring to questions about the role of the market in facilitating availability, supportive policies, and the energy efficiency of different technologies, she said that detailed information on those matters was presented in the report of the task force. There were various opportunities for adopting policies that would encourage new technologies by creating enabling market conditions, and some regional initiatives were taking place in that regard. Opportunities for international and regional cooperation included testing using common metrics, allowing for greater inter-country comparability, and developing mutual recognition agreements. In small markets, common metrics and standards allowed for signalling of increased demand, enabling markets to derive economies of scale when purchasing from manufacturers. A number of forums and initiatives were in place to facilitate collaboration and exchange of best practices with regard to energy efficiency, including the United for Efficiency, the Clean Energy Ministerial, and the Super-Efficient Equipment and Appliance Deployment initiatives. Examples of success stories included the combined efficiency and refrigeration policies of Japan, which had achieved rapid technological market transition, and the tools and approaches adopted in India, which had resulted in a significant increase in the average efficiency of air conditioning over the past decade – for example, through a well-recognized five-star labelling system and market pull policies, such as bulk procurement to help reduce the price of high-efficiency technologies.

143. Mr. Nihar Shah, a member of the task force, added that work was being done on inter-conversion technologies as they related to the energy efficiency metrics of different economies. The work enabled inter-country comparison of minimum energy performance standards.

144. Ms. Rochat, responding to a question about testing of appliances, said that that was not part of the mandate of the task force and had therefore not been included in the report. However, it was important to recognize that testing appliances and other products involved a compromise between replicable and real-life conditions. For a methodology to be replicable, it had to produce comparable data using standardized procedures, which might not reflect the reality in different geographic circumstances. Improved diagnostics were needed to allow Article 5 countries to flag whether equipment was malfunctioning and to define energy consumption levels in local conditions.

145. Concluding the question-and-answer session, Mr. Ashley Woodcock, co-chair of the task force, said that no Article 5 party should be in a position where it was importing inefficient, expensive air-conditioning equipment. It was therefore essential to support those countries' transition to low-global-warming-potential technologies with high energy efficiency, and to explore the potential in various regions of the world for enhancing the movement towards improved technological solutions.

146. In the ensuing discussion, many representatives, including one speaking on behalf of a group of countries, asked for elements to be added to the report, including an indication of what the task

force considered to be “low-global-warming-potential”, as opposed to “medium-” or “high-”, technologies for the purposes of the report; additional information about minimum energy performance standards, including on enforcement; incorporating **Minimum Energy Performance Standards** (MEPS) into building codes; designing MEPS to achieve energy efficiency while supporting the HFC phase-down; what the introduction of MEPS involved and into which sectors MEPS could be introduced in the medium term; information, in tabular form, about the relationship between MEPS and the highest-efficiency equipment available in different regions; elaboration of the concept that international and regional cooperation on standards could help countries capitalize on scale, drive innovation and reduce prices; additional information, in tabular form, on in-licensed or patented technologies available to enhance energy efficiency and new refrigerant fluids, and how that related to moving a manufacturing enterprise away from the use of HCFCs, to aid understanding of how technologies spread and what the barriers might be; a clear indication of what types of energy efficiency would fall within the context of the Protocol and how to establish a basis for future projects to be funded by the Multilateral Fund; information on the availability of technologies at the regional level; information on new approaches to procurement, regardless of the sector, for countries for which distance and transportation were a cost factor; information on international and bilateral funding available for energy efficiency projects; information on products that had been or were being introduced in Article 5 and non-Article 5 countries, in particular central air-conditioning systems that used non-HFC refrigerants, including a cost comparison with systems that used HCFCs or HFCs; additional information on not-in-kind technologies, particularly alternatives to air conditioning; an increased focus on the association between energy efficiency and safety, including concrete examples, in particular to address the concerns of high-ambient-temperature countries; and information on how to improve energy efficiency in the servicing sector.

147. In addition, several representatives from low-volume-consuming countries and high-ambient-temperature countries spoke about the particular challenges faced by such countries in accessing and adopting alternative technologies. In the case of high-ambient-temperature countries with high consumption of air conditioning, a lack of regulations applicable to manufacturers often made it difficult to eliminate undesirable technologies, threatening those countries’ ability to meet their commitments under the Protocol and the Kigali Amendment. Low-volume-consuming countries, many of which had adopted a policy of bypassing the use of HFCs to transition directly to low-global-warming-potential technologies, were facing difficulties in accessing the new technologies even when those were already available, for reasons that included their small market size, their lack of standards and capacity, and the extraordinarily high cost of bringing in new equipment.

148. Several representatives, including one speaking on behalf of a group of countries, stressed the importance of training and capacity-building. Two said that the Executive Committee of the Fund should take technical capacity-building for both new equipment and new refrigerants into consideration in approving projects. Another, speaking on behalf of a group of countries, pointed out that improving servicing and leak testing would generate green economy jobs and benefit all parties in the long term.

149. The Working Group agreed that the Technology and Economic Assessment Panel should update its report with additional information, taking into account the comments made, and present the updated report for consideration by the Thirty-First Meeting of the Parties.

## **VIII. Linkages between hydrochlorofluorocarbons and hydrofluorocarbons in transitioning to low-global-warming-potential alternatives (UNEP/OzL.Pro.30/11, para. 89)**

150. Introducing the item, the Co-Chair recalled that the issue had initially been presented by Saudi Arabia two years earlier and had been discussed at each meeting of the Working Group held since then. The Thirtieth Meeting of the Parties had confirmed the importance of the issue but had agreed to defer the discussion until the current meeting owing to time constraints. At the time, it had also been suggested that the discussion be taken up on the basis of the discussions held at the fortieth meeting of the Working Group, as summarized in the report of that meeting (UNEP/OzL.Pro.WG.1/40/7) and further summarized in document UNEP/OzL.Pro.WG.1/41/2 (paras. 50–53).

151. A representative drew attention to the fact that the agenda item had originally been proposed because some high-ambient-temperature countries had issues with the timing of the HCFC phase-out in combination with the HFC phase-down, particularly in the light of their air-conditioning needs. In

short, they faced the dilemma of potentially having to increase their reliance on high-global-warming-potential HFCs in order to meet their HCFC phase-out commitments. Countries of the Cooperation Council for the Arab States of the Gulf were looking in particular to the PRAHA II demonstration project on promoting refrigerant alternatives for high-ambient-temperature countries, as well as to the pending report on two air-conditioning manufacturing demonstration projects in Saudi Arabia, for possible solutions.

152. He therefore proposed that the discussion on the matter be deferred to the forty-second meeting of the Working Group to allow the parties time to receive the pending reports, assess the information in them and consider short- and long-term strategies for addressing the issues. Postponing the discussion would also allow time for the Technology and Economic Assessment Panel to update its report on energy efficiency, for the 2020 HCFC reduction target to be achieved and for HFC management plans to be prepared by the Group 1 Article 5 parties under the Kigali Amendment and reviewed by the Secretariat and the Executive Committee, which would further inform parties regarding the way forward towards achieving compliance.

153. Several representatives took the floor in support of the proposal to defer the discussion, including two who stressed their Governments' commitment to addressing the issues and complying with their obligations under the Protocol.

154. Two representatives, supported by a third, noted that the HCFC phase-out and the transition to low-global-warming-potential alternatives were creating banks of HCFCs and HFCs that were costly to destroy, and asked that destruction costs be taken into account in project funding.

155. The Working Group agreed to defer further consideration of the linkages between HCFCs and HFCs in transitioning to low-global-warming-potential alternatives to its forty-second meeting.

## **IX. Safety standards (UNEP/OzL.Pro.30/11, para. 199)**

156. Introducing the item, the Co-Chair drew attention to the information provided in paragraphs 54 to 57 of document UNEP/OzL.Pro.WG.1/41/2, recalling that, at the Thirtieth Meeting of the Parties, the parties had discussed the issue of safety standards for flammable low-global-warming-potential refrigerants, focusing on progress made by the Secretariat in developing a tabular overview of such safety standards, pursuant to decision XXIX/11, and had agreed to include the matter on the agenda of the current meeting. The Secretariat had since made further progress in developing the tabular overview, taking into account information received from parties, and had developed an online tool that provided the information included in the tabular overview and could be easily updated. The tabular overview and information on the online tool could be found in document UNEP/OzL.Pro.WG.1/41/INF/3/Rev.1.

157. In the ensuing discussion, many representatives expressed appreciation to the Secretariat for the development of the online tool, which they said was very helpful and user-friendly, and to all the parties that had provided information on safety standards to the Secretariat. Several representatives encouraged parties to continue providing information on safety standards to the Secretariat and requested the Secretariat to continue to update and further develop the online tool. One representative, speaking on behalf of a group of parties, proposed that the Secretariat make the online tool more easily accessible on its website and provide information on other relevant standards, such as those related to energy efficiency for buildings or equipment and to harmonized test conditions for determining the cooling performance of air conditioners.

158. With regard to specific standards, two representatives said that the review of International Electrotechnical Commission (IEC) standard 60335-2-89 to include new requirements for commercial refrigerants represented progress, as it would facilitate the expanded use of low-global-warming-potential refrigerants, and emphasized the importance of ensuring that all relevant standards were revised to enable the increased availability and use of such refrigerants and thereby advance the objectives of the Montreal Protocol. Another representative said that there was a need to consolidate information on standards governing the use of carbon dioxide as a refrigerant, in particular in the commercial refrigeration sector.

159. Two representatives said that, while the online tool was a good source of information on international safety standards that parties could refer to in developing national standards, parties should carefully consider whether certain standards were appropriate for, and should be implemented in, their own territories. They should also be cautious about requiring other parties to meet specific standards. Another representative said that, in addition to information on international safety standards, in Article 5 parties there was a need for training and capacity-building with regard to such

standards, both for Government and industry stakeholders, as well as for public awareness-raising on the safe use of relevant equipment.

160. Following the discussion, the Working Group agreed to defer further consideration of the issue to the Thirty-First Meeting of the Parties.

## **X. Review of the terms of reference, composition, balance, fields of expertise and workload of the Technology and Economic Assessment Panel (decision XXX/15)**

161. Introducing the item, the Co-Chair drew attention to a document reviewing the terms of reference, composition, balance, fields of expertise and workload of the Technology and Economic Assessment Panel (UNEP/OzL.Pro.WG.1/41/4), which had been prepared by the Secretariat pursuant to decision XXX/15. Background information on the issue was provided in documents UNEP/OzL.Pro.WG.1/41/2 (paras. 58–60) and UNEP/OzL.Pro.WG.1/41/INF/6.

162. In the ensuing discussion, many representatives thanked the Secretariat for the comprehensive and useful information provided on the issue and expressed their appreciation to the members of the Panel and its technical options committees for their hard work, most of which was not remunerated, and for the invaluable reports that they produced to inform decision-making by the parties.

163. Reflecting on how to strengthen the process of nomination and selection of members of the Panel and its subsidiary bodies, one representative suggested that the process could be improved by (a) ensuring that it was fully in accordance with the terms of reference of the Panel – for instance, by asking the Secretariat, the Panel or another entity to regularly provide detailed information to parties on the expert nomination and selection processes; (b) providing further clarity regarding the criteria for the nomination and selection of experts, including by providing more detailed information on the expertise held by current members and the basis on which each member had been selected, as well as on expertise needed, in the “matrix of needed expertise” and ensuring that the nomination and selection processes were as objective and transparent as possible; and (c) specifying the reasons for the terms of selected experts, especially for terms shorter than four years and for renewals of four-year terms, to ensure a balance between continuity and reasonable turnover.

164. Another representative expressed support for the call for greater clarity concerning the criteria for the selection of experts, adding that it was also important to achieve greater balance in the representation of Article 5 and non-Article 5 parties, as well as gender balance, on the Panel and all its technical options committees.

165. A third representative said that it was necessary to develop, in consultation with national focal points, a mechanism or process through which the parties could see whether the terms of reference of the Panel were being adhered to. Several representatives expressed support for the proposal, noting that some regions were underrepresented on the Panel and its technical options committees even though achieving balanced regional representation was a stated goal in the Panel’s terms of reference and achieving it would ensure that the unique needs of each region were given due consideration in the work of the Panel and its subsidiary bodies.

166. Several representatives expressed their support for the various proposals made by others and stressed the importance of ensuring greater transparency in the selection process, including the selection and rejection of nominated experts. One representative said that, to ensure reasonable turnover of experts, there should be limitations on the reappointment of experts who had served four-year terms.

167. One representative said that the Panel already regularly provided a lot of information to the parties on some of the issues raised, including on the composition of its bodies and the expertise and affiliation of its members. Joined by another representative, she stressed that it was also important to remember that Panel experts acted in their individual capacities and not as representatives of the countries or entities with which they were affiliated.

168. Several other representatives said that they were open to discussing ways of improving the implementation of the Panel’s terms of reference and the transparency of the expert nomination and selection process. They stressed that the discussion had not revealed any interest in revising the terms of reference themselves. Two of them expressed support for proposals to improve the matrix of needed expertise to give parties a better understanding of the expertise required by the Panel. They nevertheless wished to emphasize that ensuring a sound and transparent nomination process was a responsibility to be shared between the Panel and the parties. Specifically, it was the responsibility of the parties to duly consider the matrix of needed expertise before making nominations and to consult

with Panel co-chairs before nominating senior experts. Parties could, by nominating qualified experts, use the matrix to achieve the goals of regional balance and greater representation of Article 5 parties on the Panel and its subsidiary bodies.

169. Several representatives said that the Panel had made progress in the areas of gender and geographical balance – in fact, gender parity currently prevailed – and should not lose sight of either goal. At the same time, ensuring the right expertise and skills on the Panel and its subsidiary bodies should be the primary objective of the nomination and selection process. One representative said that a June 2019 report on gender in the ozone treaties, which had been prepared by the Secretariat and was available on its website, could be useful in pursuing gender balance in the membership of the technical options committees.

170. With regard to workload challenges, two representatives expressed the view that the practice of requiring the Panel and its technical options committees to produce interim reports for consideration by the Working Group and final reports for consideration by the Meeting of the Parties should become the exception, rather than the rule, as the production of numerous interim reports made it difficult for the Panel and its subsidiary bodies to deal with administrative issues.

171. Following the discussion, the Working Group agreed that further informal consultations on the matter would continue in the margins of the meeting.

172. Subsequently, the representative of Saudi Arabia introduced a conference room paper containing a draft decision on behalf of Argentina, Bahrain, India, Kuwait, Nigeria, Oman, Saudi Arabia and the United Arab Emirates.

173. The Working Group agreed to discuss the proposed draft decision in the context of an informal group co-facilitated by Ms. Lara Haidar (Lebanon) and Mr. Philippe Chemouny (Canada).

174. Subsequently, the co-facilitator of the informal group reported that the discussions had led to revisions to the proposed text. Furthermore, it had been suggested that the Technology and Economic Assessment Panel and the Ozone Secretariat consider whether the form for nominating experts should be updated to reflect current circumstances.

175. The Working Group agreed to forward the revised draft decision, as set out in section D of annex I to the present report, to the Thirty-First Meeting of the Parties for further consideration.

