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Item 7 of the provisional agenda
Sharm el-Sheikh mitigation ambition and implementation work programme referred to in decision 4/CMA.4

Subsidiary Body for Implementation
Fifty-ninth session
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Sharm el-Sheikh mitigation ambition and implementation work programme

Annual report by the secretariat

Summary

The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement, at its fourth session, requested the secretariat to prepare, under the guidance of the co-chairs of the Sharm el-Sheikh mitigation ambition and implementation work programme, a report on each of the two global dialogues held in 2023 as part of the work programme, reflecting in a comprehensive and balanced manner the discussions held and including a summary, key findings, opportunities and barriers relevant to the topic, and an annual report comprising a compilation of the two individual reports for consideration by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement and the subsidiary bodies. This annual report comprises a compilation of the two individual reports on the global dialogues held in 2023 that focused on accelerating the just energy transition.

Contents

		Page
	Abbreviations and acronyms	3
I.	Introduction	4
	A. Mandate	4
	B. Co-chairs of the work programme	4
	C. Topics for the global dialogues under the work programme in 2023	4
	D. Overview of the first global dialogue and investment-focused event	5
	E. Overview of the second global dialogue and investment-focused event	5
	F. Reports on the first and second global dialogues	6
	G. Possible action by the subsidiary bodies	6
II.	Report on the first global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme	6
	A. Mandate	6
	B. Proceedings	6
	C. Summary of discussions and key findings, and opportunities and barriers	9
	D. Grid and energy storage	11
	E. Carbon capture and utilization and carbon capture and storage	12
	F. Energy efficiency	15
	G. Policies and measures	16
	H. Financing issues	18
	I. Technology and capacity	20
	J. Sustainable development and socioeconomic impacts	22
III.	Report on the second global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme	23
	A. Mandate	23
	B. Proceedings	24
	C. Summary of discussions and key findings, and opportunities and barriers	27
	D. Energy and resource efficiency in the transport sector	30
	E. Electrification of vehicles	32
	F. Shifting to low- or zero-carbon fuels	34

Abbreviations and acronyms

CCS	carbon dioxide capture and storage
CCU	carbon capture and utilization
CEO	chief executive officer
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CO_2	carbon dioxide
COP	Conference of the Parties
CTCN	Climate Technology Centre and Network
EV	electric vehicle
EU	European Union
GHG	greenhouse gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
LDC	least developed country
MDB	multilateral development bank
NDC	nationally determined contribution
SB	sessions of the subsidiary bodies
SDG	Sustainable Development Goal
SIDS	small island developing State(s)
TEC	Technology Executive Committee

I. Introduction

A. Mandate

1. CMA 3 decided to establish a work programme to urgently scale up mitigation ambition and implementation in this critical decade.[1]

2. CMA 4 decided that at least two global dialogues shall be held each year as part of the Sharm el-Sheikh mitigation ambition and implementation work programme, with one to be held prior to the first regular sessions of the subsidiary bodies, starting at SB 58, and one prior to the second regular sessions of the subsidiary bodies, starting at SB 59, and that such dialogues should be conducted in hybrid format to allow both in-person and virtual participation.[2]

3. At the same session, the CMA requested the secretariat to prepare, under the guidance of the co-chairs of the work programme, a report on each of the dialogues, reflecting in a comprehensive and balanced manner the discussions held and including a summary, key findings, opportunities and barriers relevant to the topic, and to prepare an annual report comprising a compilation of the individual dialogue reports for consideration by the CMA and the subsidiary bodies.[3]

B. Co-chairs of the work programme

4. The Chairs of the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation were requested by CMA 4 to appoint, well in advance of SB 58 and every two years thereafter, in consultation with respective constituencies, two co-chairs for the Sharm el-Sheikh mitigation ambition and implementation work programme, one from a developed country Party and one from a developing country Party.[4]

5. The Chairs of the subsidiary bodies appointed Amr Osama Abdel-Aziz (Egypt) and Lola Vallejo (France) as the co-chairs for the work programme for 2023–2024.[5]

C. Topics for the global dialogues under the work programme in 2023

6. CMA 4 invited Parties, observers and other non-Party stakeholders to submit via the submission portal suggested topics in line with the scope of the work programme to be discussed under the dialogues every year. Considering these submissions, the co-chairs of the work programme are to decide on the topics to be discussed at the dialogues in a given year.[6]

7. The co-chairs decided that the dialogues taking place under the work programme in 2023 would focus on accelerating the just energy transition, including by:

(a) Implementing policies and measures with a global overview and country-specific experience;

(b) Addressing financial, technological and capacity-building needs in this area, such as through international cooperation, including with non-Party stakeholders, and provision of support to developing countries;

[1] Decision 1/CMA.3, para. 27. In the same paragraph of this decision, CMA 3 also requested that the work programme be implemented in a manner that complements the global stocktake. Information on the global stocktake is available at https://unfccc.int/topics/global-stocktake.

[2] Decision 4/CMA.4, para. 8.

[3] Decision 4/CMA.4, para. 15.

[4] Decision 4/CMA.4, para. 7.

[5] Information on the co-chairs is available at https://unfccc.int/co-chairs-of-the-mitigation-work-programme-2023-2024-0.

[6] Decision 4/CMA.4, paras. 12–13.

(c) Promoting sustainable development and understanding socioeconomic effects.

D. Overview of the first global dialogue and investment-focused event

8. The first global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme took place in conjunction with SB 58 in Bonn from 3 to 4 June 2023, in hybrid format, with 161 registered in-person and 73 registered virtual participants.[7]

9. Over the course of the two days of the dialogue, participants discussed opportunities, actionable solutions, challenges and barriers relevant to accelerating the just energy transition. The topic was explored through the following subtopics:

(a) Renewable energy;

(b) Grid and energy storage;

(c) CCU and CCS;

(d) Energy efficiency.

10. The dialogue was followed by a one-day investment-focused event, organized by the secretariat under the guidance of the co-chairs of the work programme, to consider the cost of mitigation implementation with a view to unlocking finance, including for just transitions, overcoming barriers to accessing finance and identifying investment opportunities and actionable solutions informed by NDCs to help public and private financiers, investors and international climate finance providers direct finance flows towards supporting areas of opportunity to enhance mitigation in this critical decade.[8] The event can be revisited via the webcast links.[9]

E. Overview of the second global dialogue and investment-focused event

11. The second global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme took place in Abu Dhabi from 15 to 16 October 2023, in hybrid format, with 245 registered in-person and 208 registered virtual participants.[10] The dialogue was hosted by the incoming COP 28 Presidency, and its organization was supported by Abu Dhabi Global Market and IRENA.

12. Following the structure of the first global dialogue, participants discussed opportunities, actionable solutions, challenges and barriers relevant to accelerating the just energy transition in transport systems. The topic was explored through the following subtopics:

(a) Deploying and shifting to collective and non-motorized modes of transport (rail, urban public transit, cycling, etc.);

(b) Energy and resource efficiency in the transport sector (design improvements, circular economy and material changes, vehicle vintage, carpooling, etc.);

(c) Electrification of vehicles (infrastructure, batteries and minerals);

(d) Shifting to low- or zero-carbon fuels (hydrogen, biofuels, biogas, compressed natural gas).

13. As for the first global dialogue and in line with the same mandate, the second global dialogue was followed by a one-day investment-focused event. The event, which was hosted by the incoming COP 28 Presidency and organized with the support of the United Nations

[7] The webcast links, agenda and all presentations are available at https://unfccc.int/event/first-global-dialogue-and-investment-focused-event-under-the-sharm-el-sheikh-mitigation-ambition-and.

[8] As per decision 4/CMA.4, para. 11.

[9] As footnote 7 above.

[10] The webcast links, agenda and all presentations are available at https://unfccc.int/event/second-global-dialogue-and-the-second-investment-focused-event-under-the-sharm-el-sheikh-mitigation.

Conference on Trade and Development, took place in conjunction with the World Investment Forum 2023. The event can be revisited via the webcast links.[11] Owing to technical problems at the venue, virtual two-way participation was not possible.

F. Reports on the first and second global dialogues

14. As per the mandate referred to in paragraph 3 above, the secretariat prepared reports on the first and second global dialogues under the Sharm el-Sheikh mitigation ambition and implementation work programme. The report on the first global dialogue was published on 22 September 2023,[12] and the report on the second global dialogue was published on 17 November 2023.[13]

15. This annual report is a compilation of (1) the proceedings and (2) the summary of discussions and key findings, and opportunities and barriers from the reports on the first and second global dialogues under the work programme (see chaps. II and III below respectively).

G. Possible action by the subsidiary bodies

16. The Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation, taking into account this annual report, have been requested to consider progress, including key findings, opportunities and barriers, in implementing the work programme with a view to recommending a draft decision for consideration and adoption by CMA 5.

II. Report on the first global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme

A. Mandate

17. Chapter I above describes the mandate for and background to the first global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme.

B. Proceedings

18. The first global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme took place in hybrid format in conjunction with SB 58 from 3 to 4 June 2023, with 161 registered in-person and 73 registered virtual participants.[14] It focused on the topic of accelerating the just energy transition, including by:

(a) Implementing policies and measures with a global overview and country-specific experience;

(b) Addressing financial, technological and capacity-building needs related to this topic, such as through international cooperation, including with non-Party stakeholders, and the provision of support to developing countries;

(c) Promoting sustainable development and understanding of socioeconomic effects.

19. Opening remarks were provided by Mohamed Nasr, from the COP 27 Presidency, and Hana AlHashimi, from the incoming COP 28 Presidency. These were followed by welcoming remarks from Simon Stiell, UNFCCC Executive Secretary, introductory remarks

[11] As footnote 10 above.
[12] Available at https://unfccc.int/documents/631792.
[13] Available at https://unfccc.int/documents/633399.
[14] As footnote 7 above.

from the co-chairs of the work programme, and a scene-setting presentation on accelerating the just energy transition and insights from the sixth assessment cycle of the IPCC by Youba Sokona, Vice-Chair of the IPCC.

20. Youba Sokona highlighted that global total GHG emissions in 2019 were approximately 12 per cent higher than in 2010 and 54 per cent higher than in 1990, and that limiting warming to 1.5 or 2 °C requires rapid, deep and immediate GHG emission reductions. He noted that despite ongoing efforts and commitments over the past few years, the world is not on track to limiting global warming to 1.5 °C and implemented policies are projected to lead to 3.2 °C (2.2–3.5 °C range). CO_2 from energy and industry represents the largest share of GHGs and is projected to continue to increase. He further stated that global net zero GHG emissions can be achieved through strong reductions across all sectors; however, the window for climate-resilient development is rapidly closing.

21. Youba Sokona elaborated on the conditions that enable collective action by governments, the private sector and civil society for climate-resilient development, such as inclusive governance; diverse knowledge and values relating to climate action; finance and innovation; integration of policies across sectors and timescales; ecosystem stewardship; synergies between climate and development actions; and behavioural change supported by policy, infrastructure and sociocultural factors. In contrast, conditions that constrain individual and collective action include poverty; inequity and injustice; economic, institutional, social and capacity barriers; lack of finance; and trade-offs in relation to the SDGs.

22. Youba Sokona indicated several solutions that could help to at least halve GHG emissions by 2030 compared with the 2019 level, some of which can already be implemented and would bring many benefits by addressing health, equity, justice and even economic concerns, while increasing resilience and accelerating the transition to a clean energy future. He emphasized that there are multiple opportunities for scaling up climate action on both the supply and demand sides, including mitigation options with a net lifetime cost of USD 100/t CO_2 equivalent, or less. In this context he mentioned solar and wind, as well as reducing methane from coal, oil and gas, which has considerable potential for reducing energy supply emissions by 2030. He also gave an overview of mitigation options in other areas such as land, water and food; settlement and infrastructure, including mobility systems, public transport and EVs; health; and society, livelihood and the economy. The cost of such mitigation options is often less than the reference scenarios assessed by the IPCC. As for demand-side mitigation options, Youba Sokona noted that their emission reduction potential is estimated to range between 40 and 70 per cent by 2050 compared with the 2019 level in end-use sectors, including food, land transport, industry, buildings and electricity.

23. On the first day of the dialogue, four technical experts presented on opportunities, actionable solutions and technologies relating to the following subtopics in the context of the just energy transition:

(a) Renewable energy – Juan Jose Garcia Mendez, Programme Officer, Clean Energy Transition Scenarios, IRENA;

(b) Grid and energy storage – Matthew Wittenstein, Chief of Section, Energy Connectivity, United Nations Economic and Social Commission for Asia and the Pacific;

(c) CCU and CCS – Jarad Daniels, CEO, Global CCS Institute;

(d) Energy efficiency – Rana Ghoneim, Chief, Energy Systems and Infrastructure Division, United Nations Industrial Development Organization.

24. Subsequently, participants were divided into four breakout groups. Each group discussed the above subtopics with the technical experts and facilitators. Over the course of the day, all participants were able to join each breakout group and discuss each subtopic.

25. The following guiding questions provided a framework for the discussions in each breakout group:

(a) What are opportunities, best practices and actionable solutions for the just energy transition to urgently scale up mitigation ambition and implementation in this critical

decade in each subtopics (renewable energy, grid and energy storage, energy efficiency, and CCU and CCS)?

(b) What are effective policies and measures implemented from a global perspective and country-specific experience for each subtopic?

(c) How are financial, technological, and capacity-building needs addressed for each subtopic?

(d) How are the issues of international cooperation, including with non-Party stakeholders, and the provision of support to developing countries addressed?

(e) How is sustainable development promoted and what are the socioeconomic effects under each subtopic?

26. At the beginning of the second day of the dialogue, the facilitators reported back on the first day's breakout group discussions.

27. Subsequently, four technical experts presented on barriers, challenges and financing issues relating to the just energy transition, specifically in the areas of:

(a) Barriers and challenges around policies and measures – Richard Kozul-Wright, Director, Globalization and Development Strategies Division, United Nations Conference on Trade and Development;

(b) Financing issues – Chienyen Goh, finance expert;

(c) Technology and capacity challenges – Stig Svenningsen, TEC Chair;

(d) Barriers and challenges in addressing sustainable development and socioeconomic impacts – Yin Shao Loong, Senior Research Associate, Khazanah Research Institute.

28. Participants were then divided into four breakout groups. Each group discussed the above subtopics with the technical experts and facilitators. Over the course of the day, all participants were able to join each breakout group and discuss each subtopic.

