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Technology Executive Committee

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Synthesis report of the Technology Executive Committee on technology development and transfer for the global stocktake

Cover note

I. Background

1. As per activity 1 under the thematic area of Inputs to UNFCCC process of its updated workplan for 2019-2022, the TEC is to prepare a synthesis report on matters related to technology development and transfer as an input to the technical assessment phase of the global stocktake.

2. At TEC 23, the TEC considered a concept note on the scope of and sources of input to the global stocktake on matters related to climate technology development and transfer. The TEC welcomed the concept note and provided guidance on further relevant work of the TEC. The TEC agreed to establish an ad hoc task force to support the preparation of a synthesis report on matters related to technology development and transfer as input to the technical assessment phase of the global stocktake.

3. At TEC 24, the taskforce on the global stocktake, with the support from the secretariat and a consultant, will be invited to present the draft synthesis report.

II. Scope of the note

4. The annex to this note contains the draft synthesis report of the Technology Executive Committee on technology development and transfer for the global stocktake, prepared by the TEC task force on the global stocktake.

III. Expected action by the Technology Executive Committee

5. The TEC will be invited to consider the draft synthesis report and provide guidance to the taskforce, with a view to finalizing it after TEC 24.

Annex

Draft synthesis report of the Technology Executive Committee on technology development and transfer for the global stocktake

Executive Summary

1. As part of the information collection and preparation phase for the Global Stocktake (GST), the CMA invited all relevant constituted bodies and forums under or serving the Paris Agreement and/or the Convention, including the TEC, to prepare for the technical assessment synthesis reports in their area of expertise. At its 23rd meeting, the TEC agreed on an annotated outline and possible sources of inputs to the report.

2. Guiding questions have been formulated by the Subsidiary Body (SB) Chairs for the information collection and preparation component of the GST. This synthesis report addresses the questions that are relevant for the TEC. The report first identifies achievements by the TEC on the thematic areas of the Technology Framework. Then challenges and solutions are analysed for technology RD&D, market deployment, and diffusion towards widespread utilisation in markets in developing countries. Finally, the report explores how international collaboration can support climate technology RD&D, deployment, and diffusion.

3. The work of the TEC is guided by the five thematic areas of the Technology Framework. Building further on the established practice of collaboration between the TEC and the CTCN on areas of mutual interest, both bodies have formalised a list of joint activities to be developed, designed, and executed jointly in 2021–2022.

Achievements

4. Under the theme of *innovation*, the TEC has produced technical papers and reports on international collaboration on RD&D for climate technologies, innovative approaches to adaptation technologies, and emerging climate technologies. In addition, the TEC organised virtual events and, with the CTCN and the GCF, thematic dialogue on the promotion of climate technology incubators and accelerators in developing countries.

5. On *implementation*, the TEC, in collaboration with the CTCN, supported activities related to technology needs assessments (TNAs) in the form of a workshop during the CTCN Regional Forum for NDEs in Africa, a paper on TNA experiences, lessons learned and good practices, and a guidebook (with UDP) on enhancing implementation of TNA results. Focussing on existing climate technologies, the TEC published a paper on innovative approaches for accelerating and upscaling technology implementation in developing countries.

6. Linking technology decision processes with NDC planning and implementation, the TEC, with the CTCN, published a paper on Technology and NDCs. The Technology Mechanism has been recommended to publish regular updates on Technology and NDCs.

7. Within the theme of *enabling environment and capacity building*, the TEC continued work on strengthening endogenous capacities and technologies, by collecting views on relevant endogenous capacity needs, gaps, challenges and enabling environments from national representatives, constituted body members, and technology practitioners. In collaboration with the NDC Partnership, CTCN, NDEs and other relevant organisations, the TEC published a paper on enabling environments to incentivize the private and public sector to engage in technology development and transfer.

8. Through the implementation of its activities, the TEC *collaborates and engages* with a large group of organisations (over 50 in 2021), including governments, observer organisations, NDEs, the private sector, academic institutions, financial institutions, and international organisations. Furthermore, the TEC explored, with the CTCN, opportunities to promote South–South cooperation and triangular cooperation on technologies for adaptation, in collaboration with, i.a., UNOSSC.