## **XI. Membership of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol (UNEP/OzL.Pro.30/11, para. 177)**

176. Introducing the item, the Co-Chair recalled that, during its discussion of the membership of the Executive Committee, the Thirtieth Meeting of the Parties had received a proposal, presented by the representative of Armenia on behalf of parties from the region of Eastern Europe and Central Asia, to increase the membership of the Committee from seven to eight members from non-Article 5 parties and from seven to eight members from Article 5 parties. The new arrangement would include one permanent seat for a representative of the region of Eastern Europe and Central Asia, as opposed to the arrangement based on a four-year rotation that had been adopted in decision XVI/38. The parties had subsequently discussed the matter at their thirtieth meeting, in plenary session and informally in the margins of the meeting. Further information, including a summary of the plenary discussions, could be found in document UNEP/OzL.Pro.WG.1/41/2 (paras. 61–67).

177. The representative of Bosnia and Herzegovina introduced a conference room paper submitted by Armenia and Bosnia and Herzegovina on behalf of the region of Eastern Europe and Central Asia containing a proposal for a draft decision on the matter to be forwarded to the Thirty-First Meeting of the Parties. It set out the proposal for adding to the membership one additional member from a non-Article 5 party and one additional member from an Article 5 party, with the region of Eastern Europe and Central Asia being given a permanent seat among the membership from Article 5 parties. She explained that initially two ways of rectifying the imbalance of the rotational seat had been considered: reserving that seat permanently for the region, which would have been unfair to other regions, or expanding the membership as suggested. She stressed that all regions had the equal right to participate in the work of the Executive Committee.

178. Replying to queries about whether the region of Eastern Europe and Central Asia was one of the five official United Nations regions, she recalled that the grouping had been accepted as one of the five regional groups under the Montreal Protocol. Parties in Central Asia had expressed greater affinity with the parties in the region of Eastern Europe than with those in the region of Asia and the Pacific.

At the Thirtieth Meeting of the Parties, Turkey had been nominated to be a member of the Implementation Committee, representing the region of Eastern Europe and Central Asia.

179. In the ensuing discussion, all the representatives who took the floor expressed their desire to find a solution to the issue raised by the region. Some wished to give the proposal due consideration, saying that each region had the right to be adequately represented. Others expressed concern that increasing the number of members could destabilize the nuanced balance of the Executive Committee, but added that there might be other ways of enabling the region to participate more fully. The current membership structure was very flexible as it allowed members to co-opt representatives of other parties into their delegations. One representative, recalling that, at the Thirtieth Meeting of the Parties, a number of other parties had expressed their desire for greater representation on the Committee, said that she was concerned about the precedent that adopting the proposal might set.

180. The representative of the region of Eastern Europe and Central Asia replied that the region was seeking not fuller participation but equal participation along with other regions, since equality was one of the fundamental principles of the United Nations Member States.

181. The Open-ended Working Group agreed to establish an informal group co-facilitated by Ms. Elisabeth Munzert (Germany) and Ms. Laura Beron (Argentina) to continue discussions on the proposed draft decision.

182. Subsequently, the co-facilitator of the informal group reported that the group had discussed the proposed draft decision and shared views and experiences related to the concerns expressed by the proponents. The group had considered different options for addressing those concerns, both within the existing structure of the Executive Committee and by making modifications to it, but further discussion was needed on such options.

183. The Working Group agreed to forward the proposed draft decision, as set out in section E of annex I to the present report, to the Thirty-First Meeting of the Parties for further consideration.

## **XII. Request by Azerbaijan to be included among the parties to which the phase-down schedule for hydrofluorocarbons, as set out in paragraphs 2 and 4 of Article 2J of the Montreal Protocol, applies**

184. Introducing the item, the Co-Chair recalled that in March 2019 the Government of Azerbaijan had requested that the Ozone Secretariat place on the provisional agenda of the current meeting the party's request to join Belarus, Kazakhstan, the Russian Federation, Tajikistan and Uzbekistan in implementing paragraphs 2 and 4 of Article 2J of the Protocol, thereby following a slightly later HFC phase-down schedule than other Article 2 parties. Further information on the issue could be found in document UNEP/OzL.Pro.WG.1/41/2 (paras. 69–72).

185. The representative of Azerbaijan introduced a conference room paper containing a proposal for a draft decision on the matter to be forwarded to the Thirty-First Meeting of the Parties. She said that her Government was committed to fulfilling its obligations under the Montreal Protocol and was on track to phase out HFCs by 2020. In the past, however, it had on occasion found itself in non-compliance with its obligations, and as it was in the process of ratifying the Kigali Amendment it did not want the same to occur with regard to the phase-down of HFCs. Azerbaijan had not been represented at the Twenty-Eighth Meeting of the Parties and had thus not been able to ensure that it was included on the list of parties that would implement paragraphs 2 and 4 of Article 2J of the Protocol.

186. Several representatives, including one speaking on behalf of a group of parties, expressed support for the proposal. Some of them said that they would rather exercise the flexibility of the Montreal Protocol than risk a situation of non-compliance. Another representative said that she appreciated the proactive manner in which the Government of Azerbaijan was trying to avoid non-compliance and that, while she wished to consider the issue further, she was favourably disposed towards the proposal. One representative said that his Government supported the application given the specific circumstances of Azerbaijan.

187. Some other representatives, including one speaking on behalf of a group of parties, said that they needed more time to examine the proposal and its implications, for a variety of reasons, including that the rationale for the proposal had not been clear until the oral explanation that had just been given; that they were concerned about the implications of re-opening discussions on decision XXVIII/2, which had been carefully crafted following much negotiation and compromise; that the environmental consequences of delaying implementation of the HFC phase-out by Azerbaijan were as yet unknown;

and that a precedent might be set for other parties, or there might be a proposal to modify other aspects of the decision.

188. The Open-ended Working Group agreed that interested parties should hold bilateral consultations on the matter and report on the outcome of those consultations to the plenary.

189. Subsequently the representative of Azerbaijan, reporting on the bilateral consultations she had held with various parties, said that they had been useful, given that some omissions in the proposed draft decision had indeed caused concern among some parties. She intended to submit a revised proposal for a draft decision to improve on the version being forwarded to the Thirty-First Meeting of the Parties.

190. The Working Group agreed to forward the current version of the draft decision, as set out in section F of annex I to the present report, to the Thirty-First Meeting of the Parties for further consideration.

### **XIII. Risk of non-compliance with hydrochlorofluorocarbon production and consumption reduction targets by the Democratic People's Republic of Korea**

191. Introducing the item, the Co-Chair recalled that in March 2019 the Democratic People's Republic of Korea had sent a letter notifying the Ozone Secretariat of the potential risk of non-compliance by the party with its obligations under the Montreal Protocol from 2019 onward, owing to its inability to embark on its HCFC phase-out management plan and related activities as a result of the restrictions arising from Security Council sanctions. The Democratic People's Republic of Korea had requested that the matter be considered by the current meeting and by the Thirty-First Meeting of the Parties, in accordance with paragraph 6 of Article 5 of the Montreal Protocol. The matter had been considered by the Implementation Committee at its sixty-second meeting, on 29 June 2019.

192. The representative of the Democratic People's Republic of Korea, introducing a conference room paper containing a proposal for a draft decision on the matter, said that, as an Article 5 party, the Democratic People's Republic of Korea had committed itself to reducing its HCFC production and consumption by 10 per cent from 2015 onward and had received assistance from the Multilateral Fund for stage 1 of its HCFC phase-out management plan, with UNIDO as the lead implementing agency. However, as a consequence of the sanctions imposed by the Security Council, the Executive Committee of the Fund had deferred consideration of further project proposals under the HCFC phase-out management plan. As a result, the party was unlikely to be able to comply with its 35 per cent reduction target from 1 January 2020 onward, and the national coordinating committee for the environment had approved an increase in production of HCFCs, specifically HCFC-22, until the resumption of financial and technical assistance. The Democratic People's Republic of Korea therefore requested the Executive Committee to render it sufficient financial and technical assistance for it to meet its obligations under the Protocol, regardless of any conditions or sanctions imposed by other bodies, and to permit it to exceed the limits for HCFC production and consumption stipulated under the Protocol until such assistance resumed.

193. The President of the Implementation Committee said that the matter had been referred to the Committee by the Ozone Secretariat as an issue of potential non-compliance under paragraph 4 of the non-compliance procedure of the Montreal Protocol. The Committee had heard a presentation from the Ozone Secretariat on the matter and had also received updated information from the Fund secretariat and UNIDO. The Fund secretariat had confirmed that since 2012 the Executive Committee of the Fund had approved funding of some \$1.2 million for projects and activities for the phase-out of controlled substances in the Democratic People's Republic of Korea, but that only \$335,000 of that amount had been disbursed thus far by the relevant implementing agencies. In implementing the approved projects, the agencies had followed advice sought from the Security Council Committee in order not to contravene Security Council resolutions.

194. Following its deliberations, the Committee had agreed that any work that it undertook with respect to the Democratic People's Republic of Korea should comply with the applicable Security Council resolutions. The Committee had also noted that the party had, as was reflected in its submission, taken the decision to increase production of HCFCs and could similarly take the decision to reduce production of HCFCs. The Committee would discuss the matter further in the event of any future non-compliance by the Democratic People's Republic of Korea with its obligations under the Protocol.

195. Following that statement, one representative said that the Democratic People's Republic of Korea faced difficulties in meeting its obligations under the Montreal Protocol and expressed the hope that parties would recognize those difficulties and find a suitable solution.

196. One representative said that the Executive Committee and the implementing agencies had to take into account applicable international law and rules, including legally binding provisions of Security Council resolutions. A series of sanctions by the Security Council, including in resolution 1718 of 2006, placed limitations on the types of financial and technical assistance that could be provided to the Democratic People's Republic of Korea. In the case at hand, in order to ensure compliance with such sanctions, proposed projects should be approved by the Security Council Committee established pursuant to resolution 1718 before being approved by the Executive Committee. His Government could not, therefore, support the draft decision proposed by the Democratic People's Republic of Korea.

197. Several other representatives supported that stance and expressed opposition to the proposed draft decision.

198. The representative of the Democratic People's Republic of Korea said that without approval of technical and financial assistance from the Multilateral Fund her Government would have little choice other than to increase production and consumption of HCFCs to meet demand.

199. Given the lack of consensus in support of the proposed draft decision, the Working Group agreed to close discussions on the item.

#### **XIV. Other matters**

##### **“Rome Declaration” to be presented for adoption by the Thirty-First Meeting of the Parties**

200. The representative of Italy provided an update on the status of preparations for the Thirty-First Meeting of the Parties in Rome. He spoke briefly about the ministerial round-table discussion being organized to discuss the contribution of the Montreal Protocol to a sustainable cold chain to reduce food loss, as described in document UNEP/OzL.Pro.WG.1/41/2 (paras. 73–75). He also conveyed the willingness of the Italian Government to present and discuss the text of a proposed outcome document, the “Rome Declaration”.

201. A draft of the proposed outcome document was subsequently posted on the meeting portal for parties to examine during the intersessional period and to use in their national-level consultations.

202. The Working Group agreed to continue bilateral consultations on the matter during the intersessional period and to resume discussions on the draft declaration at the Thirty-First Meeting of the Parties.

#### **XV. Adoption of the report**

203. The parties adopted the present report on Friday, 5 July 2019, on the basis of the draft report set out in documents UNEP/OzL.Pro.WG.1/41/L.1 and UNEP/OzL.Pro.WG.1/41/L.1/Add.1. The Ozone Secretariat was entrusted with the finalization of the report.

#### **XVI. Closure of the meeting**

204. Following the customary exchange of courtesies, the forty-first meeting of the Open-ended Working Group of the Parties to the Montreal Protocol was declared closed at 5.55 p.m. on Friday, 5 July 2019.

## Annex I

### Draft decisions

The Working Group agreed to forward to the Thirty-First Meeting of the Parties the following draft decisions for further consideration, on the understanding that they did not constitute agreed text and were subject in their entirety to further negotiation.

*The Thirty-First Meeting of the Parties decides:*

#### A. Terms of reference for the study on the 2021–2023 replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol

##### Submission by the contact group

*Recalling* the parties' decisions on previous terms of reference for studies on the replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol,

*Recalling also* the parties' decisions on previous replenishments of the Multilateral Fund,

1. To request the Technology and Economic Assessment Panel to prepare a report for submission to the Thirty-Second Meeting of the Parties, and to submit it through the Open-ended Working Group at its forty-second meeting, to enable the Thirty-Second Meeting of the Parties to adopt a decision on the appropriate level of the 2021–2023 replenishment of the Multilateral Fund;

2. That, in preparing the report referred to in paragraph 1 of the present decision, the Panel should take into account, among other things:

(a) All control measures and relevant decisions agreed upon by the parties to the Montreal Protocol and the Executive Committee of the Multilateral Fund [.,[including] [with particular attention to] decision XXVIII/2] [[, in particular those pertaining to the special needs of low-volume- and very-low-volume-consuming countries], as well as those of small and medium-sized enterprises,] and the decisions of the Thirty-First Meeting of the Parties and the Executive Committee at its meetings, up to and including its eighty-fifth meeting, insofar as those decisions will necessitate expenditure by the Multilateral Fund during the period 2021–2023;

(a *bis*) [The potential costs pertaining to the special needs of low-volume- and very-low-volume-consuming countries;]

(b) The need to allocate resources to enable all parties operating under paragraph 1 of Article 5 of the Montreal Protocol (Article 5 parties) to achieve and/or maintain compliance with Articles 2A–2J of the Protocol, taking into account decision XIX/6 of the Meeting of the Parties and the extended commitments made by Article 5 parties under approved HCFC phase-out management plans [and decision XXVIII/2];

(c) [The need to allocate resources to ensure enhanced and improved vigilance through the strengthening of existing monitoring, verification and reporting systems, and ensure sustained compliance [and prevent a reversal of the ozone and climate benefits already achieved];]

(d) Decisions, rules and guidelines agreed by the Executive Committee at all its meetings, up to and including its eighty-fifth meeting for determining eligibility for the funding of investment projects and non-investment projects, [including, but not limited to, institutional strengthening] [and sectoral and national phase-out plans for HCFCs];

(e) [The need to allocate resources for the preparation of phase-down plans for HFCs;]

(f) [The need to allocate resources for maintaining and/or enhancing energy efficiency of low-global-warming-potential or zero-global-warming-potential technologies and equipment while phasing down HFCs;]

(g) [To allocate resources for the introduction of zero- or low-global-warming-potential alternatives to HFCs and maintaining energy efficiency in the servicing/end users sector;]

3. [That the Technology and Economic Assessment Panel should provide indicative figures of the resources within the estimated funding required for phasing out HCFCs that could be associated with enabling Article 5 parties to encourage the use of low-global warming potential or zero-global warming potential alternatives[, taking into account global warming potential, energy use, [safety,] and other relevant factors];]

4. [That the Technology and Economic Assessment Panel should provide figures for any resources that would be needed to phase down HFCs in accordance with the Kigali Amendment to the Montreal Protocol;]
5. [The need for additional resources to enable Article 5 parties to carry out initial activities related to the phase-down of HFCs listed under Annex F and controlled under Article 2J;]
6. That in preparing the report the Panel should consult widely, including all relevant persons and institutions and other relevant sources of information deemed useful;
7. That the Panel should strive to complete the report in good time to enable it to be distributed to all parties two months before the forty-second meeting of the Open-ended Working Group;
8. That the Panel should provide indicative figures for the periods 2024–2026 and 2027–2029 to support a stable and sufficient level of funding, on the understanding that those figures will be updated in subsequent replenishment studies.]