29. One guiding question provided the framework for the discussions in each breakout group: what barriers and challenges are there for the just energy transition to urgently scale up mitigation ambition and implementation in this critical decade, taking into account the subtopics from the first day of the dialogue (renewable energy, grid and energy storage, energy efficiency, and CCU and CCS)?

30. At the closing plenary the co-chairs of the work programme invited the facilitators of each breakout group on the second day to report back on the discussions. The co-chairs of the work programme then thanked the participants, experts and facilitators, and declared the first global dialogue closed.

31. The global dialogue was followed by a one-day investment-focused event, organized under the guidance of the co-chairs of the work programme, to consider the cost of mitigation implementation with a view to unlocking finance, including for just transitions, overcoming barriers to accessing finance and identifying investment opportunities and actionable solutions informed by NDCs to help public and private financiers, investors and international climate finance providers direct finance flows towards supporting areas of opportunity to enhance mitigation in this critical decade.[15] The event started with an introduction to the global outlook on energy, including renewable energy and the energy transition, investment and country case studies, and addressed matters including project preparation, financing and opportunities for mobilizing investment, focusing on different regions. The event can be revisited via the webcast links.[16]

[15] As per decision 4/CMA.4, para. 11.

[16] As footnote 7 above.

C. Summary of discussions and key findings, and opportunities and barriers

32. This subchapter captures views shared during breakout group discussions at the dialogue but may not represent an exhaustive summary of all comments made by participants.

2. Renewable energy

(a) Summary of discussions and key findings

33. The breakout group discussion was facilitated by Elizabeth Press, Director, Planning and Programme Support, IRENA, and supported by Juan Jose Garcia Mendez.

34. The introductory presentation by Juan Jose Garcia Mendez underscored the importance of the rapid deployment of all forms of renewable energy (solar, wind, biomass, geothermal, marine, hydro, etc.) as a readily available mitigation solution that can also help to realize multiple economic, social and environmental policy objectives. It was indicated that the growing competitiveness of renewable energy, with global price levels for electricity generated by renewables already comparable to or lower than those of fossil fuels for some technologies, continues to provide a compelling pathway for decarbonizing the global energy system. In 2022, global investment in the energy transition grew by around 70 per cent compared with the level before the coronavirus disease 2019 pandemic. However, despite accelerated current deployment rates, annual global additions to renewable energy power generation and investment therein need to grow significantly by 2030 in order to stay on the pathway to limiting global warming to 1.5° C. Further, it was highlighted that the majority of renewable energy capacity deployment remains concentrated in the Global North and has reached a very limited number of developing countries; therefore, barriers faced by developing countries need to be removed in order to achieve equal global deployment. In the presentation, enablers for the energy transition were highlighted, including forward-looking planning, modernization and expansion with regard to supporting infrastructure on land and sea; facilitation of national, regional and global strategies for new supply–demand dynamics and promotion of equity and inclusion; and design of policy and regulatory frameworks that facilitate deployment, integration and trade of renewables and promote equality and capacity-building among institutions, communities and individuals to enable acquisition of the requisite skills, knowledge and expertise for driving and sustaining the energy transition.

35. During the discussions it was mentioned that the rapid and large-scale adoption of renewable energy can significantly reduce GHG emissions, thereby mitigating climate change, in addition to contributing to multiple co-benefits, including improvements in air and water quality, with some participants stating that this should happen with a parallel phase-out of unabated fossil fuels. Some participants supported a global goal for renewable energy deployment and others did not, stressing the importance of equity and the principle of common but differentiated responsibilities and respective capabilities in the light of considering different national circumstances and of taking into account national development priorities and pathways and highlighting that, according to decision 4/CMA.4, paragraph 2, the outcomes of the mitigation work programme will not impose new targets or goals. It was noted, however, that just energy transitions must be country-driven and realistic and energy must be affordable and accessible, enabling and not hindering sustainable development and other development priorities. Participants highlighted the need to ensure energy security during the energy transition. It was also highlighted that some countries have adopted pragmatic and flexible energy policies during the energy crisis, where all types of energy have a role in ensuring energy security.

36. Participants noted that while the cost of renewable technologies has fallen sharply, their deployment remains concentrated in a limited number of countries and regions.

37. Given the links between deployment of renewables and broader economic and societal issues, it was underscored that it is essential to engage with all stakeholders to secure social acceptance of renewables, especially by ensuring community involvement and benefits, as well as considering environmental issues related to the deployment of renewables. The

importance of a just transition was emphasized, while recognizing that some countries are not transitioning but developing their energy system.

38. Views were expressed that although renewable technologies are mature and ready for deployment at scale, barriers still exist in many countries and innovation is needed to further improve the efficiency and flexibility of the energy system. Existing barriers include available options for energy storage, access to finance and technologies, and costs of enabling technologies, which need to be further driven down.

39. Participants commented that the ability of countries to turn renewable potential into energy production depends on their capacity to develop and deploy technologies and systems. Access to technology, training, capacity-building and affordable finance will be vital to realizing the full potential of renewables to decarbonize the global energy system and contribute to sustainable development.

(b) Opportunities (including actionable solutions) and barriers

40. During the discussions, it was emphasized that the deployment of renewables can create new industries and jobs, stimulate economic growth, decrease dependency on fossil fuel imports and increase energy security. For instance, growth in solar and wind energy can spur the development of a skilled labour force, specialized manufacturing industries and service sectors. It was noted that 12.6 million people already work in renewables and there is the potential to triple this number by 2030.

41. Participants stated that renewable energy deployment can have important social implications, such as improving public health by reducing air pollution, and contributing to energy equity by providing energy access to the more than 600 million people who currently lack it, mostly in sub-Saharan Africa where there is abundant renewable energy potential.

42. Distributed renewable energy solutions were highlighted by participants as an opportunity to create a resilient energy system and therefore support vital adaptation measures for the most vulnerable communities, such as the coastal or rural communities that are most affected by climate change. In such locations, distributed renewable energy solutions can ease exposure to climate change impacts by providing ‘green infrastructure’ in indispensable sectors such as water, food and waste treatment.

43. Participants mentioned that renewable energy opens new opportunities for cross-border and regional cooperation to create economies of scale, promote energy trade and develop new industrial clusters, among others. It is therefore important to consider the entire value chain of technologies to recognize where such opportunities may exist. In this regard, South–South and peer-to-peer cooperation is vital to sharing experience and innovation in developing countries.

44. As for the barriers, views were expressed that the transition to renewables requires new policy frameworks, regulations and market designs to facilitate integration of new technologies into the energy system. Policies need to go beyond the development and deployment of renewables to also tackling priorities such as labour, industrialization, trade and finance.

45. Participants stated that infrastructure, including grid and energy storage capacities, is a major barrier to the rapid deployment of renewable energy in developed and developing countries. Grid modernization and integration and expansion of transmission lines is required, as well as new shipping routes and ports for the transport of carriers such as hydrogen. Further, many developing countries require extensive investment and financial support to overcome this barrier.

46. Access to affordable finance for renewable energy was mentioned as a key barrier. In this context, it was highlighted that concessional and grant finance is also needed, notably for developing countries.

47. A participant highlighted the limited consideration given to equity and common but differentiated responsibilities and respective capabilities, in the light of different national circumstances in the mitigation pathways and models assessed by the IPCC.

48. Public finance is essential for the energy transition and should continue to be used strategically to crowd in additional capital, including private capital. Risk mitigation instruments (e.g. guarantees, currency hedging instruments and liquidity reserve facilities) will still play a major role in overcoming real and perceived barriers to investment, but public finance and policy must go beyond risk mitigation by, for example, including funding for capacity-building, support for pilot projects and innovative financing instruments such as blended finance initiatives.

49. Participants mentioned that channelling technical and expert knowledge into policymaking will be key to informed decision-making. Future conversations should take a granular approach and address issues such as renewable value chains, critical materials, energy transition and jobs, and regional approaches to renewable energy and resilient infrastructure.

D. Grid and energy storage

1. Summary of discussions and key findings

50. The breakout group discussion was facilitated by Anne Olhoff, Senior Advisor, International Team, United Nations Environment Programme, and supported by Matthew Wittenstein.

51. The introductory presentation by Matthew Wittenstein highlighted that, according to current trends, investment in grid and energy storage is not sufficient to meet net zero goals. Since grid and energy storage play an important role in enabling the deployment of renewable energy – connecting demand and supply – and help to manage volatility and variability, there is a need for innovative financing mechanisms that involve private capital and climate finance, and an appropriate balance of long- and short-term market signals to incentivize investment. Regarding challenges, even though renewable energy and batteries are cost competitive, challenges such as substantial capital costs remain. The bulk of investments in grid and energy storage are in upper- and middle-income economies, with many lower-income economies experiencing high capital costs. Examples of grid investments that leverage both public and private sources of funding were presented, as in many cases public finance has competing priorities. Larger, more integrated power systems are needed as this reduces costs, improves energy security and enables decarbonization.

52. It was highlighted that grid and energy storage play an important role in enabling the energy transition, but participants noted that national circumstances and context-specific solutions need to be taken into consideration. Participants mentioned that the energy transition is inseparable from the development transition and poverty eradication, and access to employment and compensation is needed for communities adversely affected by the energy transition. At the same time, grid and energy storage bring economic development opportunities, including workforce training and lower overall air pollution, among other socioeconomic and environmental benefits.

53. International collaboration and cross-border trade were identified as essential for grid and energy storage and would contribute to managing price volatility and increase the flexibility of a new, more decentralized energy structure based on renewable energy. Participants shared experience with cross-border interconnectivity and transmission lines through examples from Asia, Europe, Latin America, the Middle East and Southern Africa.

54. Participants expressed the view that critical minerals are vital to the energy transition; environmental degradation and other detrimental effects associated with the supply chain of grid and energy storage technologies need to be avoided, especially in developing countries, where most critical minerals are present.

55. Technology availability and transfer are enabling conditions for a successful energy transition. Infrastructure is often either ageing and requires substantial investment or is weak and missing. Regarding renewable energy, participants discussed capital expenditure, surplus capacity to deal with storage needs, intermittency, higher costs of financing for renewable energy compared with fossil fuel options in developing countries, and renewable energy's importance to grid expansion.

56. Differences between domestic energy policies, such as in subsidies and energy costs, have implications for cross-border energy trade that need to be taken into consideration. Addressing regulations, rules and network codes is therefore essential for the success of cross-border interconnectivity.

2. Opportunities (including actionable solutions) and barriers

57. Participants indicated that a more systematic approach would be important to capitalize on international collaboration, experience-sharing, capacity-building and peer-to-peer learning on grid and energy storage. Exchanging views and cooperating on regulatory and legal aspects, financial solutions to address high capital costs, barriers to accessing finance, private sector involvement, and storage technologies and forecasts were also mentioned.

58. Views were shared on technological solutions such as digitizing networks, using hydrogen as an energy storage solution in the medium term, considering an international hydrogen supply chain, and grid and off-grid solutions, which constitute opportunities to enhance energy access and flexibility of the energy system.

59. Participants discussed financial needs and challenges relating to the infrastructure required for the energy transition: private sector investment remains insufficient, and most grid and storage plans rely on government investment. The costs of grid and energy storage were highlighted, alongside the need to give special consideration to developing countries and the LDCs when it comes to finance and investment solutions such as blended finance.

60. Domestic investment policy environments sometimes hinder changes and enhancements in grid and energy storage. Challenges relating to public–private partnerships and markets need to be tackled in order to enable further investment in technological advancement and deployment.

61. In many countries, barriers to grid and energy storage include ageing and/or weak infrastructure, challenging geography, lack of access to remote areas, land rights issues and the need for infrastructure linkages with expanding roads and other infrastructure, as well as barriers to technological uptake and deployment that need to be considered in energy transition pathways. It was mentioned that as long as energy storage and transmission are not feasible, reliable or cost-effective, some countries, depending on national circumstances, may need to continue the use of fossil fuels, including natural gas, to ensure energy security and meet development priorities.

E. Carbon capture and utilization and carbon capture and storage

1. Summary of discussions and key findings

62. The breakout group discussion was facilitated by Stig Svenningsen and supported by Jarad Daniels and Tim Dixon, Director and General Manager, IEA, Greenhouse Gas Research and Development Programme.

63. The introductory presentation by Jarad Daniels highlighted that the deployment of CCS at gigatonne scale will enable net zero emissions to be reached and limit temperature increase to 1.5 °C, including by achieving decarbonization in some sectors, such as industry, enable the production of low-carbon hydrogen at scale, provide low-carbon dispatchable power and deliver negative emissions. Globally, there are around 40 commercial facilities in operation with a capacity to capture and store in the order of 50 million t CO_2/year, around 20 under construction, and some 200 in the pipeline. Moreover, country- or region-specific policies are being developed or are already in place, including in North America, Europe, the Middle East and North Africa. However, more progress is required to reach net zero emissions and the temperature goal under the Paris Agreement, for which it is estimated a range between 350 and 1,200 Gt CO_2 will need to be captured and stored this century.[17]

[17] The range between 350 and 1,200 Gt CO_2 is based on three of four pathways assessed by the IPCC. The quantity of CO_2 stored via CCS over this century in 1.5 °C pathways with no or limited overshoot

Today, CCS is mostly applied for enhanced oil recovery, but its application is diversifying into a wide range of sectors (including production of fertilizer, ethanol and chemicals). The economics of CCS deployment were highlighted, such as cost range along the value chain, the role of CCS in limiting the overall system cost of decarbonization, and efforts to reduce costs by sharing infrastructure through a hub and cluster business model. Necessary action at the global level includes defining the role of CCS in national policies with specific legislation, regulating and enabling investment through market mechanisms and global information-sharing and capacity-building, including identifying support and appraising geological storage resources. Moreover, it is necessary to drive down the cost of the technologies involved, which requires deployment at scale and further technological advancement.

64. During the sessions, participants shared experience of using CCU and CCS: for example, over 20 years of CCS in Norway, including the 'longship project', one of the first industrial CCS projects; decades of experience with CCS technology in Saudi Arabia; a technology demonstration project and a long-term road map for CO_2 storage in Japan; possible use of carbon credits from multiple ongoing CCS projects in Indonesia; scaling up CCS in the EU through the proposed net zero industry act; a carbon management strategy review in Germany; a quantitative storage capacity target for 2030 in Denmark; a draft CCU and CCS policy in Trinidad and Tobago; and consideration of a CCS regulatory framework under the national climate change plan in Argentina.