9. Under the thematic area of *support*, the TEC has undertaken activities to continue its work on climate technology financing for technology development and transfer in developing countries. With the CTCN, the TEC engages with the GCF, in general to support developing countries in NDC submission and implementation and in particular to operationalise support for climate technology incubators and accelerators. Moreover, the TEC collaborates with the GEF and the SCF via, respectively, a dialogue on experiences and lessons learned from the Poznan Strategic Programme and by providing input to the draft guidance by SCF for entities operating the Financial Mechanism.

10. In their respective decisions, CMA-3 and CoP-26 invited Parties and relevant stakeholders to consider the key messages and recommendations by the TEC.

11. In 2019, the TEC agreed to mainstream gender consideration into its workplan and subsequently appointed its first-ever gender focal points in 2020. In 2021, the TEC achieved gender balance in its events for the first time in the TEC's history, with more women participating in TEC events than men.

Knowledge building on solutions

12. Based on the work of the TEC, the synthesis report identifies challenges with relevance for different steps in the process of technology development and transfer, as well as solutions to address these, based on good practice examples.

13. Under *innovation*, the TEC, first, analysed eight international RD&D programmes on climate technologies in multiple sectors, with the following main conclusions:

(a) High-level support/buy-in increases the likelihood of adequate RD&D resources and high-level key actor engagement, and supports alignment of the programmes with national priorities, needs and capabilities of participating (developing) countries;

(b) Collaborative programmes which involvement developing country researchers from the beginning, better utilise their RD&D output potential and support developing country research participation on an equal footing;

(c) While engaging private sector entities in collaborative programmes facilitates the future market uptake of technology options, in most cases private sector involvement in RD&D collaboration is limited.

14. Specifically focussing on entrepreneurs, the TEC concludes that entrepreneurship on climate technology innovation in developing countries is often hampered by an insufficiently enable entrepreneurial ecosystem. The TEC therefore recommends providing holistic, systemic support to whole groups of enterprises and entrepreneurs in developing countries. Particularly focussing on incubators and accelerators, the TEC recommends that new models for climate technology incubation and acceleration are designed for developing country contexts.

15. The TEC concludes that generally, but mostly in developing countries, private funding, including venture capital, for climate technology RD&D is scarce. Consequently, public funding and effective financial instruments are crucial for supporting access to climate technology funding. The sets of knowledge and experience of the TEC, the CTCN, the SCF, the GCF, and the GEF can support this.

16. The TEC analysed a group of key emerging primary energy supply technologies, with a tested potential for mitigation and adaptation, and elaborated on aspects of their successful deployment, commercialisation, and long-term sustainability. As many of the markets for these technologies will be in developing countries or countries with economies in transition, ambitious and fast research, development, piloting, and early commercialization programmes are needed to test whether these technologies are viable in the short term, and worth investing in for the long term.

17. With respect to *implementation*, the TEC and the CTCN concluded that the majority of NDCs mention technology, but there are significant differences in terms of structure and level of detail provided. The TEC and the CTCN recommend disseminating technology roadmaps, with good practice examples of technology planning, in support of NDCs. Moreover, lessons can be learned from interlinkages between TNAs and NDCs.

18. To explore ways for accelerating and scaling up climate technology implementation, the TEC assessed several innovative approaches in technology planning, engaging stakeholders, and public-private collaboration for enhanced access to funding and to mitigate investment risks. Using good practice examples for each of these topics, the TEC has identified key conditions for enabling governments to push technologies forwards, while supporting private entities to pull technologies further into markets.

19. Under *Enabling environments and capacity building* the TEC explored the concept of endogenous capacity, e.g., the ability of a country to adapt technologies to local conditions or to identify appropriate technologies for its climate and development needs at multiple levels. The TEC has recommended that countries are supported in acquiring a better understanding of internal conditions, thereby emphasizing that an enabling environment is a process, with an integrated

governance structure and coordinated efforts on awareness-building throughout government and private and community groups, as well as academia.

20. A key role in *support* of climate technology development and transfer in developing countries has been played by the Poznan Strategy Programme on technology transfer. Through it, four regional pilot centres have been established for climate technology transfer and finance in Europe, Latin America and the Caribbean, Africa, and Asia-Pacific. Next to strengthening countries' knowledge of technology development and transfer issues, these centres have operated as climate technology accelerators and climate innovation system builders.