## **B. Ongoing reported emissions of carbon tetrachloride**

### **Submission by Switzerland**

*Recalling* decisions XVI/14, XVIII/10, XXI/8, XXIII/8 and XXVII/7, in which the Meeting of the Parties requested the assessment panels to assess global emissions, specific emission sources and the atmospheric lifetime of carbon tetrachloride (CTC) and suggest solutions for emission reductions, and encouraged the parties to review their national data and to provide support for atmospheric research,

*Acknowledging* that the information provided by the assessment panels, the parties and the scientific community has advanced in closing knowledge gaps, in particular regarding the discrepancy between reported emissions and observed atmospheric concentrations, as well as regarding our understanding of specific emission sources,

*Recognizing* that there are ongoing efforts to establish additional monitoring systems for both emissions at individual industrial sites and atmospheric concentrations of CTC,

*Noting*, however, that further efforts are required to identify all relevant emission sources and implement mitigation measures for those sources in order to reduce emissions to levels that are in line with the provisions of the Montreal Protocol on Substances that Deplete the Ozone Layer and with the assumptions underlying the use of controlled substances as feedstock or process agents,

*Mindful* that CTC has an impact on both the ozone layer and global climate and that unrestrained emissions would delay the recovery of the ozone layer by several years,

1. To request the Technology and Economic Assessment Panel and the Scientific Assessment Panel to establish a joint task force on CTC emissions, which would:

- (a) Update the state of knowledge on potential emission sources and emission pathways of CTC and identify priorities for further research, including:
  - (i) The characterization of all industrial processes that may be relevant to CTC emissions, considering CTC production, its uses as feedstock or process agent, its shipment and processes that lead to releases of CTC as by-product, such as in chloromethane plants;
  - (ii) The quantification of emission factors and absolute amounts of emissions by geographic region for the processes identified in subparagraph (i) above;
  - (iii) The linkages between emissions of CTC and trichlorofluoromethane (CFC-11);
  - (iv) The exploration of still-unidentified emission sources;
  - (v) The explanation for the remaining discrepancy between reported emissions and observed atmospheric concentrations;

- (b) Recommend approaches and provide guidance for:
- (i) Conducting emission monitoring at industrial sites, including the choice of monitoring systems and parameters to be monitored by the countries with such industrial sites;
  - (ii) Extending the existing network of atmospheric monitoring stations, in particular to regions where monitoring data are scarce;
  - (iii) Identifying feedstock uses when reporting consumption and production of CTC under Article 7 of the Montreal Protocol, as well as identifying process agent uses when reporting these as requested by the Meeting of the Parties in decision X/14, paragraph 4, and indicating where more detailed information on such uses could improve our understanding of the relevant emission sources;
- (c) Suggest mitigation measures for reducing emissions, including but not limited to introducing specific best practices in the management of industrial processes and retrofitting facilities with state-of-the-art technologies;
- (d) Report on its advances to the Open-ended Working Group of the parties to the Montreal Protocol on Substances that Deplete the Ozone Layer at its forty-second meeting;
2. To encourage parties to review their domestic industrial processes, to report, in addition to the information provided under Article 7 of the Montreal Protocol, their use of CTC as process agent as well as the existence of CTC stocks, and to provide that information to the Ozone Secretariat;
  3. To encourage parties to share the available atmospheric monitoring data with the scientific community;
  4. To invite the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer to consider the provision of financial resources from the Vienna Convention Trust Fund for Research and Systematic Observation to support the extension of the currently operating network of atmospheric monitoring stations to regions where such monitoring data are scarce, and to invite parties to provide additional voluntary contributions to the trust fund for that purpose;
  5. To request the Ozone Secretariat to convene a workshop back to back with the forty-second meeting of the Open-ended Working Group with the participation of the task force referred to in paragraph 1 of the present decision and the Ozone Research Managers of the Vienna Convention for the discussion of technical, financial and policy issues related to the information and recommendations provided by the task force.

## **C. Potential areas of focus for the 2022 quadrennial reports of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel**

### **Submission by the European Union**

*Noting with great appreciation* the excellent and highly useful work of the members of the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel and their colleagues worldwide in preparing their 2018 assessment reports, in particular the efforts made to condense vast amounts of pertinent information in a concise and understandable form for better use by policymakers,

*Expressing gratitude* to the Scientific Assessment Panel for the considerable efforts that it made to provide comprehensive information, hitherto only partially available, on ozone depletion potential, global warming potential, atmospheric lifetimes and other parameters for a large number of relevant chemicals,

*Recalling* decisions XXIX/12, [*other relevant decisions asking TEAP, SAP, EEAP for information*],

1. To request the Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel to update their 2018 reports in 2022 and submit them to the Secretariat by 31 December 2022 for consideration by the Open-ended Working Group and the Meeting of the Parties in 2023, and to present a synthesis report by 30 April 2023, noting that the panels should continue to exchange information, including on all sectors, on

alternatives during the process of developing their respective reports in order to provide comprehensive information to the parties to the Montreal Protocol;

2. To request the assessment panels to bring to the notice of the parties any significant developments which, in their opinion, deserve such notice, in accordance with decision IV/13;

3. That for its 2022 report the Environmental Effects Assessment Panel should include an assessment and evaluation of the most recent scientific information, together with future projections and scenarios, on changes in the ozone layer, including its interaction with climate, and ultraviolet radiation, as well as controlled substances and their breakdown products, regarding their:

(a) Effects on the biosphere, biodiversity and ecosystem health, including on biogeochemical processes and global cycles;

(b) Effects on human health;

(c) Socioeconomic effects, such as on ecosystem services, agriculture and damage to materials, including for construction, transport, photovoltaic use and microplastics;

4. That the 2022 report of the Scientific Assessment Panel should include:

(a) An assessment of the state of the ozone layer and its future evolution;

(b) An evaluation of global and polar stratospheric ozone, including the Antarctic ozone hole and Arctic winter/spring ozone depletion and the predicted changes in those phenomena;

(c) An evaluation of trends in the emissions, abundances and fate in the atmosphere of relevant trace gases of relevance to the Montreal Protocol on Substances that Deplete the Ozone Layer, in particular the controlled substances and their breakdown products, which should include a comparison of bottom-up and top-down estimations of such emissions;

(d) An evaluation of consistency with reported production and consumption of those substances and the likely implications for the state of the ozone layer, the atmosphere and climate change;

(e) An assessment of the interaction between stratospheric ozone changes and climate change, including possible future scenarios regarding ozone and climate impacts;

(f) Identification and quantification, where possible, of any other issues, including new issues, of importance to the ozone layer and the objectives of the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol;

(g) Relevant information on solar radiation management research, where this is relevant to the stratospheric ozone layer;

5. That in its 2022 report, the Technology and Economic Assessment Panel should include an assessment and evaluation of the following topics:

(a) Technical progress in production and consumption sectors in the transition to technically and economically feasible, climate-friendly and sustainable alternatives and practices that eliminate or minimize emissions to the atmosphere of controlled substances;

(b) Technically and economically feasible choices for the reduction and elimination of controlled substances in all relevant sectors, taking into account their overall performance, including energy efficiency;

(c) The status of banks, including stocks of controlled substances, including those maintained for essential and critical uses, and the options available for eliminating them and avoiding emissions to the atmosphere;

(d) Challenges facing parties operating under paragraph 1 of Article 5 of the Montreal Protocol in phasing out remaining controlled substances and maintaining the phase-outs already achieved, as well as challenges for all parties related to feedstock uses and by-production to prevent emissions;

(e) The impact of the phase-out of controlled ozone-depleting substances and the phase-down of hydrofluorocarbons on sustainable development.

**D. [Terms of reference, code of conduct and disclosure and conflict of interest guidelines for the Technology and Economic Assessment Panel and its technical options committees and temporary subsidiary bodies]  
[– nomination process] [organization of the TEAP, TOCs and TSBs]**

**Submission by the informal group**

*Acknowledging* the important role of the Technology and Economic Assessment Panel and its technical options committees and temporary subsidiary bodies in the provision of independent technical and scientific assessments, which have assisted the parties in arriving at well-informed decisions,

*Recalling* decision XXVIII/1, by which the parties adopted the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer on the phase-down of hydrofluorocarbons, and recognizing upcoming challenges related to the implementation of the Kigali Amendment, such as energy efficiency, climate benefits and safety,

[*Recalling also* decision XXIV/8, in which the parties set out the terms of reference, code of conduct and disclosure and conflict of interest guidelines for the Technology and Economic Assessment Panel and its technical options committees and temporary subsidiary bodies,]

*Taking note* of decision XXX/15, in which the parties called for a review of the terms of reference, composition, balance, fields of expertise and workload of the Panel,

*Also taking note* of decision XXX/16, in which the parties were urged to follow the Panel's terms of reference and consult the Panel co-chairs and refer to the matrix of needed expertise prior to making nominations for appointments to the Panel,

[1. To reiterate the importance of the Technology and Economic Assessment Panel's terms of reference and, in particular, paragraph 2.9 of the annex to decision XXIV/8 relating to the guidelines for nominations;]

1 *bis.* [To request the Technology and Economic Assessment Panel to provide a summary of actions taken in adherence to decision XXIV/8, with specific reference to (i) the nomination [and (ii) the appointment of members and co-chairs of the Panel] and (iii) the appointment of members of its technical options committees and (iv) temporary subsidiary bodies, with full consultation with and agreement of the national focal point of the relevant party, as well as (v) termination of appointment; and (vi) replacement, including limitations and constraints noted in adherence, if any, in the annual progress report, for the consideration of the parties;]

2. To request the Technology and Economic Assessment Panel and its technical options committees and temporary subsidiary bodies to [ensure] [use] clear and transparent procedures for the selection of experts by, inter alia, preparing guidelines and objective criteria for the nomination of experts, as well as [providing] [publicizing] a detailed matrix of expertise needed and expertise available on the Panel and its technical options committees and temporary subsidiary bodies[, including mention of expertise together with names and affiliations of members, so as to facilitate the submission of appropriate nominations by parties, taking into account geographical and gender balance, in addition to expertise needed to address new issues related to the Kigali Amendment, such as energy efficiency, safety standards and climate benefits].

3. [To request parties, when nominating experts to the Panel, technical options committees or temporary subsidiary bodies, to use the Panel nomination form and associated guidelines so as to facilitate the submission of [appropriate] [relevant] nominations by parties, taking into account geographical and gender balance, in addition to expertise needed to address new issues related to the Kigali Amendment, such as energy efficiency, safety standards and climate benefits;]

4. [To request the Ozone Secretariat to make Panel nomination forms available on its website and to make the forms submitted by nominating parties for members of the panel available on meeting portals so as to facilitate review and discussions by the parties on the proposed nominations;]

5. [To request the relevant party to ensure that consultations with the Panel Co-Chairs and interested parties have taken place before the submission of a nomination.]

**E. Review of the terms of reference, composition and balance of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol and equitable representation of parties therein**

**Submission by Armenia and Bosnia and Herzegovina on behalf of the region of Eastern Europe and Central Asia**

*Noting* that, according to paragraph 1 of the terms of reference of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, as modified by the Meetings of the Parties in decisions IX/16, XVI/38 and XIX/11, the Executive Committee of the Multilateral Fund is established to develop and monitor the implementation of specific operational policies, guidelines and administrative arrangements, including the disbursement of resources, for the purpose of achieving the objectives of the Multilateral Fund under the Financial Mechanism,

*Recognizing* the equal right of all United Nations regional groups of Member States to participate in developing and monitoring the implementation of specific operational policies, guidelines and administrative arrangements, and in developing the criteria for project eligibility and guidelines for the implementation of activities supported by the Multilateral Fund,

*Appreciating* the opportunities created by the Sixteenth Meeting of the Parties, in decision XVI/38, to ensure equitable geographical representation on the Executive Committee for parties from the region of Eastern Europe and Central Asia, which allowed parties from that region to participate in the work of the Executive Committee once every four years on the basis of a rotating seat principle,

*Acknowledging* that the arrangement stipulated by decision XVI/38 nevertheless does not provide actual equitable representation for parties from the region of Eastern Europe and Central Asia,

To amend paragraph 2 of the terms of reference of the Executive Committee, as modified by the Ninth Meeting of the Parties in decision IX/16, to read:

“2. The Executive Committee shall consist of eight Parties from the group of Parties operating under paragraph 1 of Article 5 of the Protocol and eight Parties from the group of Parties not so operating. Each group shall select its Executive Committee members. Eight seats allocated to the group of Parties operating under paragraph 1 of Article 5 shall be allocated as follows: two seats to Parties of the African region, two seats to Parties of the region of Asia and the Pacific, two seats to Parties of the region of Latin America and the Caribbean, one seat rotating among the previously mentioned regions, and one seat to Parties of the region of Eastern Europe and Central Asia. The selection of members of the Executive Committee shall be endorsed by the Meeting of the Parties.”

**F. Request by Azerbaijan to be included among the parties to which the phasedown schedule for hydrofluorocarbons, as set out in paragraphs 2 and 4 of Article 2J of the Montreal Protocol, applies**

**Submission by Azerbaijan**

*Noting* that the Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer entered into force on 1 January 2019,

*Recalling* paragraph 1 of decision XXVIII/2, which provides that paragraphs 2 and 4 of Article 2J in Article I of the Amendment are applicable to Belarus, Kazakhstan, the Russian Federation, Tajikistan and Uzbekistan,

To include Azerbaijan among the parties to which the phase-down schedule for hydrofluorocarbons, as set out in paragraphs 2 and 4 of Article 2J of the Montreal Protocol, applies.

## Annex II

### Report of the contact group on unexpected emissions of trichlorofluoromethane (CFC-11)

*Presented orally to the Open-ended Working Group in plenary session on 5 July 2019*

1. The contact group met four times, with a rather broad mandate from the parties, namely to consider further: (a) technical and scientific issues related to the unexpected emissions of CFC-11 with a view to identifying the information that needed to be enhanced; and (b) institutional matters and processes under the Vienna Convention and the Montreal Protocol, including monitoring, reporting and verification, compliance, licensing and illegal trade. The parties had, at the time of the contact group's establishment, agreed that additional matters could be added to its mandate if necessary.