65. Participants discussed the role of CCU and CCS in the context of the just energy transition in this critical decade, expressing mixed views with regard to these technologies. While some identified the use of CCU and CCS as a viable mitigation option for achieving net zero emissions, others commented that these technologies should be a complement to, rather than a substitute for, other low-cost mitigation options, particularly in energy supply where more technologically mature and less expensive options are available in many countries, such as renewable energy power generation.

66. Whereas some participants stated that the use of CCU and CCS could be considered as mitigation options in the energy sector in particular, for example, in reducing emissions from upstream fossil fuel production and the production of hydrogen and ammonia from fossil fuels, others indicated that those technologies are necessary options for achieving net zero emissions beyond the energy sector by reducing emissions from sectors such as cement, steel, hydrogen and fertilizer production, where no other feasible mitigation options currently exist.

67. Another view was that consideration of technologies such as CCU and CCS should not be used as an excuse to delay the transition from fossil fuels to renewable energy, since those technologies would contribute a comparably small proportion of the emission reduction required this decade to achieve the temperature goal of the Paris Agreement. Others stated that, while the current rate of CCU and CCS deployment falls short of the level required to achieve the temperature goal of the Paris Agreement, CCU and CCS are ready for large-scale deployment that has the potential to make a significant contribution to reaching this goal given that there is more than 50 years of collective experience in implementation.

68. In addition, it was mentioned that CCU and CCS may play a future role in addressing the current emission stock through direct air capture by removing emissions from the atmosphere, contributing to negative emissions.

2. Opportunities and barriers

69. Opportunities highlighted by participants include the ongoing development of regional carbon storage hubs to reduce costs through shared infrastructure, increasing policy

in four pathways assessed by IPCC ranges from zero to more than 1,200 Gt CO_2. IPCC. 2018. *IPCC Special Report on the Impacts of Global Warming of 1.5 °C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty.* V Masson-Delmotte, P Zhai, H-O Pörtner, et al. (eds.). Geneva: World Meteorological Organization. Available at https://www.ipcc.ch/sr15/.

support to deploy CCU and CCS in several countries, and developing business cases and case studies in the context of carbon crediting.

70. Further, it was noted that potential global storage capacity is estimated to exceed 1,000 Gt CO_2, which is greater than the remaining carbon budget.

71. Participants expressed their interest in sharing knowledge and experience of CCU and CCS, particularly on measurement, reporting and verification and the regulatory framework for carbon storage in order to ensure environmental integrity, prevent leakage, mitigate liability and effectively engage with stakeholders. In this context, several guidance resources were mentioned, including the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, International Organization for Standardization standards, IEA best practice guidance and the Global CCS Institute web page. Many participants stated the need for support to build technical capacity in developing countries to assess the feasibility of geological storage sites and the necessary infrastructure.

72. Participants viewed international cooperation as necessary to address challenges, including for developing countries, such as finance, technology development and transfer, and capacity-building. Examples of international cooperation include exploring foreign storage sites owing to lack of suitable domestic geological capacity and providing support to build developing countries' technical capacity in assessing the feasibility of geological storage sites and the necessary infrastructure, including from international organizations and MDBs. The need for international support was highlighted by the LDCs in particular, owing to the small size of their private sectors combined with a lack of financial and technical capacity, difficulty mobilizing domestic resources at the scale needed for the transition and insufficient infrastructure, especially in rural areas.

73. Barriers to deploying CCU and CCS range from high upfront capital costs to capture CO_2 and the energy intensity of the capturing process; long lead times for project development; lack of transport infrastructure for captured carbon; lack of operational experience; limited technical expertise to formulate and implement regulations and standards, and to assess geological storage capacity, particularly in developing countries; and limited geological storage sites in many countries, including SIDS.

74. Participants exchanged views on the potential risks of CCU and CCS technologies. In response to inquiries about the risk of permanence and long-term environmental impact, it was mentioned that CO_2 becomes more secure the longer it is stored geologically and previous assessments by international bodies have confirmed that storage risk is acceptable, and that there are existing regulations and standards for selecting secure geological sites.

75. The legal implications of transboundary shipment of CO_2 were mentioned in relation to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (known as the London Protocol), which has been amended to allow for the cross-border transportation of CO_2 for sub-seabed storage.

76. The need for further policy support such as tax credits, subsidies and carbon pricing to promote private investment was highlighted, alongside collaboration between government, industry, the financial sector and other stakeholders that are crucial to accelerating the deployment of new technologies.

77. Participants exchanged views on the financial costs of CCS and CCU, which often become a barrier to deploying the technology and can range from USD 20/t CO_2 to USD 150/ t CO_2 and beyond depending on several factors, including:

(a) The cost of the carbon capture process, which is often the highest cost component and varies according to the purity and concentration level of CO_2 and economies of scale;

(b) The cost associated with transport, which is generally lower for pipelines but higher for shipping;

(c) The availability and quality of storage sites.

78. In this context, it was stated that the total system cost to reach net zero emissions is estimated to more than double if CCS and CCU technologies are not deployed at gigatonne scale, but others did not share this view.

F. Energy efficiency

1. Summary of discussions and key findings

79. The breakout group discussion was facilitated by Ambrosio Yobánolo del Real, Vice-Chair, TEC, UNFCCC, and supported by Rana Ghoneim.

80. The introductory presentation by Rana Ghoneim highlighted that energy efficiency is a vital building block of the energy transition and climate action. Energy efficiency is estimated to have the potential to contribute 25–40 per cent of the emission reductions necessary to achieve the goal of the Paris Agreement. It was stated that incremental global energy consumption (2016–2021) may have doubled in the absence of current energy efficiency measures. She stressed the need for accelerating the rate of improvement of energy efficiency by tripling annual investments from some USD 300 billion to an average of USD 840 billion in sectors such as industry, buildings and transport through strategic deployment of public finance, development of innovative financing and business models, deployment of de-risking instruments, financing models for small and medium-sized enterprises and counter-guarantee support for energy service companies, and market readiness activities. Energy efficiency is associated with multiple socioeconomic benefits, such as increased economic productivity and competitiveness, energy cost savings, reduced energy dependency, health improvements, gender equality and job creation. It is estimated that jobs related to energy efficiency will increase to 10 million in 2030. It was pointed out that behavioural and lifestyle changes are important for furthering the adoption of energy efficiency technologies. However, despite its numerous benefits, progress on implementing energy efficiency measures at scale is lagging behind the targets set by SDG 7.

81. During the discussions, participants highlighted the need for energy efficiency measures across all sectors, with some suggesting a global goal for energy efficiency and others arguing against such a proposal, stressing the importance of equity and the principle of common but differentiated responsibilities and respective capabilities in the light of considering different national circumstances and of taking into account national development priorities and pathways, noting that decision 4/CMA.4, paragraph 2, states that the outcomes of the work programme will not impose new targets or goals. They stressed that energy efficiency plans and targets should take into account national circumstances and the potential socioeconomic impacts of mitigation measures and indicated that when planning and implementing energy efficiency measures, socioeconomic side effects, including potential environmental impacts of technologies, should be considered to ensure a just transition.

82. Participants noted that although several energy efficiency technologies have been developed, they are not currently recognized worldwide. Participants suggested that promoting bilateral cooperation could be a way of addressing this issue.

83. The cost of energy or energy tax plays a significant role in promoting energy efficiency. As such, it is important for energy to be priced at the right level and incentives to be set for small and medium-sized enterprises and households to boost the affordability and adoption of energy-efficient technologies.

2. Opportunities (including actionable solutions) and barriers

84. Participants mentioned that the scope of energy efficiency should be broadened beyond demand, and other avenues such as energy storage, infrastructure, generation, transmission and distribution should be explored. The scaling up of efficiency action through greater market activity and particularly digitalization, so as to allow for smart control and better energy management, was discussed.

85. Interest was expressed in scaling up the deployment of EVs and shifting towards more efficient public transport systems. Participants underlined that energy efficiency measures could be easily implemented across the residential sector.

86. Participants identified concrete examples of energy efficiency measures as potential opportunities, including district cooling combined with power generation, combined cycle technologies, cogeneration and trigeneration. Given that methane emissions make a substantial contribution to the current and projected rise in global temperature and tackling methane emissions is one of the short-term mitigation strategies identified by the IPCC, it was mentioned that energy efficiency measures in the oil and gas industry could have a meaningful impact.

87. The main barriers highlighted by participants pertained to the high upfront cost of transitioning to a higher rate of energy efficiency, lack of capacity to implement energy efficiency measures, lack of international cooperation on fostering energy efficiency, and financial challenges due to the lack of innovative financial mechanisms and poor access to international climate finance. Other barriers to energy efficiency include inadequate national policy support, inconsistent regulations and limited enforcement mechanisms. The adoption of energy-efficient appliances is often further hindered by the fact that the rating of appliances varies according to a setting's specific conditions, temperature or humidity.

88. Participants also indicated that the development of energy efficiency measures is sometimes limited by lack of access to energy-efficient technologies or the unavailability of energy-efficient appliances, equipment and building materials. Lack of acceptance of these measures and technologies due to people's social and economic background, including factors such as levels of poverty and gender inequality, was also put forward as a key barrier.

89. Possible solutions for addressing barriers to energy efficiency that were shared include behavioural change in consumption patterns through education, awareness-raising campaigns and other outreach activities, as well as the empowerment of women especially at the national level. In addition, developing enabling frameworks may help to ensure private sector engagement in deploying energy-efficient technologies and better exchanges among the public and private sectors and consumers to provide systemic solutions for energy efficiency.

90. Increased international collaboration was indicated as a potential solution for driving knowledge exchange, especially in terms of matching needs with solutions through a knowledge management accelerator as a means of unlocking finance.

G. Policies and measures

1. Summary of discussions and key findings

91. The breakout group discussion was facilitated by Minoru Takada, Team Leader on Energy, Division for Sustainable Development Goals, Department of Economic and Social Affairs, United Nations Department of Economic and Social Affairs, and supported by Richard Kozul-Wright.

92. The introductory presentation by Richard Kozul-Wright highlighted the complexities of the energy transition from both a climate and a development perspective and showed that a wide range of energy policies need to be integrated in a holistic manner to accelerate the just energy transition. A just energy transition is a macro-policy challenge and financing is the key element, with an estimated 6 per cent of global gross domestic product required to meet the goals of the Paris Agreement. Developing countries often lack the necessary policy space for addressing the various limitations and asymmetries hindering the transition, in addition to facing a debt burden that is necessary for development, high interest rates and a lack of international public finance, which act as constraints for the energy transition. It was emphasized that public investment should play a more prominent role in ensuring a just and fair energy transition in developing countries. In both developed and developing countries, the energy transition requires, among other things, a revival of public banks, rethinking of the role of central banks, generation of private investment and development of policy-based

loans. In this context, it was stated that enlarging the fiscal space would require a shift in taxation in both developed and developing countries, a restructure of the international financial system to ensure that sufficient international finance is available for developing countries, and stronger policy coordination to ensure finance flows to developing countries and encourage investment in renewables. There is also a need to address capacity and financial challenges for planning, developing and implementing energy policies and measures, as well as the challenge of policy coordination at the national, regional and international level.

93. During discussions, participants noted that policies and measures for energy transformation should be considered holistically, rather than in isolation or by focusing on a specific sector or region, while ensuring that a balance is maintained between low-emission targets and other development priorities such as job creation. It was noted that there is no one-size-fits-all policy and that policies should be tailored to each country's circumstances. Some participants commented that in this regard, phasing out fossil fuel subsidies can be challenging owing to socioeconomic impacts and broader political considerations.

94. Participants indicated that to generate broad buy-in and participation in terms of implementing domestic policies and measures, it is important to have an inclusive policymaking process with regard to the public and private sectors, local communities, young people and civil society to ensure the development of sustainable policies and measures and stimulate private sector investment. Therefore, policies may be designed in a manner that provides incentives, both fiscal and non-economic, and helps to build trust for adopting new technologies over time in order to overcome the risk of returning to 'business as usual'.

95. Participants discussed the formulation of policies and measures to disrupt fossil fuel investment with a view to reducing the use of fossil fuels and promoting global investment in low-carbon energy. Consideration of equity in policies and measures was also mentioned as an important element to consider.

96. International cooperation was recognized as critical to policy planning and implementation, and to facilitating finance flows. Improving bilateral and multilateral cooperation on energy and mitigation matters was considered an important area for further exploration.

2. Opportunities (including actionable solutions) and barriers

97. Opportunities shared by participants include the development of tailored investment policies for renewable energy that may encompass, as appropriate, feed-in tariffs and tax incentives to encourage the creation of sustainable jobs and other economic opportunities within the renewable energy sector.

98. Participants shared their interest in developing enabling policies and measures to facilitate technology development and deployment. The need to ensure a conducive policy landscape for green projects and infrastructure, with clear targets and streamlined permit procedures, was discussed.

99. Participants discussed the issue of considering a carbon price when developing mitigation policies, given its potential to encourage people to shift from fossil fuels to cleaner technologies.

100. In their interventions, participants noted key barriers that need to be addressed, including the lack of technical capacity and enforcement mechanisms for designing, assessing and implementing policies and measures at the national level, and stressed that the deployment of policies is often a lengthy process as new policies have to pass through various stages of planning, adoption, implementation and enforcement.

101. Another barrier highlighted by participants is the lack of outreach to stakeholders and individuals, which inhibits policy coordination among the various levels and thereby delays the implementation of policies and measures. For instance, the adoption of energy efficiency policies often depends on voluntary individual actions. The need for vertical and horizontal coordination within government, taking into account the strengthening of collaboration among different ministries, was emphasized.

102. Participants discussed challenges with the availability of data on GHG emissions, which often hinder timely implementation of effective mitigation policy measures in the private sector.

103. The lack of policies supporting access to affordable financing was identified by some as another barrier to the just energy transition. Appropriate market systems may be developed, including fiscal frameworks for phasing out fossil fuel use.

H. Financing issues

1. Summary of discussions and key findings

104. The breakout group discussion was facilitated by Youba Sokona and supported by Chienyen Goh.

105. The introductory presentation by Chienyen Goh highlighted climate finance needs, identified by cost type and by region, in quantitative terms. Focusing specifically on sub-Saharan Africa, the cost of financing has increased, reflecting a higher risk profile for the region and for low-income countries. The relationship between debt and investment opportunities was underlined, since as debt burden increases the fiscal space available for investing in climate action decreases. Challenges such as low leverage ratios for low-income economies and uncertainties around economic developments, such as the future of African exports, were highlighted. Blended finance structures offer potential vehicles for the public sector to create investment opportunities for the private sector, but the lack of customization of these structures for low-income countries presents an obstacle. In that regard, the presentation explained, MDBs and development finance institutions often need to alter their business models to take on greater risk. It was noted that exports such as fossil fuels, minerals and metals are key sources of income for many countries, including in Africa, which poses several challenges. Factors such as the uncertainty of fossil fuel demand, the need for critical minerals for renewable energy technologies, the impact of cross-border initiatives on trade relations, and emission-intensive production could play a significant role in the path to decarbonization. Potential solutions were identified, such as introducing carbon pricing mechanisms, attracting investment in green technologies, and enhancing the mobilization of concessional financing, debt relief and resolution, as well as national economic development.