21. Support tools and mechanisms can be provided by other international public and private stakeholders, whereby international public support can help to cover incremental costs and provide risk capital and risk mitigation instruments. Typically, international public stakeholders can enable capacity building and policy support for climate technologies, while international private stakeholders (e.g., banks and pension funds), can enhance developing countries' access to technology financing.

Opportunities for enhanced international cooperation

22. For reaching the 1.5ºC target, the adoption of new climate technologies needs to be widespread. This is enabled by national innovation policies fostering the innovative uptake of climate technologies and capabilities for their deployment (e.g., industry and finance). International cooperation is a critical enabler for developing countries and vulnerable regions to strengthen their action for the implementation of 1.5°C-consistent climate responses.

23. In support of RD&D on climate technologies, also in developing countries, international collaboration can strengthen learning on successful RD&D initiatives, facilitate flexible and evolving participation of countries in line with national needs and capacities, stimulate private sector participation, and place technological RD&D in a broader ecosystem-level context (focussing technology hardware, software and orgware).

24. Next to the recommendations on making incubators and accelerators more applicable for climate technologies, the TEC recommends that international communities collaborate on the development of new incubator and accelerator models for developing country contexts. These can be jointly established by countries, e.g,. within a region. The regional training and capacity activities under the Global TNA Project, operated by regional knowledge centres, can serve as an example.

25. In their work on technology and NDCs, the TEC and the CTCN observe that experience-sharing and capacity-building collaboration between countries can stimulate the uptake of climate technologies in collaborating countries. A concrete of example of bundling climate technology knowledge and experience is that of technology roadmaps, which are based on internationally gathered good practice of planning and implementing a particular technology.

26. Based on its work on emerging climate technologies for energy supply, the TEC suggests that a global facility could help develop reduce the risk-weighted cost of capital in developing countries for investments in emerging climate technologies. Realising that some emerging technologies are mainly based on regional resources, the TEC suggests that countries in these regions form partnerships and collaboration to pursue the commercialisation of these emerging technologies.

27. Efforts to strengthen international climate technology collaboration can tap into the good practice examples of South-to-South and triangular collaboration. Further development of dedicated platforms for collaboration on climate technologies can benefit from work of already existing regional platforms such as APAN, AfriCAN, and LUCCC.

28. While the capacity needs for climate technologies depend on country contexts, international collaboration can provide tailored, multilevel training support to developing countries. NDEs are likely to have a key role in identifying capacity needs and enabling action for climate technologies in developing countries.

29. Based on the work by the TEC, country collaboration can be enhanced as follows:

(a) Country to country collaboration for knowledge exchanging and improving market conditions for climate technologies (e.g., South-to-South and triangular cooperation);

(b) Regional cooperation, such as carried under the Poznan Strategic Programme and the TNA training programme for Europe, Latin America, Africa, and South-East Asia;

(c) Processes under the Convention, such as the Technology Mechanism, GCF, GEF, and SCF.

Acronyms and abbreviations

AC	Adaptation Committee
APAN	Asia Pacific Adaptation Network
CMA	Conference of Parties serving as the meeting of the Parties to the Paris Agreement
COP	Conference of Parties to the UNFCCC
CTCN	Climate Technology Centre and Network
CYTED	Ciencia y Tecnología para el Desarrollo (Science and Technology for development)
EBRD	European Bank for Reconstruction and Development
EU Climate-KIC	EU Climate Knowledge and Innovation Centre
FAO	Food and Agriculture Organisation of the UN
G-STIC	Global Sustainable Technology & Innovation Community
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gases
GST	Global stocktake
IADB	Inter-American Development Bank
IPCC	Intergovernmental panel on climate change
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
LDC	Least developed countries
LDCEG	Least Developed country Expert Group
LUCCC	Least Developed Countries Universities Consortium for Climate Change
NAMA	Nationally appropriate mitigation actions
NAP	National adaptation plans
NAPA	National adaptation programme of action
NDC	Nationally determined contributions
NDE	National designated entity
NGO	Non-governmental organisations
NSI	National systems of innovation
PCCB	Paris Committee on Capacity Building
PSP	Poznan Strategic Programme
RD&D	Research, development and demonstration
SB	Subsidiary Bodies
SBI	Subsidiary Body for Implementation
SCF	Standing Committee on Finance
SIDS	Small island developing states
SSC	South to South Cooperation
TAP	Technology action plan (part of TNAs)
TEC	Technology Executive Committee
TEM	Technical Expert Meetings
TNA	Technology needs assessment for climate change
UNEP	UN Environment Programme
UDP	UNEP DTU Partnership
UNIDO	United Nations Industrial Development Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNOSCC	United Nations Office for South-South Cooperation
WIM Excom	Executive Committee of the Warsaw International Mechanism