2. During the contact group's first meeting the parties asked the Scientific Assessment Panel for further information and clarifications regarding its reports to the Open-ended Working Group as well as the papers by Montzka and others (2018)<sup>1</sup> and Rigby and others (2019).<sup>2</sup> The replies provided greater understanding of the scientific issues explored as well as some of the challenges in identifying the remaining sources of the unexpected emissions and gave rise to a discussion on atmospheric monitoring of emissions. At the contact group's second meeting, the parties were able to explore in more depth the approach taken by the Technology and Economic Assessment Panel task force on CFC-11 and the issues covered in its report to the Open-ended Working Group. The task force provided an overview of issues to be considered in its final report, namely:

- (a) Potential CFC-11 use in closed-cell polyurethane foams and polyol systems;
- (b) Potential quantities of CFC-11 and carbon tetrachloride (CTC) production needed to supply uses;
- (c) CFC-11 emission rates from banks (installed foams) and from landfills, not as the likely source of the increased emissions but to better quantify and understand those background emissions;
- (d) CFC-11 banks, by geographic location and market sector, to better understand background emissions levels from banks to help to better understand the magnitude of unexpected emissions;
- (e) Regulations preventing the use of dichloromethane in flexible foams;
- (f) Recent enforcement action and/or prosecutions undertaken in relation to CFC-11 and CTC production, and/or associated uses, to determine the possible scope of the problem;
- (g) Evaluation of the implications of new scientific publications, such as Rigby and others (2019).

3. The task force also identified the following topics on which it would benefit from additional information from the parties for its final report:

- (a) CTC production quantities and the uses to which CTC was put, by quantity, including export amounts and locations;
- (b) CTC and HCFC-22 plant capacities;
- (c) Validation of shutdowns and dismantling of plants producing ozone-depleting substances;
- (d) Quantities of CFC-11 inventory in stockpiles at the cessation of production, and the fate of such inventory thereafter;
- (e) Any evidence of illegal CFC-11 or CTC shipments;
- (f) The capacities and production quantities for CFC-11 and CFC-12 and CTC plants in parties regarding which less is known about historical production of ozone-depleting substances;

<sup>1</sup> S. A. Montzka and others, "An unexpected and persistent increase in global emissions of ozone-depleting CFC-11", *Nature*, vol. 557 (17 May 2018).

<sup>2</sup> M. Rigby and others, "Increase in CFC-11 emissions from eastern China based on atmospheric observations", *Nature*, vol. 569 (23 May 2019).

- (g) CFC-11 emission sources related to recycling and destruction of equipment and foams;
- (h) Foam blowing agent emissions rates that may be used for any purpose (i.e., to determine insulating capability or exposure from a public health perspective);
- (i) Specific end-of-life practices, especially for foams;
- (j) Regulations affecting the use of dichloromethane.

Parties are invited to provide any relevant information that they may have on these issues to the Ozone Secretariat by 31 July 2019 in order to give the task force time to review it and finalize their report for submission to the Thirty-First Meeting of the Parties.

4. The third and fourth meetings of the contact group dealt with the second part of its mandate. The group started by looking at issues that had been identified during the discussion of the agenda item in plenary session. The parties had a very fruitful and rich exchange of views on a number of the main issues and heard information and clarifications from the Secretariat on a few of them. The issues considered by the group comprised the following:

- (a) Very broadly, the need to understand the past: what happened, how and why, and its implications:
  - (i) Parties noted that it was important not to be complacent and to ensure that licensing and domestic enforcement systems were comprehensive and effective.
  - (ii) There was disappointment with the situation that had occurred, and there was openness to considering actions and suggestions for next steps in relation to the specific situation and in relation to considering institutional changes.
- (b) Atmospheric monitoring and observation, and actions that had been proposed in the report of the international symposium on the unexpected increase in emissions of CFC-11 held in Vienna in March 2019:
  - (i) There was broad interest in looking at additional monitoring to detect regional emissions; however, this needed to be in the context of a strategic plan and prioritization.
  - (ii) However, it was noted that monitoring was not a substitute for national-level implementation of obligations.
- (c) The General Trust Fund for financing activities relating to research and systematic observations:
  - (i) It was noted that the Trust Fund, being primarily targeted at capacity-building for parties operating under paragraph 1 of Article 5 of the Montreal Protocol (Article 5 parties), was not necessarily the right mechanism for building monitoring capability.
- (d) The role of the ozone research managers and its connection to the Scientific Assessment Panel:
  - (i) There was interest in seeking advice from the ozone research managers and the Scientific Assessment Panel on potentially useful sites for additional monitoring.
- (e) The need for equal treatment of all parties in respect of obligations:
  - (i) Parties acknowledged that all parties had Article 7 and licensing obligations to meet but that there were additional financial obligations under the Multilateral Fund for Implementation of the Montreal Protocol, which meant that there was a transparent verification of country programme data reported by Article 5 parties.
- (f) Strengthening monitoring, reporting and verification more generally:
  - (i) All parties were open to the concept of transparency of their licensing systems, with the opportunity to learn from other countries' systems.
- (g) The need for any measures adopted to be proportional to the financial resources available, especially in Article 5 countries.
- (h) Illegal trade and reporting under decision XIV/7, and the related issues of informal prior informed consent, licensing systems, and domestic compliance and enforcement:

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- (i) Licensing systems were fundamental to ensuring overall compliance with obligations, and it was important to ensuring they were fulfilling that role and would continue to do so in the future, especially in relation to new substances.
  - (ii) There was interest in additional action to address illegal trade and reporting of illegal trade to the Ozone Secretariat.
- (i) Monitoring and testing of CFC-11 in blends and polyols:
- (i) Some parties drew attention to their different control systems for polyols; it was acknowledged that differences among control systems might be confusing and that there might be room for better understanding of those differences.
5. The role of the Montreal Protocol compliance mechanism in dealing with such issues:
- (i) It was acknowledged that the existing compliance mechanism had worked well to date but was not well suited to addressing the current specific situation of CFC-11.
  - (ii) The President of the Implementation Committee said that the Committee had asked the Secretariat to prepare a discussion paper on the compliance mechanism for its next meeting, noting that the paper needed to be within the Committee's mandate.

The contact group urged the parties to consider those issues intersessionally and to come to the Thirty-First Meeting of the Parties prepared to decide on the way forward on the issues. It considered that it was important to keep the issue on the agenda of the Thirty-First Meeting of the Parties, and it requested that the present report be incorporated into the report of the forty-first meeting of the Open-ended Working Group.

**Annex III<sup>1</sup>****Summaries of presentations by the members of the Environmental Effects Assessment Panel, the Scientific Assessment Panel and the Technology and Economic Assessment Panel and its technical options committees****I. Presentations by the Scientific Assessment Panel and the Technology and Economic Assessment Panel's task force on unexpected emissions of trichlorofluoromethane (CFC-11) (agenda item 3)****A. Summary of the presentation by the Scientific Assessment Panel**

1. Dr. Paul A. Newman, Dr. David W. Fahey, and Prof. Bonfils Safari (Scientific Assessment Panel co-chairs) gave a presentation on the "SAP interim report on increased emissions of CFC-11." In response to recent observational findings concerning CFC-11, the Parties to the Montreal Protocol approved "Decision XXX/3: Unexpected emissions of CFC-11" during the 30th Meeting of the Parties to the Montreal Protocol in November 2018. This decision formally asked the Scientific Assessment Panel (SAP) to provide a summary report on this "... unexpected increase of CFC-11 emissions ..."; a preliminary summary report is required for the 41st Open-ended Working Group.
2. The SAP presentation had 6 elements:
  - (a) Some basics on CFC-11
  - (b) CFC-11 observations and global network
  - (c) What's in WMO/UNEP [2018]?
  - (d) What was said at the CFC-11 Symposium in Vienna in March?
  - (e) New paper by Rigby et al. [2019] showing regional emissions
  - (f) Plans for CFC-11 research and reporting
3. In the first section, the basics of trichlorofluoromethane or CFC-11 (CFCl<sub>3</sub>) were outlined. In particular, CFC-11 is produced from the fluorination of CCl<sub>4</sub> (CCl<sub>4</sub> + HF → CCl<sub>3</sub>F + HCl). It was primarily used for blowing foams and as a refrigerant, but also in other applications such as metered dose inhalers and as a solvent. CFC-11's atmospheric lifetime due to photolysis in the stratosphere is ~52 years, and it is both a potent ozone-depleting agent (ODP=1.0) and greenhouse gas (100-yr GWP = 5160). Production and consumption of CFC-11 was phased out in 2010, and it has been generally replaced with HCFC-141b, HFC-245fa, & other compounds.
4. The foundation for global and regional ODS emissions determinations is the precise, accurate, and long-term measurements from two ground-based networks (NOAA and AGAGE). CFC-11 atmospheric levels and trends are estimated from the averages of these network observations. Derivation of the magnitude and trends of global emissions use time series of the average global abundance, ODS atmospheric lifetime, and the interhemispheric gradient. Magnitude and trends of regional emissions are derived from network time-series measurements combined with meteorological information of prevailing winds from source(s) to measurement sites (back trajectories).
5. Measured CFC-11 levels continue to decline, but at a much slower rate than expected. Monthly averaged observations were shown from around the world, along with maps of station locations. The global averaged observations were derived from 5 AGAGE stations, and 12 NOAA background sites.
6. The CFC-11 main findings from the Executive Summary of the "Scientific Assessment of Ozone Depletion: 2018" were reiterated to the OEWG. Most particularly, there has been an unexpected increase in global total emissions of CFC-11. Global CFC-11 emissions derived from measurements by two independent networks increased after 2012, thereby slowing the steady decrease in atmospheric concentrations reported in previous Assessments. The global concentration decline

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<sup>1</sup> The annex has not been formally edited.

over 2014 to 2016 was only two-thirds as fast as it was from 2002 to 2012. While the emissions of CFC-11 from eastern Asia have increased since 2012, the contribution of this region to the global emission rise is not well known. The country or countries in which emissions have increased have not been identified.

7. The presentation included a brief summary of “The International Symposium on the Unexpected Increase in Emissions of Ozone-Depleting CFC-11.” The Symposium was held 25 - 27 March 2019 at the United Nations Office in Vienna, Austria. This was a closed scientific and technical meeting for the exchange of new ideas and information. The Symposium had 71 participants from 22 countries, and included 37 presentations on all aspects of CFC-11.

8. The Symposium brought together an international community of experts to exchange information on CFC-11, from feed stocks, to production, to products, to observations, to emissions, and finally to impacts. Unpublished new and updated results based on observations, field studies, models were shown. A technical assessment of possible new sources of CFC-11 emissions was presented by TEAP members. Atmospheric modelling studies of the impact of continuing new CFC-11 emissions conclude that there will be large impacts on the ozone layer if these emissions were sustained at a high level. It was also shown that if the new emissions were to abate quickly over the next few years the impact would be quite minor. The Symposium also generated a set of research directions and recommendations for improving monitoring of ODSs and understanding the CFC-11 issues. A Symposium summary been published in the July 2019 SPARC newsletter.

9. The presentation also included a few slides on the recently published paper by Rigby et al. in Nature, “Increase in CFC-11 emissions from eastern China based on atmospheric observations.” This study used high-frequency atmospheric observations from Gosan, South Korea, and Hateruma, Japan, along with global data and atmospheric chemical transport models to show that emissions from eastern mainland China are  $7.0 \pm 3.0$  ( $\pm 1s$ ) Gg yr<sup>-1</sup> higher in 2014–2017 than in 2008–2012. This emission increase was found in and around the northeastern Chinese provinces of Shandong and Hebei.

10. The presentation concluded with discussion on the future pathway for the CFC-11 Report that is due at the November 2020 COP/MOP. First, a brief outline was completed and commentary was solicited from the science community (> 100 scientists and technologists) on the proposed contents of this CFC-11 Report (May 2019). Following the comments, the SAP Report outline was completed (June 2019). The Report will be peer-reviewed and published by WMO. Authors for the report are under discussion.

## **B. Summary of the presentation by the Technology and Economic Assessment Panel’s task force on unexpected emissions of trichlorofluoromethane (CFC-11)**

11. Ms. Helen Tope, co-chair of the Technology and Economic Assessment Panel Task Force on Unexpected Emissions of CFC-11, introduced its presentation in response to decision XXX/3, noting that Task Force co-chair Mr. Jose Pons was unable to participate in this meeting. Ms. Tope recalled decision XXX/3 on unexpected emissions of CFC-11 that requested the Technology and Economic Assessment Panel to provide parties with information on potential sources of CFC-11 emissions and related controlled substances from potential production and uses, as well as from banks, that may have resulted in the unexpected CFC-11 emissions. She noted that the decision also requested parties to provide information to assist in the two Panels’ assessment, and that an information submission was received from one party. She explained that a Task Force was formed combining expertise from the Technology and Economic Assessment Panel and its Technical Options Committees, and also outside expertise, to address the requirements of the decision. She presented an overview of the preliminary report, which analyses, at the global level, the likelihood of potential sources of emissions, eliminates the unlikely sources, identifies the remaining potential sources for further consideration for the Final Report, and also identifies additional information that would be desirable to clarify assumptions. She indicated that the Final Report will be completed by mid-September in time for the 31st MOP. Ms. Tope explained that CFC-11 was used as a foam-blowing agent for open and closed cell foams, aerosol propellant, refrigerant for centrifugal chillers, and in smaller uses, such as asthma inhalers, tobacco expansion. She noted that alternatives have replaced these former uses. She recalled that CFC-11 production and consumption in non-A5 parties was phased out in 1996, and in A5 parties in 2010, with some limited exceptions, such as for basic domestic needs. She explained that a bank of CFC-11 remains in closed cell foams and centrifugal chillers, from which CFC-11 is released into the atmosphere over time. She added that the Science Assessment Panel has presented on the scientific background and the publication by Montzka *et al.*, which reported the unexpected global increase in CFC-11 emissions. She noted that the recent scientific article by Rigby *et al.*, which provides