106. In their discussions on financing issues, participants referred to several reports, such as the Synthesis Report of the Sixth Assessment Report of the IPCC,[18] which indicates that sufficient global capital exists to rapidly reduce GHG emissions if existing barriers are reduced; an IEA report,[19] which states that subsidies worldwide for fossil fuel consumption increased to more than USD 1 trillion in 2022; and an IRENA report,[20] which cites that global investment in energy transition technologies, including energy efficiency, reached a record high of USD 1.3 trillion in 2022.

107. Participants indicated that challenges in climate finance access, adequacy and architecture need to be addressed, as they are affecting climate ambition and action. The need for reforms in the global financial system, discussions on new climate finance commitments and tailored approaches that take into account national circumstances and economic realities were underlined, among other needs. Moreover, some participants noted that scaling up mitigation ambition in developing countries is contingent on the provision and mobilization of finance from developed countries, which should be new and additional, predictable and primarily grant-based and concessional.

108. Regarding public and private sources of climate finance, participants noted that public finance is crucial to climate action and an enabler of private sector investment. Some

[18] IPCC. 2023. *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Core Writing Team, H Lee, and J Romero (eds.). Geneva: IPCC. Available at https://www.ipcc.ch/report/ar6/syr/.

[19] IRENA. *World Energy Investment 2023*. Paris: IEA. Available at https://www.iea.org/reports/world-energy-investment-2023.

[20] IRENA. 2023. *World Energy Transitions Outlook 2023: 1.5°C Pathway.* Abu Dhabi: IRENA. Available at https://www.irena.org/Publications/2023/Mar/World-Energy-Transitions-Outlook-2023.

participants highlighted that, even though public finance is essential for climate action, it is insufficient to enable the energy transition, and private sector finance is needed. In that regard, participants shared concerns about current private sector engagement in climate action in developing countries.

109. Participants shared views on the need for reforms in international climate finance. It was stated that the current principles governing the global financial system are not in line with the goals of the Paris Agreement and international climate finance therefore needs reform, particularly with regard to MDBs. Participants reflected on aligning the portfolios of MDBs with the Paris Agreement by, for example, including climate change in balance sheets, redefining risk perception, enhancing grant-based instruments and considering climate risk in projects. One view expressed by participants was that the UNFCCC process is not the correct platform for discussing reform of the global financial architecture.

110. Several participants noted that fossil fuel subsidies should be redirected towards cleaner technologies, while others highlighted the need to consider national circumstances and priorities in that regard. A few participants mentioned that the promotion of technologies such as CCU and CCS might affect the phasing out of fossil fuel subsidies. It was mentioned that the fossil fuel industry should be considered a partner in the energy transition, as the industry is engaging in sustainability practices and supporting communities in some countries.

2. Opportunities (including actionable solutions) and barriers

111. Participants discussed innovative climate finance instruments to be explored as an avenue for countries with high levels of investment risk to access enhanced climate finance. Several participants mentioned blended finance as a useful tool for de-risking investments, while others mentioned debt-for-climate swaps as an instrument that could unlock climate finance.

112. Some participants mentioned the role of NDCs in informing the direction of international finance, noting that NDCs take into account both national economic development and climate action. Furthermore, NDC investment plans can act as a catalyst for projects and opportunities. However, it was also noted that developing investment plans for NDCs will require additional financial and human capital resources that may not be available, and the need for scaling up means of implementation and support was therefore emphasized.

113. Examples were shared of partnerships, support and collaboration, highlighting best practices and lessons learned that can be replicated and scaled up, such as the Just Energy Transition Partnerships; the Clean Energy Transition Partnership; the Danish Energy Agency ‘one-stop shop’ approach; large-scale financing for renewable energy in China; just transition practices for the coal industry in Spain; blended finance platforms in the United States of America; the European Union Emissions Trading System; the multidimensional vulnerability index for vulnerable countries; and the forthcoming handbook on blended finance from the Network of Central Banks and Supervisors for Greening the Financial System.

114. The need for fit-for-purpose climate finance instruments and enhanced enabling environments was mentioned.

115. Participants mentioned that barriers to accessing climate finance often include lengthy and demanding processes and the eligibility criteria of finance providers. A few participants mentioned that some challenges in accessing climate finance are not only technical but also political in nature.

116. Participants stressed that national circumstances, economic realities and existing barriers need to be taken into account when financing climate action. Such barriers often include high public debt levels, high financing costs, high capital costs and high-risk assessments, which hinder investment in climate action and energy transition projects, especially in low-income economies. This is often in addition to the small scale and limited capacities of domestic markets, the private sector and the banking industry, which further affects the resources available for the energy transition. It was mentioned that the timeline

for the global energy transition often puts pressure on poor and vulnerable countries since they experience competing development priorities and challenges, including energy poverty.

117. Participants noted that the current status of climate finance commitments under the Convention and the Paris Agreement presents a barrier. In this regard, it was mentioned that urgent action is needed to close the climate finance gap and prioritize related discussions on the new collective quantified goal on climate finance, taking into account the importance of transparency and the tracking of finance.

118. Financing the technology development and deployment needed for the energy transition was mentioned as a challenge. Several participants stressed that advanced technologies are often planned for or imported without considering national capacity and uptake, and that there is a need to build relevant national capacity and reduce dependence on technological imports. It was also stated that current global deployment rates, including for renewable energy technologies or CCS used in some modelled pathways limiting global warming to 1.5–2 °C, are significantly below the deployment rates provided for in the modelled scenarios, and investment therefore needs to be scaled up in order to increase deployment and achieve the goals of the Paris Agreement. Participants also stressed that national incentives and subsidies for new technologies could negatively affect national budgets.

I. Technology and capacity

1. Summary of discussions and key findings

119. The breakout group discussion was facilitated by Kaveh Guilanpour, Vice-President for International Strategies, Center for Climate and Energy Solutions, and supported by Stig Svenningsen.

120. The introductory presentation by Stig Svenningsen described the key findings of the TEC on enabling environments and challenges for technology development and transfer identified from technology needs assessments, NDCs and technical assistance provided by the CTCN. The most frequently identified challenges for mitigation were economic and financial, followed by technical, legal and regulatory, information and awareness, human skills, institutional and organizational, market conditions, and social, cultural and behavioural challenges. Opportunities to address challenges included multifaceted actions, the role of governments in creating enabling environments through regulatory and institutional frameworks, a combination of market stimulation and human capacity development in developing country Parties, education and training to assist countries in making early-stage decisions on financing, and matching countries' technology priorities. TEC findings were also shared on emerging climate technologies in the energy supply sector and their key characteristics, such as maturity level, probable cost, key applications and probable barriers, and on capacity gaps and needs and relevant recommendations, including customized capacity-building projects based on local needs and levels of skill and knowledge.

121. Participants shared examples of international cooperation, including a technology demonstration project on private investment and expert training by Japan; a technology demonstration project with intellectual property rights licensing support by Norway; a research development programme with international partners by the EU; international cooperation by Denmark with a modelling team to develop a technology catalogue for partner countries to enable them to make more informed decisions; a technology transfer experience by Spain that incentivized best practice and helped to prevent flawed decision-making; the Green Grids Initiative by the United Kingdom of Great Britain and Northern Ireland; and the Just Energy Transition Partnerships by multiple countries.

122. Participants expressed the view that the just energy transition should go beyond changing the composition of energy supply and take into account energy security, affordability and supply reliability, as well as industry and supply chain development, macroeconomic impact and socioeconomic aspects, such as creating local jobs. Reskilling

the workforce, education for new clean energy opportunities and local business development are considered important in that context.

123. Participants highlighted the need for capacity-building for decision makers to plan and implement systematic change, including through developing technology road maps and avoiding high-emission technology lock-in. Participants also mentioned the need to better utilize existing resources, coalitions and organizations, such as the high-level champions, IRENA and the NDC Partnership.

124. While trade and investment promotion were mentioned as facilitating technology deployment internationally, participants raised the issue of exporting cheaper inefficient old technologies, such as used vehicles, from developed to developing countries.

125. On the basis of the experience of technology needs assessments, the need to address challenges in translating the results of assessments and feasibility studies into implementation was underlined. Given the information shared from the TEC, participants expressed interest in learning from the work of the other UNFCCC constituted bodies. In this regard, it was mentioned that the UNFCCC Technology Mechanism could be enhanced through strengthening capacity-building and links to the entities of the Financial Mechanism under the Convention and the Paris Agreement.

2. Opportunities (including actionable solutions) and barriers

126. Participants exchanged views on strengthening knowledge and experience exchanges and discussed information on new technology development through international cooperation, including the role of existing forums such as the Clean Energy Ministerial, Mission Innovation, the TEC, the CTCN and the United Nations regional commissions.

127. New and emerging technologies were mentioned as areas for international cooperation, including grid and storage to integrate a high share of variable renewable energy, CCS, CCU and offshore wind power. In this regard, it was mentioned that many technologies, including carbon removal technologies, need enabling environments to address barriers, facilitate inclusion of these technologies in long-term planning and promote large-scale deployment. To further advance technology development, research and development funding is often critically needed, partly to bring down costs.

128. Participants discussed regional approaches that may present a possible tool for addressing some barriers. Interest was expressed by some participants in organizing a regional dialogue on the margins of regional climate weeks or other regional events.

129. Several barriers and challenges shared by participants are common across countries that differ in terms of region, population size and stage of economic development, including:

(a) The financing of the high initial cost of new and clean energy technologies, such as battery storage, particularly the allocation of cost among stakeholders with limited short-term return on investment;

(b) The requirement to update the whole energy system to be compatible with a high share of renewable energy for energy transition;

(c) The high share of variable renewable energy in power generation, which poses a challenge to grid stability, particularly in countries and regions without the modern grid infrastructure to exploit the full potential of renewable energy;

(d) The transition from existing fossil fuel infrastructure to a system based on renewable energy, which calls for a just transition that includes workforce training to create local jobs associated with clean technologies;

(e) The capacity-building required to train the workforce not only in the energy sector, but also in related sectors that consume energy, as well as the development of endogenous capacities for technology development and transfer;

(f) The need to invest in innovation, given that many key technologies are still in the research and development phase of the technology cycle.

130. Participants discussed barriers and challenges associated with specific national circumstances, including limited land for deploying solar and onshore wind power, in particular in SIDS; limited availability of geological storage for CCS in national territory; lack of economies of scale to attract private investment in small developing countries; requirements for capacity-building in developing countries in order to use new and emerging technologies and develop regulatory frameworks; weak institutional arrangements for interministerial coordination; and the risk of unsustainable technology deployment due to a reliance on foreign companies.

131. Deepening dialogues about barriers, opportunities and actionable solutions, such as technology standards, training, regional grids and economies of scale to attract private finance, was discussed as a possible avenue for generating solutions to technology problems.

J. Sustainable development and socioeconomic impacts

1. Summary of discussions and key findings

132. The breakout group discussion was facilitated by Kirsten Orschulok, Advisor for sustainable and climate-friendly transport policies, German Agency for International Cooperation, and supported by Yin Shao Loong. The aim was to provide information on the linkages between the just energy transition, sustainable development and socioeconomic impacts with a view to engaging participants on issues such as governance, policy alignment, barriers and challenges within this nexus.

133. The introductory presentation by Yin Shao Loong addressed the complexities faced by countries in contributing to global climate goals and sustainable development targets, and therefore balancing decarbonization efforts and costs with other national development priorities. The need to include social protection in sustainable development and energy transition policies was highlighted, as well as the need for coordination and communication between the public and private sectors and local communities through regular dialogue prior to the development of such policies. It was underlined that coordination and communication are crucial aspects of the just transition. As such, the need for a tripartite dialogue between government, workers and business at the national and regional level was stressed. He also discussed the importance of integrating climate-resilient development aspects into energy transition modelling and the reskilling of workforces, including by state-owned firms or through sovereign wealth funds.

134. Participants shared best practices for successful implementation of emission reduction plans to address socioeconomic issues that have involved the transfer of skills from the oil and gas industry to the offshore wind energy sector, and also from the offshore wind sector to the onshore wind sector. The EU highlighted the development of a social climate fund to support measures and investment related to energy efficiency of buildings and decarbonization of heating and cooling in buildings, including the integration of energy from renewable sources, and to improving access to zero- and low-emission mobility and transport.

135. Participants indicated that a holistic approach should be adopted for the just energy transition, balancing climate objectives with national socioeconomic development priorities, including poverty eradication, economic development, energy security and access, alignment with the SDGs, long-term low-emission development strategies and other national development policies and strategies.

136. Participants highlighted the importance of driving private sector investment and stimulating job creation and community development. In this context, tripartite dialogues with government, the private sector and local communities, including Indigenous Peoples, were mentioned in the context of the development of a national policy or strategy for the just energy transition.

137. Participants stated that a just energy transition policy or strategy cannot be a one-size-fits-all solution but should take into account the different circumstances and stages of development of a particular country.

2. Opportunities (including actionable solutions) and barriers

138. In terms of opportunities, participants indicated that a wide range of possible solutions is already available, and that countries should select appropriate policies and measures on the basis of their national circumstances and development priorities, while further avenues should be explored for scaling up just energy transition projects in a sustainable manner and replicating emission reduction plans in different countries to address socioeconomic issues.

139. Participants expressed interest in learning from countries' best practices on economic restructuring, mitigation projects, long-term low-emission development strategies and regulatory frameworks on the just energy transition and in strengthening their modelling capacity to understand the effects of mitigation actions on achievement of the SDGs.

140. It was pointed out that, in some cases, it is challenging to translate national strategies into implementation at the subnational level, often owing to a lack of coordination among public institutions, the private sector and local and Indigenous communities.

141. Participants noted that barriers often include the high upfront cost of implementing just energy transition projects at the national level; lack of energy security and access to energy at the community level; policy uncertainty for just energy transition; lack of governmental support; prioritization of projects leading to short-term economic growth rather than sustainable development; and lack of knowledge or capacity for linking the effects of mitigation actions to the achievement of SDGs.