I. Introduction and mandate

A. Background

30. The United Nations Framework Convention on Climate Change (UNFCCC) is the focus of the political process to address climate change. The Convention secretariat supports the Convention, the Kyoto Protocol, and the Paris Agreement by a range of activities, including substantive and organizational support to meetings of the Parties.

31. In 2010, the Conference of the Parties (COP) of the UNFCCC established the Technology Mechanism which consists of two components: the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The purpose of the Technology Mechanism is to facilitate the implementation of enhanced action on technology development and transfer to support countries' action in mitigation and adaptation to achieve the full implementation of the Convention.

32. The Paris Agreement states that the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) shall periodically take stock of the implementation of the Paris Agreement to assess the collective progress towards achieving the purpose of the Agreement and its long-term goals (referred to as the "global stocktake (GST)"), and shall do so in a comprehensive and facilitative manner, considering mitigation, adaptation and the means of implementation and support, and in the light of equity and the best available science (UNFCCC, 2016, pp. pp. 18-19, Art.14.1).

33. As part of the information collection and preparation phase for the GST, the CMA is requesting/inviting the preparation of 13 synthesis reports to be completed in March 2022, three months prior to the commencement of the technical assessment. In this context, the CMA invited all relevant constituted bodies and forums under or serving the Paris Agreement and/or the Convention, including the TEC, to prepare for the technical assessment, with the assistance of the secretariat, synthesis reports in their area of expertise (UNFCCC, 2018a, pp. pp. 55-56, para 24).

34. At its 23rd meeting, the TEC considered a concept note including an overview of the scope and possible sources of inputs for the synthesis report that the TEC could provide as an input to the technical assessment phase of the GST, including an annotated outline of the synthesis report. The TEC agreed on the proposed annotated outline and possible sources of inputs as contained in the concept note.[1]

B. Scope of this synthesis report

35. The scope of the report is derived from the type of information that will be considered by the GST at a collective level (UNFCCC, 2018a, pp. pp.57-58, para 36). Of these, the following information is within the area of expertise of the TEC:

(a) Finance flows and means of implementation and support and mobilization and provision of support (including information referred to in Art 9.4, 9.6, Art. 10.6, Art. 11.3, Art. 13.9 and Art. 13.10 of the Paris Agreement);

(b) Barriers and challenges, including finance, technology, and capacity building gaps, faced by developing countries;

(c) Good practices, experience, and potential opportunities to enhance international cooperation on mitigation and adaptation and to increase support under Art. 13.5 of the Paris Agreement.

36. Based on the types of information to be considered for the GST, guiding questions have been formulated by the Subsidiary Body (SB) Chairs for the information collection and preparation component of the GST. Of these, the following questions are relevant for the TEC and will be addressed in this report:

[1] Available at: https://bit.ly/3nwheaJ.

(a) What is the state of progress on the provision of means of implementation and support and mobilization and provision of support, including the information referred to in Art. 9.4 and 9.6, Art. 10.6, Art. 11.3, and Art. 13.9-10 of the Paris Agreement?

(b) What is the overall progress made towards achieving the long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce GHG emissions referred to in Article 10.1 of the Paris Agreement? What is the state of cooperative action on technology development and transfer (Article 10.2 of the Paris Agreement)?

(c) What are the barriers and challenges, including finance, technology development and transfer and capacity-building gaps, faced by developing countries?

(d) What are good practices, experience, and potential opportunities to enhance climate action, including international cooperation, on mitigation and adaptation and to increase support under Art. 13.5 of the Paris Agreement and which of these can be transferable or replicated by others?