additional information, was published after the Preliminary Report was completed. Ms. Tope explained that the Task Force considered the technical and economic feasibility of 20 potential CFC-11 production routes. She said that the main manufacturing process routes to CFC-11 use carbon tetrachloride (CTC) as feedstock. She elaborated that a range of potential CFC-11 production quantities annually were considered from small-scale production less than 10,000 tonnes per year to large-scale production greater than 50,000 tonnes per year. She explained that the Task Force considers the most likely CFC-11 production routes are carbon tetrachloride to CFC-11 produced on micro-scale plants, using minimal equipment, to make low-grade CFC-11 for foam blowing use and/or carbon tetrachloride to CFC-11/12 produced on a large-scale in an existing liquid-phase plant, such as a HCFC-22 plant. She added that if CFC-11 production is greater than 50,000 tonnes per year, then it seems less likely that a large number of micro-scale plants would be solely responsible, although some micro-scale plants could also be contributing to production. Regarding the relationship with CFC-12, Ms. Tope explained that, using traditional process routes, a mix of CFC-11 and -12 is produced, with the proportion controlled by varying operating conditions, with 100% CFC-12 relatively easily achieved, and 100% CFC-11 more difficult to achieve although not impossible in well-operated facilities, and with an operating range of 30:70, either way, comfortably achieved. She added that more than 90% CFC-11 is possible with process modifications. She said that generally emissions from production are low, at an average of 0.5%. She added that near 100% CFC-11 production is possible in purposefully designed and operated micro-scale plants, with emissions likely higher, and up to 10%. She suggested that with economics of destruction and venting, it is more likely that a small co-production of CFC-12 would be sold, into limited uses. In relation to the possible option of CFC-11/12 production in existing HCFC-22 plants, Ms. Tope stated that spare annual capacity to produce CFC-11 in an existing HCFC-22 plant is estimated to be available in Argentina, Mexico, Russia and Venezuela for small scale CFC-11 production less than 10,000 tonnes, the European Union and the United States for medium-scale CFC-11 production between 10,000 and 50,000 tonnes, and China for large-scale CFC-11 production greater than 50,000 tonnes. She noted that, for carbon tetrachloride, the majority production is in chloromethanes plants as an unavoidable part of the production of dichloromethane and chloroform, and that carbon tetrachloride is also produced in perchloroethylene/carbon tetrachloride plants, according to demand for one or the other. She stated that, in 2016, the global maximum amount of potential carbon tetrachloride available from chloromethanes production was 305,000 tonnes, after existing local supply commitments had been met. She noted that a number of regions have spare annual capacity that might allow carbon tetrachloride production in the amounts required for small-scale CFC-11 production, and that China, European Union, and United States have largest chloromethanes capacities, and hence also the largest potential carbon tetrachloride availability. She added that only China has the spare annual capacity that could supply the larger amounts of carbon tetrachloride required for large-scale CFC-11 production. She said that there are five perchloroethylene/carbon tetrachloride plants operative in the EU and the US, and that spare global capacity to produce carbon tetrachloride by this process is estimated to be between 50,000-100,000 tonnes per year, existing mainly in the European Union. She stated that the Task Force has not found or received evidence, from customs or other agency activities, that illicit international trade in significant quantities of CFC-11 or CTC has occurred after the phase-out. She noted, however, that there have been indications of marketing of CFC-11 for use in foams in recent years between 2016 and 2018. Ms. Tope continued by saying that the main use of CFCs was as a pressurized liquid in aerosols, which is an emissive use, where CFC-11 worked very well in combination with CFC-12. She clarified that CFC-11 cannot be used alone as a propellant due to its physical properties, and that mixtures of hydrocarbon propellants and CFC-11 are technically feasible. She added that it is unlikely that CFC-11 would be produced or used for aerosols because hydrocarbon propellants are much cheaper than CFCs. She stated that for technical and economic reasons, it is unlikely that CFC-11 would be used in a newly established plant as a process agent in manufacturing synthetic fibre sheet, as a solvent, or for tobacco expansion or the processing of uranium. Regarding refrigeration and air conditioning, she continued by saying that a small number of CFC-11 chillers are still in operation and expected to reach their end of life in the next 1 to 5 years, but that it is unlikely that CFC-11 production would be employed to maintain this very small number of operating CFC-11 chillers. She stated that, based on estimates of CFC-11 chiller banks and emissions, it is highly unlikely that emissions from CFC-11 chillers are the cause of the sudden increase of global CFC-11 emissions. She mentioned that there might be a small CFC-12 demand for a limited number of CFC-12 mobile air conditioners in some vehicles built before 2002 in Article 5 parties but that it is unlikely there is significant resumption of CFC-12 usage in R/AC sub-sectors in both non-A5 and A5 parties, implying that no significant new CFC-12 production is needed for this purpose.

12. Ms. Helen Walter-Terrinoni, Task Force co-chair and co-chair of the flexible and rigid foams technical options committee, provided background on the use of CFC-11 in foam noting that CFC-11 was used mainly in open-celled flexible polyurethane (PU) foams (e.g., bedding and other uses) until

the mid-1960s and then primarily used in closed-cell rigid insulating polyurethane (PU) foams for appliances and construction, with CFC-11 usage peaking in the late 1980s. She also commented that CFC-11 is low cost and easy to use in closed-cell PU foam.

13. Ms. Walter-Terrinoni then described recent indications of CFC-11 marketing and technical activity in foams after phase-out. For example, FTOC was provided with a copy of an offer for sale of CFC-11 through distribution, has seen offers for sale on internet websites, and learned more through industry discussions. She then provided details that a minimum order quantity was for 15.5 tonnes CFC-11 in one advertisement and an offer for sale with a price of 2,200 USD per tonne CFC-11 in Jan. 2018. She then stated that a number of patent applications has also been filed for foam products in recent years.

14. Ms. Walter-Terrinoni then described potential drivers as well as the feasibility of converting from HCFC-141b back to CFC-11 in PU foams and pre-blended systems as being low-cost with almost no technical changes needed. She noted that a single quoted CFC-11 price is lower than market price of HCFC -141b and that the phase-out of HCFC-141b in the spray foam sector and in SMEs has created technical and economic challenges that might promote the use of CFC-11, although actual usage has not been confirmed. Ms. Walter-Terrinoni went into further detail that there is a lack of available HCFC-141b supply due to production phase-out and the price of HCFC-141b has been increasing due to the allocation-based supply and demand imbalance. She also described some challenges regarding alternatives including the flammability of hydrocarbons and associated conversion investment and the higher cost of HFCs and HFOs for which funding is limited to a single year of MLF funding for HCFC-141b conversions for funded companies. Ms. Walter-Terrinoni then concluded that based on its current assessment, including the modelling work completed by the Task Force, the Task Force finds that production of closed-cell foam products using CFC-11 may be a potential source of the increased emissions, as it is technically and economically feasible. She discussed in more detail that if the observed increased CFC-11 emissions are due to new CFC-11 production used in closed-cell foams, actual CFC-11 production would be significantly larger than the increased emissions detected to date and the non-emitted CFC-11 would accumulate in the foam banks which she explained were a way to describe the CFC-11 stored in foams and then the foams in landfills, from which it would be slowly released over time. She also stated that, although technically feasible, there is little economic incentive in replacing very low cost dichloromethane with CFC-11 in open-cell foams. Nevertheless, the Task Force will consider regulatory limitations on the use of dichloromethane in flexible foams.

15. Next Ms. Walter-Terrinoni discussed end-of-life emissions from foams noting that there is a difference between the projected estimated CFC-11 emissions rates from foams banks (including landfills) (< 1.5%) and atmospheric derived emissions rates (3-4%), including in regions where CFC-11 has not been used in foams in decades and that this difference could be partly explained by handling losses during dismantling and disposal practices that are not best practice. Although, the task force would further investigate emission rates from foams banks is warranted to differentiate these background emissions from other potential new sources, in order to better quantify these other potential sources, Ms. Walter-Terrinoni concluded that the increased CFC-11 emissions are unlikely to come from traditional handling of foams at end-of-life alone and that the Task Force found no evidence for a significant change in end-of life foam processes.

16. Ms. Walter-Terrinoni went on to discuss emissions and banks modelling starting with a discussion of the IPCC/TEAP Special Report on Safeguarding the Ozone Layer and the Global Climate System (the "SROC" report) noting that the 2005 SROC report was published in 2005 before the sudden increase in CFC-11 emissions included scientific and technical information regarding alternatives to ODSs that may also affect the global climate system. She further stated that SROC estimated bank sizes and maximum possible emissions in business as usual (BAU) and mitigation scenarios from 2002-2015 concluding that the Task Force analysis concluded that emissions associated with banks, as calculated in the SROC report, cannot explain the increased atmospheric derived CFC-11 emissions in recent years.

17. Ms. Walter-Terrinoni then described the Task Force development of a new "bottom up" emissions model and sensitivity analysis which evaluated the impact of specific variables (e.g., emissions from potential CFC-11 production, installation into foams or chillers, existing banks, or end-of-life disposal) on the estimated "bottom up" emissions which were compared with the atmospheric derived global emissions ("top-down" emissions). Based on this analysis, the Task Force determined that past production, historic usage, and the resulting bank, are unlikely to account for the increased global CFC-11 emissions.

18. Ms. Walter-Terrinoni described another approach the Task Force employed to explore emissions from CFC-11 banks to examine localised CFC-11 emissions in different regions of the world (“top-down”) specifically emissions from Western Europe. Ms Walter-Terrinoni stated that the majority of CFC-11 in banks are contained in foams in buildings and landfills and that foams are ultimately landfilled or destroyed with very low emissions rates from these processes. Ms Walter-Terrinoni said that emissions from banks in Western Europe (derived from atmospheric measurements), where CFC-11 has not been consumed for several decades, continue to decline generally and unless banks are treated very differently in other regions, which is unlikely, the Western Europe bank emissions rates can be considered typical and extrapolated to estimate global bank emissions rates from the banks. She concluded once again that based on this additional approach, the overall decline in emissions shown by this regional CFC-11 bank once again demonstrates that the unexpected increased CFC-11 emissions cannot be explained by the global CFC-11 bank.

19. Ms Walter-Terrinoni then discussed an analysis of the derived atmospheric emissions of foam blowing agents noting that the observed global HCFC-141b atmospheric emissions have started to decline in recent years, as expected with the production freeze and phase-down and that the sum of derived global emissions from higher boiling, fluorocarbon blowing agents for PU closed-cell foams (CFC-11, HCFC-141b, HFC-245fa, HFC-365mfc) have been gradually increasing since 2004, in parallel with increased PU foam use. She noted that the derived global CFC-11 emissions have increased while HCFC-141b emissions decreased stating that this is not conclusive; however, it is consistent with some replacement of HCFC-141b with CFC-11 in closed-cell PU foams.

20. Ms. Walter-Terrinoni then described the Task Force analysis of additional hypothetical scenarios beyond the scope of the sensitivity analysis in an attempt to duplicate the derived increased atmospheric emissions. She stated that some extreme hypothetical assumptions did not align with derived increased emissions (increasing or decreasing the CFC-11 bank emissions rates by 50% or the use of 35 kilotonnes per year of CFC-11 used to charge chillers). She then noted that some extreme hypothetical assumptions aligned with derived increased emissions, but are implausible (increases in CFC-11 bank emissions rates, changing in different time periods with no known reason that global foam bank emissions rates would increase from less than 2% per year to much larger rates of 8% to 24% per year after 2012; new CFC-11 used in open-cell foam seems unlikely because dichloromethane is much cheaper (\$0.7/kg); and direct release of 25-50 kilotonnes/year of newly produced CFC-11). She then concluded that only one category of extreme hypothetical assumptions aligned with the derived increased emissions and remains plausible which was the use of 35-70 kilotonnes per year of CFC-11 used in closed-cell foams.

21. Finally, Ms. Walter-Terrinoni concluded by noting that the Task Force evaluated a number of scenarios and eliminated most of them because they do not explain the unexpected emissions or they are technically or economically infeasible with the only remaining plausible scenario is the use of newly produced CFC-11 in closed-cell PU foams. She then noted that CFC-11 production would also require CTC production and that the Task Force will continue to refine its analysis for the Final Report.

## **II. Quadrennial assessment of the Montreal Protocol for 2018 (agenda item 5)**

### **A. Summary of the presentation by the Environmental Effects Assessment Panel on the 2018 quadrennial assessment**

22. The Co-chairs, Janet Bornman and Nigel Paul of the Environmental Effects Assessment Panel (EEAP), presented the Quadrennial Assessment for 2018 on the environmental effects and interactions of stratospheric ozone depletion, UV radiation, and climate change. The Assessment highlighted the important contributions of the Montreal Protocol to a more sustainable Earth through alignment with many of the Sustainable Development Goals.

23. Co-Chair Janet Bornman introduced the Assessment, noting with appreciation the contributions of 43 scientists from 18 different countries to the 2018 EEAP Quadrennial Assessment, which was peer-reviewed by 73 scientists.

24. It was noted that modelling studies of a world without successful control of ODS, the so-called ‘world avoided’, show that implementation of the Montreal Protocol and its Amendments has prevented catastrophic effects on human health and the environment. Although quantitative analyses are still scarce, modelled estimates of skin cancer incidence in the ‘world avoided’ have been done for

the USA, showing that more than 250 million cases of skin cancer have been avoided and more than 45 million cases of cataracts prevented.

25. It was pointed out that assessments of the effects on humans and the environment of changes in stratospheric ozone, UV radiation and climate are complex, because they are interlinked and mostly involve biological rather than physical systems. These dynamic interactions have consequences for the environment, food and water security, human well-being and the sustainability of ecosystems.

26. Moderate exposure to UV radiation is required for human health, such as for production of vitamin D in the skin and for lessening incidence of some diseases. However, high levels of UV radiation are harmful, particularly to the human skin and eyes. Light-skinned populations are most at risk with respect to skin cancers, while cataract is more widespread among many population groups. However, there is still a lack of quantitative analysis on these issues apart from estimates carried out by a few countries, including the USA, Australia, New Zealand, South Africa and some Northern hemisphere countries. It was also noted that the current and projected high incidences of skin cancer and cataract are placing a substantial financial burden on health systems. Other effects of UV radiation for which more extensive studies are needed, include reactivation of latent viral infections and the decreasing efficacy of many vaccines by UV radiation.

27. It is important to be mindful of the fact that for several decades the consequences from past high sun exposure, such as high incidence of skin cancer will continue to be evident. This is due to the lag between exposure and the manifestation or expression of the disease.

28. Co-chair Nigel Paul then presented some of the key findings on the environmental effects. He re-emphasised that the Montreal Protocol is protecting crop production and natural ecosystems around the globe from the damaging effects of both elevated UV radiation and climate change. There is current strong evidence that ecosystems are being modified by climate change due to greenhouse gas emissions. Therefore, realistic assessments of the effects of depletion and recovery of stratospheric ozone, and associated changes in UV radiation, need to take account of the role of climate change in modifying the responses of organisms and ecosystems.

29. Many ecosystem responses reflect a balance between the beneficial effects of moderate amounts of UV radiation (e.g. changes in plant chemistry, animal behaviour and the survival of parasites and pathogens in surface waters) and harmful effects of high levels of UV radiation. In particular, solar UV radiation is damaging many aquatic organisms, estimated at reducing the primary productivity of the world's oceans by about 20%. UV radiation contributes to the release of carbon dioxide, methane, and nitrous oxides into the atmosphere by breaking down organic material in aquatic and terrestrial ecosystems: one point of interaction between climate change and changes in stratospheric ozone. UV radiation is also a modifying factor in breaking-down pollutants, such as plastics and oil spills.

30. EEAP's current assessment is that the use of substitutes for ozone-depleting substances does not pose a significant risk to the environment. This includes both the direct emissions of substitutes during use and their atmospheric degradation products (e.g. trifluoroacetic acid, TFA).

31. The quality of the air we breathe is increasingly recognised as a major factor affecting human health around the globe. The air quality is determined not just by emissions, but also by weather and photochemical transformations induced by UV radiation.

32. UV radiation oxidises plastics, wood, and other commercial products used outdoors, including the polymer-based components of photovoltaic modules. These effects are amplified by rising temperatures, moisture, extreme weather events, and air pollutants, shortening the lifetime of these materials.

33. Co-Chair Nigel Paul drew attention to the current and future challenges. He highlighted that quantifying the full range of potential effects of UV radiation, changes in ozone depletion and climate on human health and the environment remains challenging. Future assessments of the many interactive effects will continue to depend on new research on both direct effects of changing UV radiation and stratospheric ozone, but also other changes including tropospheric air quality.