142. Some actionable solutions proposed by participants for scaling up mitigation ambition and implementation and achieving socioeconomic benefits in addition to the SDGs are:

(a) Strengthening international collaboration to unlock finance;

(b) Promoting stronger collaboration among institutions and the private sector to drive the just energy transition at the national level;

(c) Developing robust national regulatory frameworks for the just energy transition;

(d) Furthering social and inclusive dialogues on the just energy transition and the SDGs and socioeconomic issues;

(e) Promoting the transfer of skills among sectors through continuous education and skills development to ensure job security;

(f) Accelerating knowledge management to bring about behavioural change through the adoption and implementation of technologies in the community, since new technologies create uncertainty and are rarely affordable;

(g) Empowering women to support the just energy transition;

(h) Strengthening regional collaboration with banks and power industries;

(i) Ensuring access to affordable, reliable and sustainable modern energy for all, including by addressing energy shortage and inaccessibility, in the context of sustainable development, equity and poverty eradication.

III. Report on the second global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme

A. Mandate

143. Chapter I above describes the mandate for and background to the second global dialogue under the Sharm el-Sheikh mitigation ambition and implementation work programme.

B. Proceedings

144. The second global dialogue took place in Abu Dhabi from 15 to 16 October 2023, in hybrid format, with 245 registered in-person and 208 registered virtual participants.[21] The dialogue was hosted by the incoming COP 28 Presidency, and its organization was supported by Abu Dhabi Global Market and IRENA. In line with the topic for the dialogues in 2023, the topic of the second dialogue was accelerating the just energy transition in transport systems, including by:

(a) Implementing policies and measures with a global overview and country-specific experience;

(b) Addressing financial, technological and capacity-building needs related to this topic, such as through international cooperation, including with non-Party stakeholders, and the provision of support to developing countries;

(c) Promoting sustainable development and understanding of socioeconomic effects.

145. Following the structure of the first global dialogue, participants discussed opportunities, actionable solutions, challenges and barriers relevant to accelerating the just energy transition in transport systems under the following subtopics:

(a) Deploying and shifting to collective and non-motorized modes of transport (rail, urban public transit, cycling, etc.);

(b) Energy and resource efficiency in the transport sector (design improvements, circular economy and material changes, vehicle vintage, carpooling, etc.);

(c) Electrification of vehicles (infrastructure, batteries and minerals);

(d) Shifting to low- or zero-carbon fuels (hydrogen, biofuels, biogas, compressed natural gas).

146. Opening remarks were made by Adnan Amin, CEO of COP 28, representing the incoming COP 28 Presidency; Francesco La Camera, Director General, IRENA; Nabeel Munir, Chair of the Subsidiary Body for Implementation; and Simon Stiell, UNFCCC Executive Secretary.

147. On the first day of the dialogue, eight technical experts made presentations on opportunities, actionable solutions and technologies relating to the subtopics in the context of the just energy transition in transport systems:

(a) Deploying and shifting to collective and non-motorized modes of transport (rail, urban public transit, cycling, etc.): Amanda Ngabirano, Professor, University of Makerere, Uganda, and former Vice-President of World Cycling Alliance, and Philip Turner, Head of Sustainable Development, International Association of Public Transport;

(b) Energy and resource efficiency in the transport sector (design improvements, circular economy and material changes, vehicle vintage, carpooling, etc.): Karla Cervantes Barron, Research Associate in Climate Compatible Growth, Department of Engineering, University of Cambridge, United Kingdom, and Johan Falk, CEO, Exponential Roadmap Initiative;

(c) Electrification of vehicles (infrastructure, batteries and minerals): Anvita Arora, Program Director, Transport and Infrastructure, King Abdullah Petroleum Studies and Research Center, and Elizabeth Connelly, Lead, Global EV Outlook, IEA;

(d) Shifting to low- or zero-carbon fuels (hydrogen, biofuels, biogas, compressed natural gas): Amer Ahmad Amer, Transport Chief Technologist, Research and Development Center, Aramco, and Gurbuz Gonul, Director, Country Engagement and Partnerships, IRENA.

[21] As footnote 10 above.

148. Following the expert presentations, a World Café session was held to provide the opportunity for more focused interaction between experts and smaller groups of participants. Participants joined 1 of 16 tables, which were divided into four groups of four tables, each group having a specific guiding question. After 45 minutes of discussion, participants moved to a different group. Two World Café sessions were held over the course of the global dialogue, one on each day. This way, all participants were able to contribute to the discussions on each of the four guiding questions. The table below states the guiding question for each group and names the facilitating expert for each table. The results of the discussions at the World Café tables have been integrated into the relevant sections of chapter IV.C below with the breakout group discussions.

World Café sessions: guiding questions and facilitators

Guiding question	*Day 1 facilitators*	*Day 2 facilitators*
Group 1		
Governments face multiple important considerations when developing and updating transport infrastructure, including mobility demand, the transport network and freight logistics. What are the barriers, challenges, opportunities and actionable solutions to ensure optimal public policies and investment for low-carbon urban infrastructure, taking into account different transport modes such as walking, cycling, road and rail?	Table 1: Philip Turner, Head of Sustainable Development, International Association of Public Transport Table 2: Maruxa Cardama, Secretary-General, Stichting Partnership on Sustainable, Low Carbon Transport (SLoCaT) Foundation Table 3: Mohamed Hegazy, Transport Lead, Climate Champions Team Table 4: Christopher Dekki, Senior Specialist, Energy Transition, COP 28 Partnerships	Table 1: Philip Turner Table 2: Maruxa Cardama Table 3: Mohamed Hegazy Table 4: Christopher Dekki
Group 2		
Considering a product's life cycle often guides energy and resource efficiency in international value chains, including dumping of inefficient used vehicles, emissions associated with biofuel production and critical minerals for batteries, what are the barriers, challenges, opportunities and actionable solutions to reduce life cycle emissions of internationally traded transport-related goods, including vehicles, to improve global energy and resource efficiency?	Table 5: Celine Tan, Professor, University of Warwick, United Kingdom Table 6: Romeo Bertolini, Deputy Director and Head of the Bonn Office NDC Partnership Support Unit, NDC Partnership Table 7: merged with table 6 Table 8: Stelios Pesmajoglou, Manager, Mitigation Division, UNFCCC secretariat	Table 5: Celine Tan Table 6: merged with table 7 Table 7: Mareer Mohamed Hunsy, Climate Change Expert, TEC Table 8: Stelios Pesmajoglou
Group 3		
While the number of EVs is rapidly increasing in certain countries, their deployment remains uneven across countries owing to such issues as affordability, charging infrastructure, electricity supply and battery supply chain. What are the barriers, challenges, opportunities and actionable solutions to accelerate adoption of EVs and public transportation and ensure their affordability with financial, technological and capacity constraints, particularly in developing countries?	Table 9: Elizabeth Connelly, Lead, Global EV Outlook, IEA Table 10: Anvita Arora, Program Director, Transport and Infrastructure, King Abdullah Petroleum Studies and Research Center Table 11: Domenik Kohl, Transport Sector Associate, Climate Champions Team Table 12: Amjad Abdullah, Head of Partnerships, IRENA	Table 9: Elizabeth Connelly Table 10: Anvita Arora Table 11: Domenik Kohl Table 12: Amjad Abdullah

Guiding question	*Day 1 facilitators*	*Day 2 facilitators*
Group 4		
Multiple options and technology development possibilities exist for low- or zero-carbon fuels, with various levels of potential for scale and their own set of constraints. What are the barriers, challenges, opportunities and actionable solutions to strengthen synergies and address trade-offs with sustainable development, taking into account the characteristics of a specific low- or zero-carbon fuel?	Table 13: Amer Ahmad Amer, Transport Chief Technologist, Research and Development Center, Aramco Table 14: Gurbuz Gonul, Director, Country Engagement and Partnerships, IRENA Table 15: John Mark Mwanika, Global Labour Institute, and Amalgamated Transport and General Workers' Union/ International Transport Workers' Federation Table 16: Eman Thani Alsuwaidi, Market team lead – Negotiation, Incoming COP 28 Presidency	Table 13: Amer Ahmad Amer Table 14: Simon Benmarraze, Team Lead, Technology and Infrastructure, IRENA Table 15: John Mark Mwanika Table 16: merged with table 15

149. On the first day of the dialogue, the World Café session was followed by breakout group discussions. Participants were divided into four breakout groups to discuss one of the subtopics listed in paragraph 145 above with the facilitators and technical experts assigned to the group. Over the course of the day, all participants were able to join each breakout group and thus discuss each subtopic.

150. The following guiding questions provided a framework for the discussions in each breakout group on the first day:

(a) What are opportunities, best practices and actionable solutions for the just energy transition in the transport sector to urgently scale up mitigation ambition and implementation in this critical decade in each subtopic (collective and non-motorized modes of transport, energy and resource efficiency, electrification of vehicles, low- or zero-carbon fuels)?

(b) What are effective policies and measures implemented from a global perspective and country-specific experience for each subtopic?

(c) How are financial, technological and capacity-building needs addressed for each subtopic?

(d) How are the issues of international cooperation, including with non-Party stakeholders, and the provision of support to developing countries addressed?

(e) How is sustainable development promoted and what are the socioeconomic effects under each subtopic?

151. At the beginning of the second day of the dialogue, the facilitators reported back on the first day's breakout group discussions.

152. Subsequently, seven technical experts made presentations on barriers, challenges and financing issues relating to the just energy transition, specifically in the areas of:

(a) Financing issues: Binyam Reja, Global Practice Manager, Transport Global Unit, World Bank Group, and Celine Tan, Professor, University of Warwick, United Kingdom;[22]

[22] The presentations on financing issues were moved to the start of the expert presentations, and the presentations on the barriers and challenges around policies and measures were moved to the end of the expert presentations owing to technical issues. The summary of discussions in chapter III is presented in the original order of the breakout groups as shown in the agenda for the second global dialogue.

(b) Technology and capacity challenges: Mareer Mohamed Hunsy, Climate Change Expert, TEC, and Roland Roesch, Director, Innovation and Technology Centre, IRENA;

(c) Barriers and challenges in addressing sustainable development and socioeconomic impacts: John Mark Mwanika, Program Officer, Amalgamated Transport and General Workers' Union; Chair of the Urban Transport Committee Gig Economy Working Group and Co-Chair of the Sustainable Transport Working Group, International Transport Workers' Federation; and team member, Global Labour Institute;

(d) Barriers and challenges around policies and measures: Maruxa Cardama, Secretary-General, Stichting Partnership on Sustainable, Low Carbon Transport (SLoCaT) Foundation, and Mahua Acharya, former CEO, Convergence Energy Services Limited, India.

153. Following the expert presentations, the second World Café session was held, which had the same format as the session for day one (see para. 148 above and the table above).

154. The World Café session was followed by breakout group discussions. Participants were divided into four breakout groups on the second day as well. Each group discussed one of the subtopics listed in paragraph 152 above with the facilitators and technical experts assigned to the group. Over the course of the day, all participants were able to join each breakout group and thus discuss each subtopic.

155. One guiding question provided the framework for the discussions in each breakout group on day two: What are the barriers and challenges for the just energy transition in the transport sector to urgently scale up mitigation ambition and implementation in this critical decade, taking into account the subtopics from day one (collective and non-motorized modes of transport, energy and resource efficiency, electrification of vehicles, low- or zero-carbon fuels)?

156. At the closing plenary, the co-chairs of the work programme invited the facilitators of each breakout group on the second day to report back on the discussions. The co-chairs then thanked the participants, experts and facilitators, and declared the second global dialogue closed.

157. The global dialogue was followed by a one-day investment-focused event (see paras. 10 and 13 above). The event's opening session included introductory remarks on accessing finance for mitigation projects. This was followed by presentations on successful case studies of energy transition in the transport sector and then a 'Pitch Hub', where interested Parties shared project ideas with investors, financial institutions and policymakers with a view to getting these projects investment-ready. In the next session, participants discussed issues related to addressing structural barriers to clean energy investment and opportunities for mobilizing investment, and the session that followed focused on different regions. The event can be revisited via the webcast links.[23] Owing to technical problems at the venue, virtual two-way participation was not possible.

C. Summary of discussions and key findings, and opportunities and barriers

158. This subchapter captures views shared during the World Café sessions and breakout group discussions at the dialogue but may not represent an exhaustive summary of all comments made by participants.

2. Deploying and shifting to collective and non-motorized modes of transport

(a) Summary of discussions and key findings

159. The breakout group discussions were facilitated by Philip Turner.

160. The introductory presentation by Philip Turner underscored the importance of deploying and shifting to collective and non-motorized modes of transport to achieving the

[23] As footnote 10 above.

overarching goal of sustainable mobility. As only half of the global population has adequate access to public transportation – and only 16 per cent use public transport – private vehicles are the predominant mode of transport around the world. A reduction in emissions from transportation of 45 per cent could be achieved by doubling public transport capacity, thus investment in public transportation is seen as an effective strategy to reduce emissions. Reflecting this, public transport is mentioned in 67 per cent of NDCs. Promoting active mobility by prioritizing non-motorized modes of transport (e.g. walking and cycling) is a viable option for highly urbanized areas such as cities. Sustainable mobility can be achieved in cities by implementing three key actions: designing cities around mass public transport and active mobility, optimizing road management and establishing innovative and efficient public transport systems.

161. The introductory presentation by Amanda Ngabirano discussed examples of how mobility options have been made more sustainable in cities, particularly in developing countries. The transportation sector accounts for a quarter of GHG emissions worldwide; a share that is expected to increase owing to growing demand for mobility. The negative impacts of increased mobility, including traffic congestion and air pollution, can be mitigated through land-use planning with a focus on non-motorized transport, particularly in city centres and central business districts. Improving the connection of walkways with public transport hubs has the potential to decongest the road network within densely populated inner-city areas. Other public transport modes can then be connected to outer areas of the city, allowing more efficient circulation of private transport. This multi-modality approach improves accessibility for all and results in spatial gains that can benefit social welfare by being used for, for example, recreational facilities.

162. During the discussions, participants emphasized the importance of tailoring transportation policy and technology solutions to the unique needs and circumstances of each country, region and city, including those related to local climatic conditions, geographical features, and socioeconomic and cultural factors. In some regions, for example, extreme temperatures discourage the use of public transport, walking and cycling, whereas in other regions the lack of alternative modes of transport often leads to a high share of non-motorized transport.