37. Within this scope, this synthesis report will, first, provide its context by referring to the relevant provisions of the Paris Agreement to promote and facilitate enhanced action on technology development and transfer. Steps in this context to be highlighted are the establishment of the Technology Mechanism, Article 10 of the Paris Agreement, the establishment of the Technology Framework (Art. 10.4), its adoption in 2018 and subsequent operationalisation by the TEC and the CTCN in their respective work programme.

38. The report will proceed with research on the work of the TEC under the various themes of the Technology Framework, including innovation, implementation, enabling environments and capacity building, collaboration and stakeholder engagement and support, including through desk-study. For that, the work of the TEC, including publications and TEC events, relevant for the technical assessment phase of the GST will be synthesised.

C. Objective of the report

39. Within the scope outlined above, this Synthesis Report aims to provide input to the technical assessment phase of the GST, thereby considering the expertise and previous work of the TEC[2] and ensuring complementarity with other synthesis reports under the GST process. For this, this report has the objective to discuss:

(a) **Achievements** by the TEC to promote and facilitate enhanced action on technology development and transfer (Article 10.4) and strengthening cooperative action between countries at different stages of the technology cycle (Article 10.6);

(b) **Lessons learned** by the TEC on the challenges and solutions for technology development and transfer (UNFCCC, 2018a, pp. pp.57-58, para 36(f)). With that, it will be demonstrated how the TEC has contributed to extending the knowledge base on innovation for technology research, development, and demonstration (RD&D), innovative approaches for scaling up climate technology uptake in developing countries, viable ways to support innovation and implementation through supporting measures and capacity building;

(c) **Next steps** for the TEC to utilise opportunities for enhanced international cooperation between countries on technology development and transfer. This will build further on the achievements by the TEC and the TEC's contribution to the extended technology knowledge base, by identifying topics and areas for enhanced cooperation, as well as the different forms for that, such as bilateral, multilateral, North-South, or South-South(-North) cooperation.

40. These three subjects (achievements, lessons learned and next steps) will form the core chapters of this report, which is further explained in the next section.

[2] For example, the TEC provided input to the Talanoa Dialogue in 2018, available at: https://bit.ly/3yZm2In.

D. Structure of the report

41. This report is structured as follows:

(a) Chapter II contains a **background** description of the work and context of the TEC, including the relevant passages in the Paris Agreement and the establishment of the Technology Framework. Key outputs of this chapter are an overview of main themes and action areas for climate technology development and transfer, which have formed the basis for the TEC rolling workplan;

(b) Chapter III discusses the **achievements** of the TEC in terms of the current state of, and progress made on, climate technology development and transfer. For that, the chapter describes TEC outputs (background papers, policy briefs or other reports), their outcomes (highlighted topics and key findings in each output), and impacts (i.a. inclusion of the TEC outcomes into COP and CMA Decisions);

(c) Chapter IV highlights **lessons learned** by the TEC on supporting climate technology RD&D (through innovation) and accelerating implementation through technology deployment and diffusion (i.a. innovative approaches on planning, finance, and climate entrepreneurship);

(d) Chapter V takes a forward-looking perspective by exploring ways to support climate technology RD&D and implementation through enhanced international cooperation, including between developing and developed countries.

42. The report will be concluded with a chapter on Key findings.

II. Background: The Paris Agreement and climate technology

43. The Paris Agreement calls for a long-term vision "on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions" (UNFCCC, 2016, pp. 14, Art. 10.1). This vision encompasses all stages from technology RD&D towards its market diffusion, covering both technologies for mitigation (reduce emissions) and adaptation (improve resilience). Strengthening cooperative action between countries supports this (UNFCCC, 2016, pp. 9, Art. 10.2).