34. Co-Chair Janet Bornman concluded the presentation with the potential areas of focus for the 2022 assessment.

## **B. Summary of the presentation by the Scientific Assessment Panel entitled “The 2018 WMO/UNEP Scientific Assessment of Ozone Depletion”**

35. Dr. David W. Fahey, Dr. Paul A. Newman, Prof. Bonfils Safari, and Prof. John Pyle (Scientific Assessment Panel (SAP) Co-Chairs) gave a presentation titled 'The 2018 WMO/UNEP Scientific Assessment of Ozone Depletion.' The Montreal Protocol requires the SAP to provide quadrennial assessments of the latest information on the state of the ozone layer, the stratosphere, and ozone depleting substances (ODSs) such as chlorofluorocarbons (CFCs). The presentation included a basic update on the completion of the 2018 assessment with a few scientific highlights along with proposed terms of reference (ToR) for the 2022 quadrennial assessment report.

36. The presentation began with information on the structure of the 2018 assessment. The assessment is composed of 6 chapters:

1. Ozone-depleting substances
2. Hydrofluorocarbons
3. Global stratospheric ozone: Past, present & future
4. Polar stratospheric ozone: Past, present & future
5. Stratospheric ozone changes and climate
6. Scenarios and information for policymakers

37. The Executive Summary was delivered to the Ozone Secretariat on 5 November 2018 and the main chapter volume delivered on 4 February 2019. The outreach document, 'Twenty Questions and Answers about the Ozone Layer,' is expected to be completed before the 31st Meeting of Parties in November 2019. The following highlights of the assessment were presented along with one or more figures from the Executive Summary to illustrate the results.

1. Actions taken under the Montreal Protocol have led to decreases in the atmospheric abundance of controlled ozone-depleting substances (ODSs) and the start of the recovery of stratospheric ozone
2. The Kigali Amendment is projected to reduce future global average warming in 2100 due to hydrofluorocarbons (HFCs) from a baseline of 0.3–0.5 °C to less than 0.1 °C.
3. There has been an unexpected increase in global total emissions of CFC-11.
4. Sources of significant carbon tetrachloride emissions, some previously unrecognised, have been quantified.
5. Continued success of the Montreal Protocol in protecting stratospheric ozone depends on continued compliance with the Protocol.

38. Following the approach in earlier assessments, several overall topics were proposed for the 2022 report: distribution and trends in ODSs and stratospheric ozone; changes in the Antarctic ozone hole; changes in ozone recovery dates; updates on the connections between stratospheric ozone and climate change; and updates on policy options. The more specific areas of focus proposed were the interpretation of continued CFC-11 observations for global and regional emissions; interpretation of continued HFC and HCFC observations for global and regional emissions; interpretation of continued very short-lived substances (VSLs) observations to derive anthropogenic global and regional emissions; trends and variability in methyl bromide concentrations and emissions; trends in minor CFCs and other ultra-trace substances; and new information about the budget of carbon tetrachloride.

39. The final topic proposed was the potential impact on stratospheric ozone from solar radiation management (SRM) scenarios and other sources such as increased rocket launches and a new supersonic transport fleet. Perspective was provided by noting results available in the 2018 assessment; namely, that intentional long-term SRM implementation that substantially increases stratospheric aerosols to mitigate global warming by reflecting sunlight would alter the stratospheric ozone layer and possibly delay the recovery of the Antarctic ozone hole. Furthermore, the results from calculating the response to SRM scenarios show that the estimated magnitude and even the sign of ozone changes in some regions are highly uncertain.

## **C. Summary of the presentation by the Technology and Economic Assessment Panel on the 2018 quadrennial assessment**

40. Mr. Ashley Woodcock, co-chair of the Technology and Economic Assessment Panel (TEAP), started the presentation of the panels' 2018 quadrennial assessment report for 2015-2018. He stated that the TEAP is composed of 20 members: three co-chairs, five Senior Experts, and twelve co-chairs

of the five Technical Options Committees (TOCs). He then briefly reviewed Decision XXVII/6: Potential areas of focus for the 2018 quadrennial reports and the request by parties to the TEAP. He noted that aside from its annual Progress Reports and bi-annual reports on Critical Use Nominations for methyl bromide, since the 2014 Assessment Report, TEAP has prepared forty-one special reports in response to various Decisions issued by the parties to the Protocol. He then provided the key messages from the TEAP 2018 Assessment. One of these is that the Montreal Protocol continues to be effective. Control measures have created incentives for new technology, enterprises and organizations have worked diligently to implement new technology and the Multilateral Fund has financed the agreed incremental costs of the transition for A5 parties. Through these efforts, the world has avoided the substantial economic, environmental and health consequences of increases in ultraviolet radiation and global warming. The Kigali Amendment creates new challenges and additional milestones for parties to achieve the phase-down of controlled HFCs. He noted that since 2014 important technical developments have taken place as the parties to the Montreal Protocol continue working toward key ODS production and consumption phase-out milestones, but a key message of the Assessment Panels from their 2014 assessment remains relevant today: “The sustained success of the Protocol hinges on continued vigilance by the parties to fulfil their commitments and prevent any future actions that threaten to nullify the ozone and climate benefits achieved under the agreement. Success also depends on continuing the lessons of collaboration, leadership, innovation, and shared investment in our global environment that was the promise made to future generations under the Protocol.”

41. Mr. Paulo Altoe, co-chair of the Flexible and Rigid Foams Technical Options Committee (FTOC), provided an update noting that demand for thermal insulation continues to grow in the construction sector to support enhanced energy efficiency criteria and that regulations continue to evolve regarding the use of controlled HFCs in foams driving transitions to low-GWP alternatives in several regions and especially in many non-A5 parties in the last two years. He then noted that there have been significant improvements in the development and availability of additives, co-blowing agents, equipment and formulations enabling the successful commercialisation of foams and foam systems containing low-GWP blowing agents. He then stated that global blowing agent consumption is expected to grow at around 4% per year through to 2020 reaching consumption in excess of 500,000 tonnes with hydrocarbons representing over 50%.

42. Mr. Altoe then commented that by 2020, much of the ODS blowing agents in foams will be difficult to recover from landfill especially for products with more limited lifecycles (e.g. appliances) and that the declining GWP the climate benefit accruing from recovery will further decline over the period through to 2020, making the economic justification for recovery more challenging.

43. He then stated that A5 parties face the combined challenge of phasing out hydrochlorofluorocarbons (HCFCs) and phasing down high-GWP HFC blowing agents noting that in general, HCFCs are ~ 20-30 % of the cost of high-GWP HFCs, and hydrofluoro-olefin/hydrochlorofluoro-olefin (HFO/HCFO)-blown foams remain more expensive than HFC foams due to the total cost of blowing agent and required additives.

44. He then commented that SME and spray foam companies seeking to maintain current cost of manufacture may have limited options as lower cost alternatives (e.g. hydrocarbons or water) may not be suitable from a safety or efficacy perspective and additional technical expertise may be needed to use lower cost options while the capital investment for safety mitigation measures to use lower cost, flammable may not provide sufficient return on investment.

45. Mr. Adam Chattaway, co-chair of the Halons Technical Options Committee (HTOC), presented the HTOC Quadrennial Assessment Report, starting with the banks of halons and high-GWP HFCs: For halon 1301, the HTOC model estimates that the size of the global halon 1301 bank at the end of 2018 was 37,750 metric tonnes. Since halons are still being consumed but no longer produced, this would result in a run-out date of between 2032 and 2054, as estimated under Decision XXIX/8. In the previous Quadrennial Assessment Report (2014), emissions of halon 1301 based on the HTOC model agreed very well with emissions based on atmospheric measurements. However, emissions based on the most recent atmospheric measurements appear to be higher than those based on the current HTOC model. Mr. Chattaway explained that if these emissions were from fire protection banks, then this would result in a ~25% smaller bank and consequently an earlier run-out date.

46. For halon 1211, emissions based on atmospheric measurements of halon 1211 are significantly higher than those estimated by the HTOC model. This would result in a significantly smaller bank than the 24,000 metric tonnes estimated by the HTOC model. Mr. Chattaway noted that in some countries, large amounts of halon 1211 were not allowed to be re-used. As a result there was no economic reason to prevent emissions, which could account for the emissions being higher than those estimated by the HTOC model.

47. For halon 2402 The HTOC estimates that the majority of the estimated global bank of 6,750 metric tonnes of halon 2402 remains in the former Countries with Economies in Transition.
48. Looking at banks of HFCs in 2018, the HTOC estimated that the annual emission of HFC 227ea from fire protection applications was about 3,400 metric tonnes. Assuming a global average annual emission rate of 2.5%, the global HFC 227ea fire protection bank at the end of 2018 is estimated to be about 130,000 metric tonnes. The HTOC believes that emissions and banks of other HFCs used in fire protection are much smaller. Mr. Chattaway stated that the recovery of HFCs in fire protection is meeting as much as 75% of servicing requirements for existing fire protection equipment. This indicates that banking of HFCs is occurring, and appears to be primarily in parties that have well-established halon banking programs. In contrast, banking of HCFCs is in its infancy.
49. Mr Chattaway then made the point that, owing to the extended transition from halons, and their continuing important uses, parties may wish to consider addressing the need for awareness programmes to re-establish the apparent loss in institutional memory in this sector.
50. Now looking at alternatives since the 2014 Assessment, Mr. Chattaway indicated that no substantial progress on potential alternatives for total flooding systems has been reported and that although research continues, it could be several years before a viable agent could possibly have significant impact on the fire protection sector.
51. Mr Chattaway explained that as merchant ships that had halon 1301 installed come to the end of their lives, they are decommissioned and some fraction of that halon 1301 becomes available for recovery and re-deployment for other applications, but this fraction is unknown. This limited supply is currently estimated to continue to be available through 2023 to 2033, assuming the average ship life is 30-years or 40-years, respectively. Given that merchant shipping is believed to be one of the major remaining sources of supply of halon 1301, this could also affect the run-out date mentioned earlier.
52. Turning to commercial aviation, Mr. Chattaway explained that the fire extinguishant 2-bromo-3,3,3-trifluoroprop-1-ene, known as 2 BTP, has now been commercialized and qualified for civil aviation use to replace halon 1211 in portable extinguishers and the transition to this agent is ongoing. He indicated that for halon 1301 civil aviation applications, despite over 20 years of research, the civil aviation industry has failed to find any acceptable replacements, but research is still on-going. Therefore, halon 1301 dependency is likely to continue beyond the time when recycled agent is readily available (i.e., 2032-2054). He further explained that the timeframe when halon is no longer available to civil aviation could also be the timeframe when halon is no longer available to other users (e.g., oil and gas facilities, nuclear facilities, and military installed/reserves) that do not have dedicated, long-term stockpiles, who might need to submit an EUN(s) to support their enduring uses.
53. Marta Pizano, co-chair of the Methyl Bromide Technical Options Committee, on behalf of her co-chair Ian Porter presented a summary of that body's 2018 Assessment Report. Initially referring to controlled uses of methyl bromide, she stated that 99% of the global peak consumption of 64,000 t of MB was now reported as phased out, and that only 141 t of MB had been approved for 'Critical Use' in 2018. This indicates that technical alternatives exist for almost all remaining controlled uses of MB. In proceeding with her presentation Ms Pizano stated that many A5 parties previously included among the largest MB users had reported complete phase-out by the 2015 deadline and had not submitted CUNs. Only four A5 Parties had requested CUNs since 2014 and almost all (97.5%) of the A5 controlled use baseline had been replaced. She expressed however that concern still exists that a much greater amount of MB used for controlled purposes may be presently unreported.
54. In addressing quarantine and pre-shipment (QPS) use of MB, which are exempted under the Protocol, the co-chair said that this is presently the largest unregulated use of an ODS under the Montreal Protocol and amounts to more than 10,000 t/ year. She reported that increases in QPS use of MB by some countries were offsetting major reductions in others, which had led to only a small overall reduction in QPS use over the last twenty years. In 2017, QPS consumption in A5 Parties represented 69% of global consumption and that of non-A5 Parties 31%, with a general upward consumption trend for A5 Parties and a downward trend for non-A5 Parties in the past decade. She then indicated that MBTOC had identified opportunity for replacing between 30 and 40% of QPS uses with immediately available alternatives and suggested that Parties might wish to consider reducing and replacing QPS uses, particularly those for pre-shipment treatment which are mostly aimed at controlling cosmopolitan pests.
55. Referring to emissions of MB, Ms. Pizano said that over 8,500 t of MB are emitted annually from QPS uses, with virtually no implementation of emission reduction technologies by most countries. However, since 2014, several Parties have made significant technical advances and taken strict policy decisions leading to reductions of emissions and in some cases have phased-out MB for

some QPS applications, due to concerns over worker safety and local air quality in addition to ozone depletion. In closing her presentation, the co-chair said that control of all emissions by use of recapture and destruction technologies or barrier films (for any remaining pre-plant soil fumigation) would eliminate more than 70% of these emissions and that this would provide a significant near-term gain to the reduction of ODS substances in the stratosphere.

56. Mr. Keiichi Ohnishi, co-chair of the Medical and Chemicals Technical Options Committee (MCTOC), noted that CFC-containing metered dose inhalers have been successfully phased out worldwide, and that a range of alternative treatment methods is available. He added that the choice of treatment methods may be enhanced with publicly available information about environmental impact, including carbon footprint, of inhaler products. He stated that technically and economically feasible alternatives to CFC and HCFC propellants and solvents are available for aerosol products, and that small HCFC uses remain in a few countries for specific medical aerosol products. He noted that the complete phase-out of HCFCs in sterilisation to meet the Montreal Protocol schedule is readily achievable. For chemicals uses of ozone-depleting substances, total production of ozone-depleting substances for feedstock uses was about 1.2 million tonnes, with estimated emissions of 2,200 ODP tonnes. He noted that the largest production for feedstock uses are for HCFC-22, carbon tetrachloride and HCFC-142b, accounting 75% of the total production. He stated that process agent uses are long-standing processes built around the unique solvent properties of ozone-depleting substances, making it difficult to convert to alternatives. He noted that a suite of measures exists to minimise consumption and emissions. Mr. Ohnishi said that CFC-113 and 1,1,1-trichloroethane have been phased out for solvent cleaning in both Article 5 and non-Article 5 parties, except for CFC-113 in aerospace applications that will continue until stockpiles are depleted. He added that HCFC-141b and HCFC-225 have been largely phased out for solvent cleaning in non-Article 5 parties, except for aerospace and military applications, and in Article 5 parties, HCFC use for solvent cleaning is declining. Mr Ohnishi observed that the discrepancy between carbon tetrachloride emissions calculated from atmospheric observations and those estimated from industrial activity can be better explained by revised estimates of previously unaccounted emission sources and partial carbon tetrachloride lifetimes. He suggested that Parties may wish to consider examining potential sources of carbon tetrachloride emissions to increase understanding of those emissions and the accuracy of emissions estimates. In relation to dichloromethane and dichloroethane, which are not controlled substances, he stated firstly that dichloromethane contributes a small percentage to current total stratospheric chlorine loading. He added that, given predicted market trends, global dichloromethane production and atmospheric concentrations are unlikely to increase significantly. He explained that dichloroethane is a very short-lived substance, for which, based on predicted consumption, the background atmospheric concentration could double by 2030. Mr Ohnishi noted that the reported global production of all reported ozone-depleting substances for laboratory and analytical uses was relatively small at 151 tonnes in 2016. He explained that alternative procedures are available for CTC used as a solvent in bromination reactions involving N-bromosuccinimide and that preferable alternatives exist for methyl bromide used as methylating agents. He noted that many standards still require the use of small quantities of ozone-depleting substances. He suggested that parties may wish to consider additional measures to facilitate the replacement of ozone-depleting substances in standards. Mr. Ohnishi stated that more than 300,000 tonnes of ozone-depleting substances have been destroyed since 1996, of which the majority was carbon tetrachloride. He noted that a global destruction rate of about 3% of the ozone-depleting substances (excluding carbon tetrachloride) potentially available for destruction was achieved in the year 2016.