163. Some participants highlighted that an integrated, well-designed and holistic transportation infrastructure that includes sustainable transport, non-motorized transport, mixed land use and pedestrian walkways is often lacking in developing countries. Some participants stated that transportation conditions are different in developing countries compared with developed countries and therefore the effectiveness of public transport is city-specific.

164. The role of subnational and local governments in identifying and implementing effective policies and measures was often highlighted by participants because transport infrastructure is closely linked to land-use planning and urban development. The need for aligning national climate change strategies with local transport policies, and challenges therein, was also highlighted. It was also mentioned that low-carbon development of transport infrastructure requires the consideration of many aspects, such as institutional arrangements, technical and engineering standards, project design specifications, investment budget guidelines and innovation.

165. Several participants considered stakeholder engagement as crucial in developing accessible public transport policies and measures and ensuring local acceptance thereof. Local political support was seen as essential to addressing local priorities and ensuring continuity in long-term transport infrastructure investment despite possible changes in government at different levels. Public–private partnerships were often mentioned as a useful approach to developing transport infrastructure.

166. Consideration of social as well as economic factors – particularly the safety of public transport and bicycle lanes, gender disparity in the use of different modes of transport, air quality and private vehicle use as a symbol of economic status – was often mentioned as key to effective policy implementation.

167. Also often mentioned was the need for international cooperation to overcome financial challenges in transport infrastructure development and to remove technical capacity

constraints in the operation of reliable and efficient public transport, particularly in countries with limited resources.

(b) Opportunities (including actionable solutions) and barriers

168. Participants shared their ideas on effective policies, measures and strategies implemented at the national and local (city) level, including reducing congestion by expanding the public transport network and reallocating public spaces, along with increasing public safety for cyclists and pedestrians; expanding cycle networks, with investment in bicycle parking at train stations; developing pedestrian paths combined with public awareness-raising campaigns; developing specialized infrastructure for cycling; developing national strategies to monitor and control mobility volume and optimize infrastructure; reducing rail ticket prices to incentivize frequent travel by rail; and combining regional development with intercity railway routes for passengers and freight.

169. Participants noted areas of ongoing international cooperation, including through initiatives and partnerships, such as holistic mobility planning to improve public transport and active mobility in urban areas particularly and to develop readiness for investment opportunities in developing countries, capacity-building initiatives on active mobility aimed at training cycling experts, financial assistance for purchasing electric buses and behavioural change initiatives geared towards sustainability.

170. Opportunities resulting from shifting to the more sustainable modes of transport mentioned by participants include digitalization and remote work, which reduce daily transportation demand; the growing popularity of e-bikes among young people; a shift in attitudes towards car ownership among young people, many of whom now see it as unnecessary; and a modal shift in freight transport, from road to railway. The conversion of unused spaces into sustainable transport infrastructure, ensuring the involvement of all relevant stakeholders in the decision-making process, was indicated as an actionable solution to advance the just energy transitions in the transport sector.

171. Several barriers and challenges shared by participants were common across many countries that differ in terms of region, population and stage of economic development. These shared barriers and challenges, which offer opportunities for enhanced cooperation, include:

(a) The need for policy coordination among public institutions, both vertically (at the federal, regional and municipal level) and horizontally (ministries beyond transport and climate), to provide a more coherent set of policies and enable an integrated approach to land-use and transport infrastructure planning and management;

(b) The need for holistic solutions in developing integrated public transport, including land-use planning, behavioural change and infrastructure development (e.g. charging stations, smart meters and app-based monitoring for electric buses);

(c) Lack of financing for the development and update of transport infrastructure, including for e-mobility, and the high operational cost of public transport;

(d) Lack of connectivity and accessible transport infrastructure in rural areas;

(e) Increased reliance on personal vehicles arising from concerns about safety during the pandemic, which led to increased reliance on personal vehicles.

172. Barriers and challenges associated with specific national circumstances in relation to promoting collective and non-motorized modes of transport in many regions included an unfavourable cultural perception of public transport, which is often linked to lower socioeconomic groups; personal vehicles being seen as a symbol of status and freedom; concerns about safety and sexual harassment when using public transport, particularly for women and children; divergent standards of public transport arising from private ownership of the various modes in a public transport network; disparity in the quality of the public transport infrastructure across cities; lack of connectivity between different public transport modes (such as train stations and bus stops), leading to the increased use of cars; limited and fixed public transportation routes, which cause inconvenience and make it difficult to carry out daily tasks without a private vehicle; the possible impacts of hurricanes and severe storms

on the safety of public transport systems in island nations; and the lack of political stability to ensure long-term transport infrastructure investment.

173. More specific examples include extreme temperatures and hot and humid climatic conditions as a barrier to promoting walking and cycling; geographical features, particularly limited land, as a barrier to developing dedicated infrastructure such as bicycle lanes; low population density as a barrier to the cost-effective operation of public transport; lack of government control over land use as a barrier to developing transport infrastructure; and obsolete urban design of cities as a barrier to meeting the current needs of residents.

174. Participants highlighted the need for capacity-building and technical assistance to be provided to developing countries, particularly those which lack well-developed public transport systems, including assistance for developing a legal framework and collecting data that enable an assessment of the feasibility of transport infrastructure projects. In addition, participants often alluded to challenges in aligning timelines between the preparation and the implementation of national policy strategies and NDCs.

D. Energy and resource efficiency in the transport sector

(a) Summary of discussions and key findings

175. The breakout group discussions were facilitated by Ghanim Hableel, Senior Climate Negotiator, Mitigation and Response Measures, incoming COP 28 Presidency.

176. The introductory presentation by Karla Cervantes Barron highlighted the role of resource efficiency in reducing GHG emissions from the production and consumption of energy and materials in the transport sector. Several options to enhance energy and resource efficiency in the transport sector were discussed, including demand reduction, a shift to public transport and improved efficiency of each transport mode. While electrifying vehicles and decarbonizing electricity reduces emissions, the current trend of large car sizes will lead to more emissions and material use – building electric sports utility vehicles (‘SUVs’) rather than electric cars of medium size requires 57 per cent more material. Adopting the circular economy approach is an opportunity to make the design and manufacture of EVs more efficient and sustainable, including through design innovations (reduction in raw material and energy use), consideration of vehicle attributes (reduction in car size and compliance with efficiency standards) and use of low-carbon materials. Local authorities can explore alternative mobility options (e.g. car sharing and low-carbon transport networks) and realign waste management practices to focus on reuse and recycling.

177. The introductory presentation by Johan Falk highlighted ways to scale up policies and solutions in order to halve transport emissions by 2030. The point was made that success will not be found in one-size-fits-all solutions, but rather in combinations of strategies that reflect the demands of the population and socioeconomic realities. For example, EVs are highlighted as a targeted solution. Their sales have grown exponentially since 2015 and are forecasted to surpass 14 per cent of total personal car sales in 2023. If such trends continue, EVs are projected to comprise 80–90 per cent of new vehicle sales in 2030. Nevertheless, the electrification of vehicles will not be enough to reach net zero goals – that will necessitate an overhaul of the entire value chain, following the principles of the circular economy and continued investments in greening the power grid, increasing the use of renewable energy sources, promoting car sharing and providing mobility as a service. Combining these strategies with initiatives targeting behavioural change and policies will help to ensure energy efficiency in the transport sector. Case studies of cities with best practices in integrated transport solutions – Bogotá, Oslo and Stockholm – were presented.

178. Participants shared their ideas on effective policies and measures for increasing resource efficiency, one of which was a vehicle deposit system in which a payment is required as a deposit at the time of every new vehicle purchase and is reimbursed to recycling and scrapping companies on disposal of the vehicle. Other examples shared were extended producer responsibility, which would require manufacturers to take responsibility for how their vehicles are disposed of and recycled at end of life; compulsory registration of vehicles owned by local authorities as a complementary measure to manage their end of life; and

efforts to regulate the export of inefficient old vehicles from developed countries to developing countries through international regulatory measures.

179. Upgrading energy efficiency standards, promoting energy-efficient driving and developing a platform for information on energy efficiency were mentioned as examples of effective policies and measures for increasing energy efficiency. Some participants highlighted the role of clear local goals, strategies and local targets in national circumstances to promote resource and energy efficiency while other participants did not agree with this view and stressed that there is no one-size-fits-all solution.

180. The importance of comprehensive life cycle assessment, particularly for EVs and biofuels, was underlined by participants with reference to the cross-border supply chain. It was noted that solving a transportation problem in one country can create a different problem in another country along the supply chain (e.g. deforestation, need for disposal of EV batteries, and mining of critical minerals).

181. Participants called for more international cooperation between technology exporters and importers because many countries that have to import all vehicles owing to the lack of domestic vehicle manufacturing capacity are required to follow technical standards set by foreign manufacturers. Global policy coordination was mentioned as a way to prevent old, inefficient vehicles from being exported to developing countries where necessary spare parts are sometimes not available locally. The need for data on and measurement of the carbon footprint of products to ensure international consistency was highlighted.

182. Some participants also highlighted that, owing to different capacities among countries, additional support and innovation are required in order to make use of available energy efficiency measures, taking into account common but differentiated responsibilities and respective capabilities in the light of different national circumstances.

(b) Opportunities (including actionable solutions) and barriers

183. The opportunities around resource and energy efficiency mentioned by some participants include:

(a) The implementation of digital and smart transport systems to improve transport efficiency;

(b) A circular economy approach to transport systems and associated business innovation, including battery recycling, EV leasing schemes, smaller vehicle use, carpooling to reduce road congestion and reusing asphalt pavements for road construction;

(c) The upgrading of energy efficiency standards for various types of vehicles, including locomotives;

(d) Behavioural change by consumers;

(e) International cooperation on setting standards for sustainable fuels.

184. The barriers to resource and energy efficiency mentioned by some participants include:

(a) Insufficient transport-related data and local capacity to develop comprehensive projects addressing energy efficiency and resource efficiency;

(b) Lack of technical capacity and infrastructure for handling electronic waste, which often necessitates its shipping to other countries, leading to increased costs;

(c) Limited financial returns from the retrofitting of existing vehicles;

(d) The trade-offs, which would need further consideration, associated with encouraging the use of existing internal combustion vehicles until the end of the product lifetime to reduce material consumption and promoting the adoption of EVs to reduce GHG emissions from vehicle operation.

E. Electrification of vehicles

(a) Summary of discussions and key findings

185. The breakout group discussions were facilitated by Anvita Arora and Elizabeth Connelly.

186. The introductory presentation by Anvita Arora discussed mechanisms for accelerating the just energy transition in transport systems. The 'avoid-shift-improve' approach was introduced as part of a broader strategy to achieve sustainable mobility. Countries should prioritize an approach that avoids or reduces the need for motorized travel and that enables a shift to more sustainable modes of transport, which can significantly reduce emissions at a lower cost than an approach that involves improving transport modes, such as electrification, and boosting operational efficiency. Moving from internal combustion engine cars to internal combustion engine buses is estimated to lead to larger CO_2 emission reductions than moving to EVs. Analysis has shown that subsidizing EVs in some places is an expensive way to decarbonize the transport sector, including because of the intensive mining activities required to extract critical minerals. A multidimensional perspective that takes into account product life cycle and a circular economy approach is needed to develop integrated transportation decarbonization policies that look beyond exhaust pipe emissions. Vehicle technologies, including alternative fuels, should be part of a wider strategy. To recognize differences across countries, decarbonization pathways need to be context- and country-specific. A just and equitable implementation of pathways to the electrification of transport should include life cycle analysis, consider the broader context in managing competing priorities, and prioritize the electrification of mass transit and shared mobility.

187. The introductory presentation by Elizabeth Connelly provided an overview of the global EV industry. In 2022, electric car sales exceeded 10 million units, and the trend of strong sales is expected to continue as cheaper EV technologies become available. Electric car sales grew globally by 55 per cent in 2022. Sales were led by China, Europe and the United States, but a growing trend in sales was also observed in emerging economies such as India, Indonesia and Thailand. The electrification of vehicles is not confined to two- and three-wheelers and medium-sized cars, with sales of electric buses and trucks also picking up at a steady rate. Globally, public charging infrastructure is keeping up with the demand from increased EV sales. The number of available charging stations for light-duty vehicles increased by 55 per cent in 2022, with China, Greece, India and the Republic of Korea surpassing the global average. An increase in battery material prices in 2022 had an impact on EV prices, but EV prices tend to be stable owing to the introduction of alternative battery chemistries. Nonetheless, reliable battery supply chains are essential to the planned transition to EVs and their capacity could grow fourfold by 2030 if recent announcements of expected capacity increases are realized.

188. During the discussions, participants noted that, while the political momentum towards decarbonization has accelerated the uptake of EVs in some countries, barriers to wider deployment exist, especially in developing countries, such as the high upfront cost of EVs, limited EV model availability, inadequate charging infrastructure, the lack of a clean, stable electricity supply, and the current battery supply chain, coupled with the need for sustainable waste management of batteries and recycling processes. The need to ensure energy access and affordable energy for all before moving to electrification of the transport sector in developing countries was emphasized, with references made to competing priorities to electrify households, ensure adequate power grid capacity and improve energy security.

189. Some participants mentioned the use of financial incentives, including subsidies, preferential loans, tax incentives and public procurement, as an effective policy or measure to advance the electrification of vehicles, whereas other participants considered such fiscal measures as not feasible in many developing countries owing to government budget constraints and stressed the need for further cost reductions to ensure affordability.

190. Participants underlined that a one-size-fits-all solution is not feasible for implementing the transition to EVs because of different national and regional circumstances, different economic realities and disparities in production capacities. Some participants

highlighted the need to also consider the principles of equity and common but differentiate responsibilities and respective capabilities in the light of different national circumstances.

191. Several suggestions for effective policies and measures were put forward, including:

(a) Designing national-level strategies and clear road maps to enhance coordination among different government agencies, subnational and municipal governments, and the private sector;

(b) Applying holistic approaches to integrate the use of EVs into broader sustainability and energy policies, including those for renewable energy supply, power grid expansion and energy storage;

(c) Prioritizing the electrification of public transport vehicles, such as buses, over that of private vehicles to yield greater benefits;

(d) Linking EV development with clean electricity supply;

(e) Taking life cycle and circular economy perspectives to ensure sustainable EV value chains, from the extraction of raw materials to end of product life;

(f) Developing long-term plans to facilitate public and private partnerships and stakeholder engagement, including car dealers, local communities and manufacturers, to expedite EV uptake and infrastructure development, including through addressing financial and technological gaps;

(g) Implementing awareness-raising, training and capacity-building activities in parallel with evolving technologies and infrastructure.