57. Mr. Fabio Polanara, co-chair of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC), started his presentation with the update on refrigerants. Since the 2014 RTOC Assessment Report, 35 new refrigerants have received a standard designation and safety classification, 5 are single-compound refrigerant. He noted that there will be no single “ideal” refrigerant for every use and selection parameters include: suitability for the targeted use; availability and cost of the refrigerant and associated equipment and service; energy efficiency; and safety, ease of use, and environmental issues. The Kigali Amendment, plus regional and national regulations, are driving the use of low- and medium-GWP refrigerants, which are often flammable and some may also have higher toxicity. To maintain the current safety levels new technologies are being developed and an increased level of training will be needed.

58. Mr. Polanara then reviewed specific progress in the various sub-sectors of refrigerant use. In domestic appliances, HC-600a (predominantly) or HFC-134a continue to be the refrigerant options for new production. More than 1 billion domestic refrigerators use HC-600a. None of the other new refrigerants have matured to become an energy-efficient and cost competitive alternative. In commercial refrigeration, lower GWP HFC/HFO blends and non-halocarbon options like R-744

(CO<sub>2</sub>), HC-290, HC-600a and R-717 (ammonia) are growing in use. Research and development continues into improving system performance. New safety standards and codes go into effect in the next few years. In industrial refrigeration and heat pump systems, in larger industrial refrigeration plants, R-717 (ammonia) has been extensively used for more than 150 years. Current technological advances enable the use of low charge R-717 systems, as well as cascade systems using R-717 together with R-744 (CO<sub>2</sub>), opening up new opportunities. In transport refrigeration, R-404A has been completely replaced by a lower GWP blend R-452A in new truck and trailer equipment in Europe. R-744 and R-513A now introduced in intermodal container applications. R-744 is being field tested in trucks and trailers. In air-to-air (room) air conditioners and heat pumps, the phase out of HCFC-22 in non-A5 parties is complete and is progressing in A5 parties. New refrigerants are continuously being introduced for use in air-to-air air conditioners and heat pumps (HC-290 (propane), HFC-32 and HFO-based blends). He noted that component and system optimisation can be a design challenge. Also, safety standards remain restrictive to several low and medium GWP flammable refrigerants in certain product types but are under revision for all refrigerants. Some localized transition to lower GWP refrigerants has occurred, but it is not yet widespread. For water and space heating heat pumps, equipment using low-GWP refrigerant HC-290 and the medium-GWP refrigerant HFC-32 are commercially available. R-744 based water heating heat pumps have been commercialised in Japan. In Europe, commercial sized units are being installed for multi-family houses and hotels. For chillers, the phase out of ODS in new chillers is nearly complete with limited production continuing in A5 parties for small chillers. Research for alternative refrigerants with lower GWP is nearly complete and has yielded several acceptable alternatives. For vehicle air conditioning, HFC-134a will remain widely accepted worldwide; however, the use of HFO-1234yf continues to grow especially in the US, Europe and Japan supported by regulations. R-744, currently available for very few car models, is expected to be considered as an option for electric vehicles, when used at the same time for a heat pump function.

59. Mr. Polonara also discussed the status of Not-In-Kind (NIK) technologies noting that they do not primarily use mechanical vapour compression technology to produce air conditioning or refrigeration. He stated that these technologies can be classified as “widely commercially available”, “commercially available” or “emerging and R&D”. They are divided into three groups: (1) thermal, (2) solid-state, and (3) electro-mechanical technologies. NIK technologies are expected to provide savings in operating costs. Their unique ability to use waste and renewable energy sources makes their application potentially highly energy efficient. He also presented considerations related to addressing High Ambient Temperature (HAT) conditions. He noted that research done at HAT conditions reveals viable low- and medium-GWP refrigerant alternatives that can be effectively used. There is more awareness of the challenges faced at HAT conditions in the design, implementation, and even servicing of equipment using low-GWP refrigerants. With regard to energy efficiency and sustainability applied to refrigeration systems, he stated that industry and policymakers have methods, tools and incentives available to stimulate and support improvements on energy efficiency and sustainability.

60. Mr. Ashley Woodcock then presented information on the impact of ODS phaseout on sustainable development. Decision XXVII/6 para 8(a) requested the TEAP, in its 2018 Assessment Report, to consider the “impact of the phase-out of ozone-depleting substances (ODS) on sustainable development.” He noted that in September 2015, the United Nations adopted 15-year global plan of action with 17 Sustainable Development Goals (SDGs). TEAP’s response to decision included describing a brief history of ODS phaseout; identifying key success factors – including industry partnership, technical assessment to determine pace of safe phaseout, assistance to A5 parties, etc.; and identifying 11 relevant SDGs where the Montreal Protocol, through the sector transitions away from ODS, has made significant contributions. In summary, he noted that the Montreal Protocol has been a remarkably effective mechanism to prevent global catastrophe, from the twin threats of ozone depletion and climate change. The near elimination of ODS with technically and economically feasible alternatives under the Montreal Protocol has made a major and effective contribution to sustainable development. When ODS replacements such as HFCs have been phased down and replaced by environmentally neutral, safe and sustainable alternatives, the Montreal Protocol will have made its full contribution to sustainable development.

### **III. Technology and Economic Assessment Panel 2019 report (agenda item 6)**

61. Ms. Bella Maranion, co-chair of the TEAP, started the presentation of the panels’ 2019 Progress Report. She stated that the presentation was on volumes 1 and 2 of TEAP May 2019 Report including the progress reports of the TOCs as well as updates to certain standing decisions. She presented the current membership of the TEAP as of May 2019. TEAP currently includes 19 members,

including TEAP/TOC co-chairs and Senior Experts. Over 150 experts serve on TEAP and its five TOCs. The TEAP and TOC memberships, as at 31st May 2019, are included in the annexes to the report, and information includes each member's term of appointment, expertise brought together by the TOCs and a matrix of needed expertise for the TEAP and its TOCs. Specific organisational issues relating to each TOC and to TEAP are also discussed in Chapter 7 on Other TEAP Matters and in the relevant annexes. With regard to organisational matters of the panel, Ms. Maranion stated that the TEAP and its TOCs assessments focus on the phaseout of ODS under the Montreal Protocol and phasedown of HFCs under the Kigali Amendment. TEAP continues to review its work under these mandates, including its current pool of experts, the potential loss of expertise through attrition or lack of support for some experts, and the need for specific and cross-cutting expertise within TOCs and TEAP itself. TEAP works to identify appropriate expertise and find qualified candidates interested and available to serve in these positions. The panel indicates these needs through its matrix and welcomes early communication with parties considering nominations, to manage an orderly transition, and avoid significant disruption to its work.

62. Ms. Maranion stated the panel had continuing challenges with regard to recruiting and retaining the needed expertise. TEAP and its TOCs continuously evolve to meet current and future needs of the parties, especially so that its TOCs are structured in size and expertise to support future efforts. The challenge remains to identify candidates with adequate history and experience as well as technical expertise and time, in order for TEAP to continue to meet the significant demands of delivering outputs to support the deliberations of parties, without loss of continuity. Through TEAP Task Forces, and/or TOCs, experts share their experience, knowledge, ability to communicate and write, and their capacity to contribute in a timely manner; important considerations for TEAP/TOC membership. TOCs have been challenged with attrition through retirement of members which raises growing concern to the consensus process.

63. Another continuing challenge is workload. The workload of TEAP, its TOCs, and Temporary Subsidiary Bodies (TSBs) (e.g., Task Forces) has grown substantially in recent years. TEAP noted that 41 reports had been delivered to parties during the past quadrennium. Task Forces in particular face challenges when two reports are requested by a decision (for the OEWG, and then for the MOP). This essentially doubles the workload of a Task Force, which is unsustainable, especially in years where other standing reports must also be delivered to parties. She requested that parties, in making decisions, to consider the overall annual workload of TEAP, the deadlines for delivery, and the support needed by TEAP for the work being requested. She also reiterated that TEAP welcomes the opportunity to further engage with parties to address these challenges to the functioning of the TEAP and its TOCs.

64. Before overviewing the needed expertise, Ms. Maranion noted that TEAP presents technical and economic information relevant to policy. She stated that in addition to providing the required technical expertise, potential members to the TEAP, TOCs and Task Forces are assumed to come with certain skills and abilities beyond their technical expertise that could ensure that they are fully successful in their contributions to the work of the TEAP and its TOCs. These skills include: proficiency in English as meetings and documents, essentially the work of TEAP, TOCs, and Task Forces are in English; proficiency in working electronically to edit reports and provide comments which is an important part of TEAP's review process for its documents and reports; availability meaning the commitment of time required (away from other work or personal commitments) to provide thorough and timely review of TEAP draft documents and reports, and travel to be able to participate in TEAP, TOCs, and/or Task Force meetings as relevant to the individual expert (most meetings are at a minimum a week's commitment but possibly longer and more frequent given membership or memberships in these groups); and the ability to be able to work for and toward consensus within TEAP, TOCs and Task Forces, as relevant.

65. TEAP and TOC co-chairs continue to assess current expertise, and work to improve gender and geographical balance. As described in Chapter 7 of the current report and specified in the matrix of needed expertise (available at <https://ozone.unep.org/science/assessment/teap/teap-expertise-required>). TEAP, FTOC, MBTOC, MCTOC, and HTOC are currently seeking experts; RTOC is not seeking additional experts at this time, whilst assimilating the recent appointments of members. RTOC co-chairs are working to review the structure and function of RTOC, in order to manage the increasing workload across the wide range of refrigeration and air conditioning sectors. Section 2.1.1 of TEAP's TOR states "The membership size of the TEAP should be about 18-22 members, including...2-4 Senior Experts for specific expertise not covered by the TEAP co-chairs or TOC co-chairs, taking into account gender and geographical balance." The role of the Senior Expert on the TEAP is an important one to fill any gaps in expertise not currently met by the other members of the TEAP. As indicated in the matrix, specific expertise is sought to support the upcoming work on a report on the replenishment of the Multilateral Fund for the next triennium. Related to this is TEAP's interest to strengthen its

expertise in the fields of economics and economic assessment and environmental economic modeling on the TEAP or its Task Force that will be working on the replenishment report. Ms. Walter-Terrinoni, co-chair of the Flexible and Rigid Foams Technical Options Committee (FTOC), noted that new foam blowing agent manufacturing facilities are now producing HCFO-1224yd in Japan and significant quantities of HCFO-1233zd(E) in China. She then noted that total global production of polymeric foams continues to grow (3.2% per year) at a slightly lower rate than noted last year (4.0%), from an estimated 25.4 million tonnes in 2018 to 29.8 million tonnes by 2023. Mr. Dan Verdonik, co-chair of the Halons Technical Options Committee (HTOC), provided the 2019 HTOC Progress report. He indicated that Decision XXX/7 on future availability of halons and their alternatives, requested the Ozone Secretariat to liaise with the secretariat of the International Maritime Organization (IMO) in order to facilitate the exchange of information between relevant technical experts regarding halon availability; and requested the Technology and Economic Assessment Panel (TEAP), through its HTOC, to perform the following: to continue engaging with the IMO and the International Civil Aviation Organization (ICAO) to better assess future amounts of halons available to support civil aviation and to identify relevant alternatives already available or in development; to identify ways to enhance the recovery of halons from the ship breaking; to identify specific needs for halon, other sources of recoverable halon, and opportunities for recycling halon; and to submit a report to the parties in advance of the forty-second meeting of the Open-Ended Working Group (OEWG) of the parties to the Montreal Protocol, which is currently scheduled for July 2020 in Montreal, Canada.

66. In response to Decision XXX/7, HTOC has developed an internal working group to continue to work with both IMO and ICAO. In February 2019, the HTOC met with IMO staff during the HTOC 2019 meeting, which was held at the IMO Headquarters in London, England. The consultations with IMO staff suggest that the lifetime of ships could be less than the 30 to 40 years estimated by the HTOC in its reports for Decision XXVI/7 and XXIX/8. If so, the amount of halon 1301 available from shipbreaking could be already almost exhausted. The HTOC will continue to work with IMO to refine the expected lifetime of ships containing halon 1301 and amounts expected to be available for recovery and re-use in the future.

67. For civil aviation efforts in 2019, ICAO has continued its informal working group that was originally formed in response to Decision XXIX/8 and will continue its work to better estimate halon emissions from civil aviation. Mr. Verdonik stated that the HTOC's ability to respond to Decision XXX/7 will be limited by changes in ICAO procedures for getting onto the agenda for their triennial General Assembly. In the past, the HTOC would coordinate with ICAO in January of the year of the General Assembly to be placed on the agenda. However, now, safety issues, such as for halons and fire protection, for the General Assembly need to be coordinated with ICAO a full year before the General Assembly, which for the upcoming 2019 General Assembly would have been in September 2018, which as before the Decision XXX/9 was passed. This means that further halon issues will not be addressed again until the 2022 General Assembly. Mr. Verdonik stated that meanwhile, not to lose three years in managing halon issues, individual parties may wish to consider liaising with their civil aviation airframe manufacturers and civil aviation regulatory bodies to urge the adoption of halon 1301 alternatives in cargo bays and engine nacelles, and to encourage activities to reduce emissions from these applications.

68. Mr. Verdonik reported that although research continues in 2019 for halon, HCFC and high-GWP HFC alternatives in fire protection, it could be several years before a viable agent could possibly have significant impact on the fire protection sector. This is particularly applicable to civil aviation alternatives where there are currently no alternatives on the horizon for both cargo bays and engine nacelle applications and it is likely that it will be many years before any replacement agents could be proposed for certification by civil aviation regulatory bodies.

69. In February 2019 during the Second Global Inter-regional and Parallel Networks Meeting for National Ozone Officers sponsored by UNEP OzonAction, two of the HTOC co-chairs briefed eight of the nine regional networks on ongoing issues related to halons and on preparations for addressing HCFCs and high-GWP HFCs in the fire protection sector. The HTOC plans to continue to liaise with each of the networks to improve awareness and institutional strengthening (capacity building) on current halon issues and to prepare for upcoming HCFC and HFC issues in the fire protection sector. This activity directly ties to the HTOC 2018 Quadrennial Assessment report statement that parties may wish to consider addressing the need for awareness programmes to re-establish the apparent loss in institutional memory.