192. The socioeconomic aspects of vehicle electrification mentioned by participants include positive impacts on public health due to improved air quality, especially in areas with a high volume of traffic; the need for reskilling to address job losses in the conventional transport vehicle industry; and the linkage between energy access, clean electricity supply and electric mobility.

193. International cooperation on information exchange, awareness-raising, and technology development and transfer was highlighted by some participants, who referred to positive experiences in some developing countries. The need for enhanced support on finance, technology cooperation and capacity-building for developing countries was also underlined by some participants. Participants raised concerns about the export of inefficient, used internal combustion engine vehicles to developing countries as EV uptake increases in high-income countries. The need for fair competition based on a non-discriminatory and predictable market environment to promote innovation, trade and investment was mentioned by some participants, given that the development and deployment of EVs is still at an early stage.

(b) Opportunities (including actionable solutions) and barriers

194. The opportunities around the electrification of vehicles mentioned by some participants include:

(a) Economic growth from the mining of critical minerals, battery production and the local EV manufacturing value chain;

(b) The charging of electric two- and three-wheelers with solar power, particularly in countries with a high potential for solar energy;

(c) The electrification of public transport, combined with stakeholder engagement, to alleviate traffic congestion, improve air quality and enhance accessibility;

(d) The growing focus on innovation, research and development, including for local solutions.

195. The barriers to enhancing the electrification of vehicles highlighted by some participants include:

(a) Lack of access to financial resources to develop infrastructure, including a sufficient number of charging stations, particularly in high-density, low-income cities and many developing countries; a stable, clean electricity supply; and an adequate power grid;

(b) Lack of technical capacity to deploy charging stations and ensure the safety of EVs;

(c) Certain characteristics of EVs compared with internal combustion engine vehicles, including the higher upfront cost, need for charging time, shorter distance coverage and lack of vehicle variety to meet local geographical requirements;

(d) Job losses in the conventional transport vehicle industry;

(e) Limited information on and awareness of EVs, including the fear of battery explosion;

(f) Lack of electricity access by the population and insufficient grid capacity to accommodate EV charging.

F. Shifting to low- or zero-carbon fuels

(a) Summary of discussions and key findings

196. The breakout group discussions were facilitated by Gurbuz Gonul and Amer Ahmad Amer.

197. The introductory presentation by Gurbuz Gonul provided an overview of the current global shift towards low- and zero-carbon fuels. According to the IRENA publication *World Energy Transitions Outlook 2023*, in 2020, modern biomass use accounted for only 1 per cent of global total final energy consumption, and the shares of green hydrogen and its derivatives were very small. Liquid biofuel, hydrogen, synthetic kerosene, green ammonia and green methanol are expected to contribute to emission reductions in the transport sector towards 2050, with the electrification of vehicles likely to be the largest contributor to reductions. However, only a limited number of NDCs mention biofuels and hydrogen as alternative fuels for reducing transport sector emissions. The presentation outlined the opportunity of greening heavy-duty road freight – particularly heavy-duty trucks on long-haul trips, which generate most road freight emissions – through transitioning to low- and zero-carbon fuels such as biomass-based diesel substitutes, biogas and biomethane. Policy support to improve technology readiness would accelerate the use of advanced biofuel and e-fuel[24] options, which will mature at different paces.

198. The introductory presentation by Amer Ahmad Amer highlighted the potential role of e-fuels in enabling a resilient mobility transition. The need to decarbonize the transport sector and reduce emissions is met with the challenge of rising transport energy demand due to population growth and increasing wealth in emerging economies. Energy-dense liquid e-fuel could facilitate the electrification of transport thanks to its ability to act as a portable renewable electricity storage medium. In order to scale up the use of e-fuels, a clear incentive scheme for the private sector to invest in renewable energy sources is needed, together with stringent yet achievable GHG intensity reduction targets. The use of hybrid e-fuels (a blend of 5 per cent e-fuels with conventional fuels), which have the potential for reducing annual emissions by 60 million t CO_2, could be an initial step towards the broader use of e-fuels. The costs of synthetic e-fuels vary in different regions; for example, e-kerosene is cheaper in the Middle East and North Africa and in Southern Europe. The speaker noted that countries should focus on emission reductions and not on technology elimination when considering e-fuel production and use.

199. Participants discussed the potential role of low- and zero-carbon fuels in transport sector decarbonization, particularly in heavy-duty transport, aviation and maritime transport. Given the unique opportunities, challenges and strategies related to the transition to low- and zero-carbon fuels, participants underlined the importance of context-specific solutions, based

[24] E-fuels are made by synthesizing captured CO_2 emissions and hydrogen produced from renewable or CO_2-free electricity.

on national circumstances, available infrastructure, capabilities and international cooperation.

200. While some participants considered compressed natural gas a feasible option for low-carbon fuel, other participants questioned its viability. Some participants expressed that electrification of road transport should take precedence over the use of low- and zero-carbon fuels owing to the immaturity and high cost of many of these fuels, while other participants argued that the use of low-carbon fuels is necessary, referring to GHG emission reductions achieved at a low cost in their countries, together with a sustainability co-benefit of improved air quality.

201. Raising awareness about new low- and zero-carbon fuels was considered key to facilitating their adoption, together with developing effective policies and measures around infrastructure, implementing national road maps for deploying low- and zero-carbon fuels, providing market-readiness support, promoting the use of different fuels, and considering agricultural land use and the biofuel supply chain in land-use planning. The need to adopt a full life-cycle approach to ensure holistic accounting of all GHGs was highlighted by some participants as a way to ensure an optimal combination of solutions enabling the shift to low- and zero-carbon fuels and to minimize socioeconomic and environmental impacts being shifted across sectors.

202. The need for international cooperation, including peer-to-peer exchange through regional dialogues and South–South cooperation, was underscored by participants as being crucial to addressing the challenges related to low- and zero-carbon fuels, such as high production costs, technical capacity constraints, lack of regulation and lack of awareness. The need to develop standards and certification for low- and zero-carbon fuels, including from a carbon intensity perspective based on a life cycle approach, especially for green hydrogen, was highlighted by one participant.

203. In order to reduce the cost of low- and zero-carbon fuels, several ideas and solutions were mentioned by participants, including the co-processing and co-feeding of intermediate energy carriers in existing refining assets with minimal complexity and retrofit cost, scaling up production driven by growth in demand initially coming from aviation, to improve learning and reduce the associated costs, and processing such fuels in countries with high levels of renewable energy.

204. Synergies and trade-offs related to low- and zero-carbon fuels were discussed, with participants highlighting the socioeconomic aspects, including the need for reskilling and training to address potential job losses and the need for life cycle and socioeconomic impact analysis, particularly for biofuels owing to their potential negative impacts (which may include decreased food security, land degradation and deforestation). Some participants mentioned a potential complementarity between synthetic e-fuels and biofuels, as both can be blended with conventional fuels to reduce carbon intensity while providing time for scaling up production to meet demand, considering limited feedstocks for biofuels globally and balancing competing demand for land use. Energy security due to diversified energy sources was noted as a co-benefit of the use of low- and zero-carbon fuels.

(b) Opportunities (including actionable solutions) and barriers

205. Participants shared examples of opportunities for scaling up the deployment of low- and zero-carbon fuels:

(a) Advances in research and development, including those achieved through international cooperation, can lead to lower costs of low- and zero-carbon fuels and lower life cycle emissions of synthetic fuels;

(b) The use of synthetic fuels can bring down the energy transition cost since existing infrastructure is used, including through their blending with existing fuels;

(c) Countries with lower production costs could find new trade opportunities through low- and zero-carbon fuels such as green hydrogen;

(d) Under the food–waste–energy nexus, and with holistic planning approaches, organic food waste and waste from the timber industry offer the potential to scale up biofuel production without risking food security;

(e) Enhanced energy security can be realized through the development of domestic low- and zero-carbon fuel sources;

(f) Strengthened engagement and partnerships with stakeholders, particularly those involving the private sector such as public–private partnerships, could make investing in low- and zero-carbon fuels and related infrastructure more attractive;

(g) Applying appropriate pricing and removing fossil fuel subsidies could promote low- and zero-carbon fuels;

(h) Taking advantage of all relevant sources, technologies and approaches to identify solutions based on national circumstances, available infrastructure and capabilities.

206. Participants often highlighted concerns about high upfront costs and general affordability, which were seen as barriers to the wider adoption of low- and zero-carbon fuels, particularly in countries with limited financial resources and those lacking production capacity for such fuels. Financing barriers mentioned by participants include limited finance available from international public finance institutions for implementing low- and zero-carbon fuel projects, lack of finance for new infrastructure development, and lack of financial instruments to de-risk private sector investments.

207. Other barriers mentioned by some participants to scaling up the use of low- and zero-carbon fuels include:

(a) Lack of legal frameworks, including regulations, standards and certification procedures, to define or qualify low- and zero-carbon fuels;

(b) Absence of political commitment from leaders and clear road maps;

(c) Limited awareness, limited technical expertise and challenges related to technology transfer.

208. As several low- and zero-carbon fuel options are nascent technologies with their own set of constraints and challenges, several participants mentioned that each low- and zero-carbon fuel has economic, technological and environment constraints and challenges, including high cost, the need for a technology breakthrough to increase safety, low energy density, a supply shortage owing to limited resources and a trade-off with biodiversity. In this context participants highlighted:

(a) Limited feedstock potential for biofuels arising from the risks biofuel production poses in terms of reduced food security and increasing food prices, land degradation, deforestation, biodiversity loss and competition for water resources;

(b) An energy-intensive production process for hydrogen, as well as storage difficulties and safety concerns.

2. Policies and measures

(a) Summary of discussions and key findings

209. The breakout group discussions were facilitated by Maruxa Cardama.

210. The introductory presentation by Maruxa Cardama covered global dynamics in deploying and shifting to collective and non-motorized modes of transport. Most of the world's population lacks access to affordable, safe and sustainable transport, while demand for mobility services continues to rise, a situation that has led to increasing energy demand and GHG emissions. Globally, two thirds of passenger journeys between 2018 and 2022 were made by private car, which highlights growing concerns about traffic congestion and related health issues (premature deaths attributed to particulate matter 2.5 from road transportation contribute to around 5 per cent of total premature deaths, with regional disparities). Despite the increasing deployment of EVs and renewable energy, EVs still have only around a 1 per cent share of the global vehicle fleet, and only a quarter of EVs are fuelled by electricity from

renewable sources. Informal transport modes, despite being used for travel by millions of people in urban areas, are largely ignored by governments, generating large gaps in policy, knowledge and data. The vast majority of roads worldwide are not safe for cyclists and pedestrians. These barriers reinforce dependence on private vehicles. An integrated, inter-modal and multidimensional transport approach is one that provides opportunities for improving access while avoiding unnecessary motorized trips; shifting to modes that are less carbon and energy intensive; and improving vehicle design, energy efficiency and renewable and zero-emission energy sources.

211. The introductory presentation by Mahua Acharya focused on the challenges and opportunities faced by countries in moving from the current model of owning and operating vehicles to mobility as a service, including through electric buses. Barriers to rolling out electric buses include limited skills, capacity of and technologies used by local manufacturers, limited financial capacity of bus operators, reduced distance able to be travelled owing to road congestion, insufficient charging infrastructure and grid capacity, high capital costs for initial investment, and institutional fragmentation. Nevertheless, these barriers provide opportunities for a holistic, integrated approach in transitioning to electric buses. Firstly, particularly in new cities, all initiatives contributing to the transition should ideally be part of the broader land-use planning process to ensure that all infrastructure and related services are interconnected and function efficiently. Secondly, projects should be adapted to local conditions, including through consultative processes involving national and local authorities, the private sector, non-governmental organizations, academia and civil society. Finally, all government offices involved in the transition should be given specific tasks, which should then be centrally coordinated by a project management office, to resolve the barrier related to institutional fragmentation and to avoid the duplication of effort.

212. The importance of applying a tailored, holistic approach to the transition to sustainable transport systems, taking into account multiple policy areas, including urban development, transport and energy, was underscored by participants, as was the importance of engaging with various stakeholders, including private sector actors, local governments and individuals.

213. In this context, the needs to establish institutional arrangements for planning and implementation, as well as to mainstream climate change mitigation in other policy areas, were highlighted as crucial to addressing the fragmented landscape of policies and measures developed in isolation by national, subnational and local governments. Participants mentioned the value of policy replication, learning and efforts to support the capacity of local governments, including through city-to-city collaboration.

214. Some participants stressed that the mandate of the work programme is not to impose new targets or goals and that the approaches to develop, plan and implement policies and measures will vary across countries, as they need to align with specific national priorities and circumstances. Others highlighted that each country would need to determine its own set of policies and support measures in order to avoid unsustainable socioeconomic impacts.

215. Participants mentioned the benefit of applying a combination of policies and measures in order to align different policies and different areas of policymaking, including those relating to regulation, public procurement, infrastructure development and taxation. Raising public awareness about existing policies and measures was considered key to their successful implementation. The potential of fiscal measures, including subsidies and tax incentives, to encourage behavioural change towards emission reduction was noted.

216. The interdependence between policy implementation and financial resources, access to technology, and technical and policymaking capacity was emphasized by participants, indicating that many policies cannot be implemented without sufficient finance, appropriate technology and adequate capacity. The role of international cooperation in enabling policy implementation with adequate financial and technical support was highlighted. In this regard, some participants mentioned the need to create a predictable and enabling international environment to enhance international cooperation.

(b) Opportunities (including actionable solutions) and barriers

217. Opportunities in relation to policies and measures mentioned by some participants include:

(a) The development of national road maps and the sending of clear policy signals at the national level to direct policies, measures and investment in a coordinated manner that reflect national priorities and circumstances, including those that involve long-term energy planning;

(b) The identification of suitable policies and the prevention of their premature implementation through technical assessment;

(c) The use of voluntary international initiatives to pilot and support transport decarbonization, while recognizing that any party may join an international initiative on a voluntary basis, as there is no one-size-fits-all solution;

(d) Regional-level policy cooperation, including through regional institutions and harmonized regulation;

(e) Private sector efforts to make sustainability a competitive advantage.

218. Barriers to the planning and implementation of policies and measures mentioned by some participants include:

(a) Lack of data such as proper energy balances;

(b) Political instability (cases were mentioned where policy initiatives and investments were cancelled simply because they were proposed by the previous administration);

(c) Outdated measures, particularly when new technology becomes available;

(d) Inadequate urban planning;

(e) Lack of resources, particularly finance, making long-term investment planning difficult.