70. Finally, Mr. Verdonik stated that the HTOC expresses concern that the assessment of the risk of use of flammable refrigerants, in practice, meaning in actual service, requires specific fire protection expertise that currently may be lacking in some evaluations.

71. Mr. Fabio Polonara, co-chair of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee (RTOC), provided an update on standards for flammable refrigerants in commercial refrigeration. He first provided information on the ASHRAE and ISO classification system used for refrigerants indicating characteristics for flammability and toxicity. The International Electrochemical Commissions (IEC) facilitates development and publishes international standards and conformity assessment for all electrical, electronic and related technologies. In May 2019, the IEC Subcommittee (SC) 61C (Safety of refrigeration appliances for household and commercial use) approved for publication the “final draft international standard” (FDIS) to revise IEC 60335-2-89 “Household and similar electrical appliances — Safety — Part 2-89”. He reported that the revised standard was now final and had been published (June 2019). The previous version limited the upper refrigerant charge in commercial refrigeration appliances to 150 g, irrespective of the flammability type, i.e., A2L, A2 or A3. The revised standard increases charge limits for flammable refrigerants in commercial refrigeration appliances up to about 500g for A3 and up to 1,200g for A2 and A2L refrigerants. With this decision, charge sizes in excess of 150 g can be used, provided that the appliance passes a “surrounding concentration test”. Mr. Polonara noted that compliance with the IEC standard is voluntary, however in certain countries the national version adopted (modified or not) may be mandatory. He referred to additional context and information on flammable refrigerants and safety standards available from the following: the TEAP Report on “Safety Standards for Flammable Low Global-Warming-Potential (GWP) Refrigerants” (Decision XXVIII/4) and the Ozone Secretariat document, “Information on the tabular overview of safety standards for refrigeration, air-conditioning and heat-pump systems and appliances” (Decision XXIX/11).

72. Ms. Helen Tope, co-chair of the Medical and Chemicals Technical Options Committee, recalled decision XXIX/7 on process agents requesting the Technology and Economic Assessment Panel to report at this meeting on the industrial application of any alternative technologies employed by parties that have already eliminated the use of ozone-depleting substances as process agents in the processes listed in table A. She noted that the decision also urged parties to update their information on the use of controlled substances as process agents and provide to the Ozone Secretariat by the end of 2017. She stated that China, the European Union, and the United States submitted information about their process agent uses in response to the decision, which was considered along with other information in preparing the response. She reminded parties that process agent uses are long-standing processes built around unique solvent properties of ozone-depleting substances, making it difficult to convert to alternatives, which can happen during longer term planned upgrades to plants. She presented 5 process agent applications listed in Table A of decision XXIX/7 and the alternative technologies that have already eliminated the use of ozone-depleting substances as process agents and indicated that further details were contained in Volume 1 of the Progress Report, and also noted that MCTOC had made recommendations in 2018 for changes to Table A relating to 2 of those process agent uses. She presented available information on the remaining 6 process agents listed in Table A of decision XXIX/7, where alternatives either do not exist or no information is available. In relation to technical updates contained in the Progress Report, Ms. Tope stated that, in 2017, the total production of ozone-depleting substances for feedstock uses was 1,340,000 tonnes, with estimated emissions of 2,500 ODP tonnes. She noted that this production quantity was the largest in metric tonnes for this purpose since 1990, with HCFC-22 constituting 47% of the total, carbon tetrachloride 19% and HCFC-142b 11%. She observed that the quantity of HCFCs produced for feedstock has been growing since records began in 1990, mainly as a consequence of the growth of fluoropolymers. She mentioned that carbon tetrachloride produced for feedstock had been growing at an average of 6,700 tonnes per year since 2009, then increased by 33,500 tonnes, or 15%, from 2016 to 2017 due to increasing demand for low-GWP hydrofluoroolefins and perchloroethylene. She reported that, in aerospace applications, HCFO-1233zd(E) has been approved by NASA as an acceptable replacement for HCFC-225 for solvent cleaning and verification sampling of propulsion oxygen systems and associated applications at propulsion test facilities. She stated that non-ODS solvents are expected to replace HCFC-225 for syringe/needle coating in Japan by end of 2019. She recalled that n-propyl bromide, which is not a controlled substance, is used as a cleaning solvent and in manufacture of agrichemicals and pharmaceuticals. She reported that recent market research estimates global production of n-propyl bromide as 75,000 tonnes in 2015, which is 3 times larger than previously estimated by MCTOC. Ms. Tope noted that the reason given for the increase in production in last 15 years is aggressive marketing as a substitute for other chlorinated solvents. For laboratory and analytical uses, Ms. Tope noted that reported total global production of ozone-depleting substances increased slightly from 2016 to 2017 to 162 tonnes, with a continuous decline in non-A5 parties, and a slight increase in A5 parties in the 3 years to 2017. She reported that one new draft standard in China uses cyclohexane or tetra-chloroethylene as alternatives to ozone-depleting substances for testing oil in water. She noted that parties had authorised an essential use exemption for China for 65 tonnes of carbon tetrachloride for 2018, for production of carbon tetrachloride (CTC) for use in testing of oil in

water, and that China produced and used the entire quantity authorised. She added that a new standard HJ 637-2018, that replaced carbon tetrachloride with tetrachloroethylene as the extractant, commenced on 1 January 2019.

73. On behalf of TEAP, the Methyl Bromide Technical Options Committee (MBTOC) co-chairs, Mr. Ian Porter and Ms. Marta Pizano presented the progress report and an overview of the trends and outcomes for the CUN nominations submitted in 2019 for use in 2020 and 2021. In summarizing key issues for the progress report, Mr. Porter reported that only 6 nominations for critical use had been submitted in 2018 and that progress in phasing out specific critical uses was proving more difficult for strawberry runners in Canada and Australia and the false root-knot nematode (*Nacobbus*) on tomato in Argentina. He also mentioned that there was concern on the future of some key fumigant alternatives to MB and their future sustainability, as their volatile nature facilitates their emission into the environment with potential negative impacts on human health and the environment. As an example, sulfuryl fluoride (SF) is widely used, but it has a very high GWP (4780). Also, 1,3-dichloropropene, chloropicrin and others are under scrutiny from regulatory authorities in some countries and their future is uncertain.

74. Mr. Porter explained that Quarantine and Pre-shipment (QPS) uses of MB are highly emissive to the atmosphere and that policies in some large MB user countries implemented as a result of concerns over emissions, were proving that recapture systems can be effectively used to reduce emissions. MBTOC estimated that there was scope to avoid ~70% of the current yearly emissions derived from QPS (about 8,500t) if recapture/destruction technologies were fully implemented. He further explained that MBTOC had increased cooperation with the International Plant Protection Convention (IPPC) and that this body was critical to set standards for replacement of MB for quarantine pests. As an example, the ISPM 15 dealing with treatment of wood packaging materials has recently included sulfuryl fluoride as an additional valid treatment to MB or heat (including microwaves).

75. Mr. Porter stressed that parties were having difficulties in reporting correctly MB usage for controlled and exempted uses, as well as differentiating categories of use (controlled and exempted). For example, MBTOC had become aware of one party, which had not reported controlled uses since 2004 and never reported any QPS uses, announcing a ban on MB for controlled uses in 2019. Further, of a 'quarantine' use of MB for the treatment of imported paper and plastic waste intended for recycling, to control pests and potential disease vectors (e.g. insect, rodents) for which alternatives are likely available. It was not clear if the use is a QPS use or if it is reported under Article 7 and/or if recycling/recapture is used. It was suggested that parties may wish to improve reporting of sectors which use MB for QPS to ensure MB is only used under the definitions of the Montreal Protocol.

76. Further to the presentation, Mr. Porter explained that one emergency use, as allowed under Decision IX/7, from Israel had been notified to the Ozone Secretariat for the use of 100 kg (0.1 tonne) of MB. This was to control an infestation of the common furniture beetle (*Anobium punctatum*) in the library of the Greek Orthodox Patriarchate in Jerusalem. The party had provided advice that phosphine could not be used as it would damage the manuscripts (which could not be moved) and sulfuryl fluoride could not be used as it was not registered in Israel. MBTOC indicated relevant research conducted in Israel with gases such as nitrogen and carbon dioxide, which could be used for efficient control of pests under similar circumstances, but indicated it was possible that application of inert gases in a library was difficult. In closing this issue, he indicated that MBTOC experts stand ready to provide further assistance if required.

77. Mr. Porter then introduced the outcomes from the interim assessment of the critical use nominations submitted for 111.441 tonnes in 2019. One party submitted for 2021 and 3 others for 2020. He explained that the total amount for CUNs was still declining although MBTOC was unable to determine exact amount of MB used for controlled uses because of the unknown level of stocks. The outcome of the interim assessment recommendation for all countries totalled 74.427 tonnes. He reported that MB stocks reporting was incomplete, and that total of stocks held was unknown as parties are not required to be reported from all parties. MBTOC made no adjustments to CUEs on account of stocks.

78. In detailing the outcomes from the CUNs, Ms. Pizano then explained that the interim recommendation from Australia for 28.98 t for 2021 has been reduced to 14.49 t as per the transition plan provided by the party, which was based on the uptake of methyl iodide (MI, pending registration). If circumstances were to prevent adoption of MI, the party would still have the opportunity to re-apply before 31st MOP or in the 2020 round. It was considered that there was also good progress with TF80 (Telone/Pic).

79. The interim recommendation for the nomination of 5.261 t from the Canadian strawberry runners t in 2020 was reduced by 4.6% to 5.017 t. The reduction was based on the uptake of soilless culture for a proportion (10%) of the G2 production of runner tips only for varieties that have shown equivalent performance to those grown with methyl bromide.

80. Ms Pizano then showed the trends in amounts of MB requested in nominations from five A5 parties since 2015, which had generally declined. She indicated that Mexico and China were no longer requesting CUNs, but that MBTOC was unable to determine if these parties had phased out MB or were using stocks, since there is no requirement for parties to report stocks gathered before 2015.

81. The two nominations from Argentina - for strawberry fruit and protected tomato production, the interim recommendations were reduced amounts of 7.83 t and 12.79 t respectively based on an adjustment of dosage rate from 26 to 15 g/m<sup>2</sup> to meet MBTOC standard presumptions.

82. In closing her presentation, Ms. Pizano explained that the nomination from South Africa of 1.5 t for mills was reduced 0.3 tonnes based on allowance of only one fumigation per year at a 20 g/m<sup>3</sup> dose rate for the three mills nominated, to allow time for adoption of IPM and sulfuryl fluoride. In the case of house fumigation, the interim recommendation was for a reduction of 15% in the nomination of 40.0 t to 34.0 tonnes.

#### **IV. Report of the energy efficiency task force on the cost and availability of low-global-warming-potential technologies and equipment that maintains or enhances energy efficiency (agenda item 7)**

83. Ms. H  l  ne Rochat and Mr. Ashley Woodcock, co-chairs of the energy efficiency task force (EETF), accompanied by the Chapter Lead Authors Dr. Omar Abdelaziz, Mr. Bassam Elassaad and Dr. Gabrielle Dreyfuss, presented the results from the EETF report prepared for the OEWG 41. Ms. H  l  ne Rochat started elaborating on the mandate in paragraph 3 of decision XXX/5, which requested the Technology and Economic Assessment Panel (TEAP) "to prepare a report on the cost and availability of low-global-warming-potential technologies and equipment that maintain or enhance energy efficiency, inter alia, covering various refrigeration, air-conditioning and heat-pump sectors, in particular domestic air-conditioning and commercial refrigeration, taking into account geographical regions, including countries with high-ambient-temperature conditions". Ms. Rochat presented the list of the 20 members of the task force and noted that 60% of the task force were from A5 Parties and 30% were female. The availability and costs questions were divided each in one chapter. In addition, a chapter on markets was included as markets play an important role in the availability of technologies. Each chapter lead authors then presented their chapter.

84. Mr. Bassam Elassaad started by defining availability in terms of presence in the different regions and climatic zones of the world and concluded that medium and low GWP refrigerants for energy efficient appliances are widely available while the products using these refrigerants are available to varying degrees. The components to build those products are available from some sources. He noted that research & development (R&D) to increase energy efficiency (EE) is focusing on lower GWP technologies, although some development is still taking place on the high GWP HFCs. There is no new development to increase the EE of HCFCs as these are already phased-out in many countries and being phased-out in the remaining countries. The availability of components to build AC products, like variable speed compressors and microchannel condensers, was also discussed. For commercial refrigeration products, energy efficiency is determined by equipment design and the majority of technical options for improved energy consumption are currently in use and do not depend on the refrigerant being used. Mr. Elassaad concluded that the impact of high ambient temperature (HAT) on the decrease of EE is well documented and that various research and testing projects are being conducted at high ambient temperatures (PRAHAI & II). They have given the indication that viable alternatives providing comparable EE levels to the baseline refrigerants are available and can be used for the different applications but that further optimization of the design is needed.

85. Mr. Omar Abdelaziz presented on the capital and operating costs associated with the conversion towards energy efficient low-GWP technologies. He indicated that the task force has identified the required additional capital and operating costs to convert manufacturing lines for ACs to accommodate simultaneous transition towards higher energy efficiency low GWP refrigerants. He then presented a table containing detailed information on the range of capital costs associated with conversion of manufacturing lines of lower GWP room air conditioner with higher energy efficiency. The conversion cost was found to range between 300 and 535 thousand USD when no heat exchanger modifications are considered and between 1.3 to 2 million USD if they are. He noted that smaller diameter tube and microchannel heat exchangers can be used to further reduce the refrigerant charge and improve system efficiency. As for operating costs, Mr. Abdelaziz summarized the availability,

potential energy efficiency improvement, and impact on product cost. He showed that using a variable speed compressor can improve the system efficiency by up to 30% but would result in 20% increase in unit cost. On the other hand, microchannel heat exchangers may improve system efficiency by up to 15% with no impact on the unit cost. He noted that microchannel heat exchangers are especially known for the impact they have on the refrigerant charge reduction of up to 40%. Finally, Mr. Abdelaziz discussed the concept of life cycle cost analysis for policy making and borrowed an example used by the energy policymaking community. He then presented a case study done by the U.S. department of energy during the rulemaking process for the minimum efficiency performance standard for the self-contained commercial refrigeration. This case study depicted the correlation between initial cost, performance, and life cycle cost. It was shown that the least life cycle cost equipment is not necessarily the most efficient equipment.

86. Ms. Gabrielle Dreyfus described the role of markets and policies in determining the availability of energy-efficient refrigeration and air-conditioning equipment and low-GWP refrigerants. The main findings included that policies create an enabling environment for market development, with manufacturers responding to policies that promote energy efficiency and refrigerant transition by investing in research and development. She highlighted that a simultaneous transition toward lower-GWP and higher energy-efficiency equipment reduces costs to manufacturer for research and development and capital investment cycles, with benefits passed on to consumers, and can be further enabled through market transformation mechanisms. The converse is also observed with weak or absence of energy-efficiency policies being associated with market dominance of inefficient and HCFC technologies in some regions. She noted that if governments adopt common or comparable standards and metrics where markets and climates are similar, the demand for products meeting those standards would go up, increasing scale and availability.

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