3. Financing issues

(a) Summary of discussions and key findings

219. The breakout group discussions were facilitated by Celine Tan.

220. The introductory presentation by Celine Tan provided an overview of the costs of a just energy transition in the transport sector. Costs can be differentiated as being specific to financing transport projects, to mitigating the impacts of transition on affected communities or to enhancing the adaptive capacity of communities. Access to and availability of financial resources is key to scaling up ambition and implementation of a just energy transition. Financial institutions should consider the disproportionately high costs of finance for developing countries, particularly for the LDCs and SIDS. The high costs of unjust, disorderly energy transition, combined with technology transfer, capacity-building and sustainable development needs, should also be taken into account. Barriers to financing just energy transitions include financing needs exceeding the capacities of national budgets; regulatory and financial risks due to reliance on debt instruments and private finance; risk of fragmented investments that are not aligned with national policy plans; limited financing and limited social and economic safeguards; and technology and capacity-building requirements. To overcome these barriers, financing the just energy transition must be part of a broader package of reforms to the current system of global economic governance and international economic law. Moreover, financial instruments and terms of financing should be aligned with national climate action plans and the SDGs to strengthen country ownership and drive mitigation ambition.

221. The introductory presentation by Binyam Reja discussed challenges and opportunities with respect to financing issues related to energy transition in the transport sector. The World Bank's approach is based on the 'avoid-shift-improve' approach, which highlights active mobility through human-centred urban planning. Electrification alone will not be enough to reach decarbonization targets. EV policies need to be embedded in a comprehensive national sustainable transport strategy. Concerning demand-side barriers, the vehicle sales market is often fragmented and does not have large enough demand to attract investment or lending. Small investments can lead to high transaction costs. Governments have limited fiscal space

to support public transport investment, particularly in developing countries. Regarding the supply side, domestic financial institutions perceive investments in the transport sector as high risk owing to the largely informal and poorly regulated mobility and logistics sector. Establishing a regional facility is recommended to aggregate fragmented, small-scale investments into a sizeable programme that can be attractive to investors and financial institutions. Furthermore, such a programme would reduce transaction costs, which could increase participation by individual borrowers.

222. Given the significant gap between required finance and available funding and investments, participants highlighted the urgent need for tailored financing and investment solutions and suitable financing mechanisms to address this and other financial challenges, including debt-related barriers in developing countries. The high initial cost for transport infrastructure and facilities, long payback periods, lack of a mechanism to help ensure a suitable level of profit and low return on investment in the transport sector were mentioned as constraints for the just energy transition. Noting the high upfront costs of EV and relevant infrastructure, participants mentioned inclusivity, fairness and affordability as important considerations, and that many of the discussed solutions are not possible without adequate access to finance tailored to national circumstances.

223. Participants emphasized the important role of transport in development and the need for financing, including the need for public finance to mobilize private capital, including through blended finance and public–private partnerships, especially in regions that are not usually prioritized by private entities, together with the need for governments to provide assurance to the private sector regarding new technologies. The importance of country-level efforts was mentioned, including the establishment of a green finance entity, sustainable bonds and taxonomy, and the use of national road maps to attract investment. The need for global investment signals was also highlighted, as was the need to address debt burden in many developing countries and to consider equity and common but differentiated responsibilities and respective capabilities in the light of different national circumstances and the need for developed countries to provide adequate and predictable support to developing countries to allow for a just transition in the transport sector.

224. While some participants were in favour of a carbon tax as a revenue source for the government, other participants expressed concerns about its potential to create political challenges and trade barriers.

225. The importance of comprehensive cost–benefit analysis was highlighted by participants, including analysis of investment costs, debt levels and the costs of inaction; risk analysis; analysis of the difference between short-term gains and long-term benefits; and life cycle assessment.

(b) Opportunities (including actionable solutions) and barriers

226. Opportunities related to financing issues mentioned by some participants include:

(a) The exploration of debt forgiveness as a reset mechanism;

(b) The creation of new market opportunities from carbon credit trading;

(c) Repurposing of fossil fuel subsidies;

(d) The exploration of government partnerships with international financial institutions and international initiatives to increase financial support for developing countries.

227. Several barriers and challenges to financing that are common to many countries were highlighted by participants, including:

(a) Increased capital costs and high debt levels following the pandemic;

(b) Budgetary constraints due to competing policy priorities.

228. Barriers and challenges to financing associated with specific national circumstances mentioned by some participants include:

(a) Reluctance from the private sector to invest owing to the lower return on investment as a result of a sparce population and a small market size;

(b) Currency exchange risk due to foreign currency finance;

(c) The long time frame and prolonged efforts required to access international finance coupled with limited availability of domestic finance;

(d) The potential for investments in certain biofuels to become obsolete owing to shifts in the market environment;

(e) The disproportionately higher cost of finance and debt and the high level capital required for transport projects pose challenges for many developing countries and can affect the implementation of the just energy transition.

4. Technology and capacity challenges

(a) Summary of discussions and key findings

229. The breakout group discussions were facilitated by Mareer Mohamed Hunsy and Simon Benmarraze.

230. The introductory presentation by Roland Roesch highlighted the fact that while many NDCs mention transport targets, few have specific long-term targets aligned with net zero goals. Systemic innovation is key to accelerating the just energy transition. The *Innovation Landscape for Smart Electrification* report[25] published by IRENA in 2023 identifies 100 innovations that can play a role in decarbonizing the energy use sector. The speaker mentioned the main barriers to energy transition as being the costs of EVs and charging infrastructure. Several potential blind spots were highlighted, including those relating to smart charging, which does not necessarily mean bidirectional charging; development of charging infrastructure, which should not mimic petrol stations or focus only on fast charging; charging infrastructure, in terms of standardization and interoperability; EV charging infrastructure deployment, in terms of inclusiveness and reflection of local circumstances; electrification strategies, in terms of taking into account mobility trends; EV charging points, in terms of co-location with solar generation to minimize their impact on grids; and maintenance of charging infrastructure by state agencies, in terms of coordination and consistency.

231. The introductory presentation by Mareer Mohamed Hunsy described the importance of climate technologies in providing solutions for sustainable road mobility. Climate technology refers to any equipment, technique, knowledge or skill needed to reduce GHG emissions. An analysis of technology needs assessments and technical assistance provided under the CTCN revealed that economic and financial challenges are the dominant technology-related challenges, and they are seen as relevant to 84 per cent of technologies.[26] Common capacity-related challenges include limited information and awareness, technical skills and human capacities. A TEC publication on deep decarbonization technologies for sustainable road mobility[27] summarizes the opportunities, barriers and policy options for plug-in EVs, fuel-cell EVs, advanced biofuels, shared mobility and fully automated vehicles. For example, barriers to plug-in EVs include the lack of supporting infrastructure such as charging stations and, in many countries, grid networks. The production process for advanced biofuels is not yet optimized owing to the lack of compatible vehicle stock and impacts on food prices and food security. The concept of shared mobility has not been fully explored owing to prevailing customer preferences for private transport modes.

232. The need for commercially viable, affordable and proven technologies was underscored by participants, particularly for countries without manufacturing capacity that depend on imported technology. Although technologies are available, many are in the early stages of implementation.

[25] Anisie A, Jimenez Navarro JP, Antic T, et al. 2023. *Innovation landscape for smart electrification*. R Roesch (ed.). Abu Dhabi: IRENA. Available at https://www.irena.org/Publications/2023/Jun/Innovation-landscape-for-smart-electrification.

[26] See TEC document TEC/2021/23/9.

[27] See TEC document TEC/2022/25/8.

233. The need for international cooperation, including through partnerships and support, to facilitate access to technologies and strengthen local capacities, including institutional arrangements for policy implementation and technology deployment, was also highlighted. International cooperation was also mentioned as a way to achieve economies of scale for emerging technologies, including by aggregating demand beyond a specific country. Some participants emphasized the need for international standards to ensure the universal compatibility and safety of technologies such as those involved in EV charging.

234. Participants indicated the value of raising public and policymaker awareness of clean technologies to increase their social acceptance, enable behavioural change and identify feasible, practical solutions for specific countries and regions.

235. Participants mentioned that there is no one-size-fits-all approach to developing the right technology pathway, but that combinations of different modes of transportation, technologies and policy approaches need to be pursued, based on national, regional and local circumstances. Taking a holistic view and considering cross-sector collaboration throughout the value chain for just energy transitions was highlighted by participants as being important to identifying and deploying technologies suitable for national circumstances, including technologies for manufacturing and other areas such as power grid capacity, charging infrastructure, raw material (such as minerals) availability and supply, and battery recycling.

236. Participants discussed the need for capacity-building for different stakeholder groups, including policymakers, the workforce, youth and the general public, to drive innovation and technology development and transfer.

237. Participants exchanged views on the challenges experienced with different technologies. With regard to the electrification of vehicles, issues discussed include infrastructure deficits particularly in developing countries, limited travel distance, the need for efficient EV batteries while addressing the issue of waste disposal, power grid capacity constraints, and competition for other electricity use and limited power generation capacity. Challenges relating to synthetic e-fuels include scalability, safety concerns regarding hydrogen use and lack of international standards, although participants noted the progress in the initial stages of research development on hydrogen- or ammonia-fuelled ships.

238. Some participants highlighted that existing transport infrastructure is often not adapted to the development needs of electrified transportation or to the provision of efficient transport conditions in growing cities, and noted that this provides an opportunity for, but also challenges to, accelerating the electrification of transport.

(b) Opportunities (including actionable solutions) and barriers

239. Opportunities related to technology and capacity-building mentioned by some participants include:

(a) Reduced costs of new and emerging technologies, including those related to EVs, low- and zero-carbon fuels, and artificial intelligence, through continued efforts in innovation, research and development, including by start-ups;

(b) Joint pilot projects to gather data on the performance of new technologies and the sharing of experience on new technologies in different environments;

(c) A road map for the roll-out and scaling up of specific technologies, combined with a holistic finance and investment plan;

(d) The acquisition of new skills by youth through capacity-building and technical assistance;

(e) Overcoming existing structures and lock-in effects through the application of new technologies, including the start of new economic opportunities.

240. Barriers related to technology and capacity-building mentioned by some participants include:

(a) Lack of local know-how and necessary skills in the workforce, including among mechanics, for maintaining EVs and charging infrastructure and handling EV battery recycling;

(b) Supply chain constraints resulting from the concentration of specific technologies in only a few areas;

(c) Cheaper and easily accessible but unsustainable technology (e.g. inefficient used vehicles) often combined with limited consumer awareness of better options;

(d) Heavy reliance on maritime transport in SIDS with limited affordable technology options.

5. Sustainable development and socioeconomic impacts

(a) Summary of discussions and key findings

241. The breakout group discussions were facilitated by John Mark Mwanika.

242. The introductory presentation by John Mark Mwanika highlighted the socioeconomic dimensions of the barriers and challenges faced by countries in transitioning to sustainable mobility. Four areas for barriers in the transport sector were described: policy and regulations, technological limitations, financial investment, and public awareness and acceptance. The lack of political will for advancing sustainable mobility and the inconsistency or inadequacy of policies, regulations and incentives at various levels often lead to the prioritization of short-term economic gains over long-term sustainability goals. Overcoming technological limitations of EVs will require significant time, resources and multi-stakeholder collaboration. There is limited public understanding of the benefits of EVs, which often results in various forms of resistance by consumers. These barriers are often accompanied by challenges related to social equity; job transition and skills gaps, as highlighted by labour impact assessment studies; economic impacts on existing industries; and access to sustainable transport in underserved areas. Social equity refers to addressing potential disparities in accessing benefits and fostering inclusivity and fairness in policy initiatives. Key transport workforce issues include poor working conditions, harassment, sexual exploitation, gender discrimination and limited access to affordable finance to purchase or upgrade vehicles. These barriers and challenges provide opportunities for formalizing workforce arrangements by including informal workers and economic activities in the scheme of benefits and rights applied for the formal economy. This inclusion can be achieved through strong, democratic and representative trade unions and associations. These associations should be included in industry-wide just transition plans that focus on collective action by governments, industries, communities and individuals.

243. The need to assess both positive and negative socioeconomic impacts of sustainable mobility was emphasized by participants, with employment being the most commonly cited issue. The importance of facilitating the reskilling of workers and providing support to disadvantaged communities was underlined, given the potential job losses in certain industries. Stakeholder engagement, including through trade unions, was considered as key to facilitating a just transition.

244. The application of a gender-based approach and access to modern energy were underlined by some participants as important to ensuring an equitable outcome of the energy transition, including in the transport sector. Linkages to other sustainable development aspects were also mentioned, including to sustainable resource management, land use, deforestation and food security.

245. Some participants underlined that the just energy transition in transport systems needs to contribute to achieving the SDGs, including those directly and indirectly linked to transport such as ensuring energy access (SDG 7) and poverty reduction (SDG 1). The multidimensional aspects of transport systems were discussed, including the empowerment of poor people and economic productivity increases through reduced travel time and better transport access for everyone. Countries need to balance different, and sometimes competing, development priorities.

246. Many participants stressed that sustainable socioeconomic development is a priority for many developing countries; therefore, affordability of EVs and low- and zero-carbon fuels was mentioned as an important factor to enabling energy transition in the transport sector.

247. Participants discussed that sustainable development in transport systems can be promoted through various means, including the implementation of policies and measures that integrate environmental, economic and social considerations and through policy coordination approaches. This can involve adopting a holistic, nationally driven approach that balances the needs of present and future generations, thereby ensuring the protection of the environment, promoting economic growth and social well-being, and addressing the need for equity, social justice and inclusivity.

248. Some participants also raised the point that accessibility to efficient transport services and not only affordability of those services should be considered. Affordable and proper access to transport systems for all needs to be ensured.

(b) Opportunities (including actionable solutions) and barriers

249. Opportunities related to sustainable development and socioeconomic impacts mentioned by participants include:

(a) Co-benefits, including improved public health owing to reduced air pollution, job creation and business development, and improved road safety;

(b) International cooperation, including the sharing of best practices.

250. Barriers related to sustainable development and socioeconomic impacts mentioned by some participants include:

(a) Trade-offs with economic development, particularly where transitioning away from fossil fuels leads to reduced tax revenues and in developing countries where oil reserves have recently been discovered;

(b) Lack of political leadership, weak institutional frameworks, corruption and competing interests;

(c) Private land ownership, competing land use and cultural beliefs of the local population regarding the development and use of transport infrastructure;

(d) Lack of available data on socioeconomic impacts and lack of modelling tools;

(e) Lack of international finance and technology support.