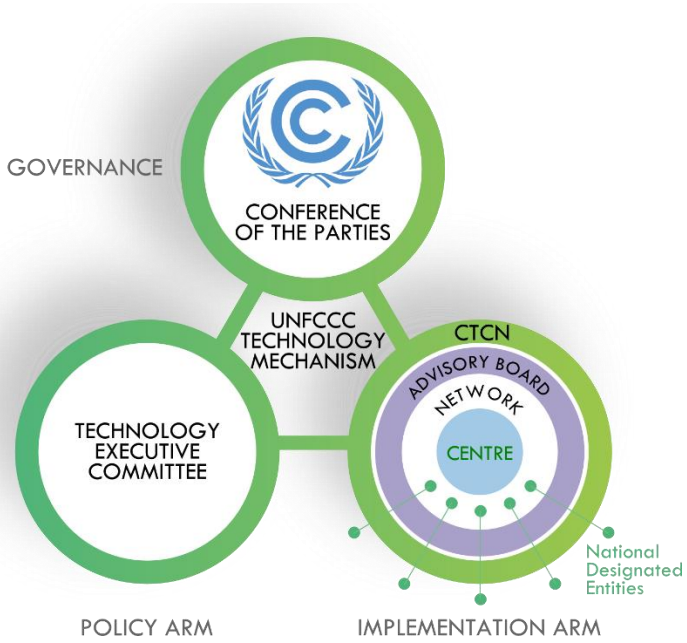
44. The Paris Agreement established the Technology Framework "to provide overarching guidance to the work of the Technology Mechanism in promoting and facilitating enhanced action on technology development and transfer in order to support the implementation of" the Paris Agreement (UNFCCC, 2016, pp. 14, Art. 10.4)

45. In its Article 10.5, the Paris Agreement (UNFCCC, 2016, p. 14) refers to collaborative approaches to RD&D and facilitating access to technology to developing countries. In this respect, supporting roles are foreseen by the Technology Mechanism and, through financial means, the Financial Mechanism of the Convention.

46. Finally, the Paris Agreement (UNFCCC, 2016, pp. 14, Art. 10.6) calls for support to be provided to developing countries for "strengthening cooperative action on technology development and transfer at different stages of the technology cycle, with a view to achieving a balance between support for mitigation and adaptation." Efforts related to support on technology development and transfer for developing countries shall be considered by the global stocktake.

47. The Technology Mechanism serves the Paris Agreement (Article 10.3). It consists of the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN), whereby the TEC serves as the policy body of the Technology Mechanism and the CTCN as implementation (see Figure 1). This report considers the work of the TEC.

Figure 1
The TEC and the CTCN form the Technology Mechanism to support climate technologies (UNFCCC, 2021a)



48. The TEC supports countries in identifying policies to accelerate the development and transfer of climate technologies (see Box 1 for its mandate). For that, the TEC analyses climate technology issues and identifies solutions with concrete policy recommendations for their implementation. This work is implemented through a rolling workplan which includes outputs/deliverables such as technical background papers and TEC Policy Briefs on selected topics. Annually, the TEC reports to the COP, jointly with the CTCN.

Box 1. Mandate of the TEC

To enhance climate technology development and transfer, the TEC has the following functions (UNFCCC, 2010):

- Provide an overview of countries' climate technology needs and analyse policy and technical issues related to climate technology development and transfer
- Recommend actions to promote climate technology development and transfer
- Recommend guidance on climate technology policies and programmes
- Promote and facilitate collaboration between climate technology stakeholders
- Recommend actions to address barriers to climate technology development and transfer
- Seek cooperation with climate technology stakeholders and promote coherence across technology activities
- Catalyse the development and use of climate technology road maps and action plans

The TEC consists of 20 technology experts serving in their personal capacity and from developed and developing countries, who meet at least twice a year and work intersessionally in task forces.

49. In support of its work, the TEC engages with a wide range of stakeholders, such as environmental NGO's (ENGO), country representatives, intergovernmental and UN organisations, experts and academia, youth (YOUNGO), business and industry NGO's (BINGO), research and independent NGO's (RINGO), local government and municipal authorities (LGMA), Indigenous peoples organisations (IPO), Trade union NGO's (TUNGO), Women and gender (WGC), and farmers. These stakeholders are regularly invited to TEC meetings and participate in task forces, workshops, thematic dialogues, expert meetings, and side events.

50. Through the Technology Framework, the activities of the TEC and the CTCN are directly placed within the context of the goals of the Paris Agreement. This implies that the focus of the TEC and the CTCN has become broader, i.e., from supporting climate technology development and transfer to enhancing transformational changes with help of climate technology actions.

51. In 2018, CMA-1 adopted the Technology Framework (UNFCCC, 2018b). Under the guidance of the CMA, the TEC and the CTCN are responsible for the implementation of the Technology Framework. The TEC has incorporated this guidance in its workplans (TEC, 2021a), including the monitoring and evaluation of the activities undertaken. The Technology Framework has the following key themes:

(a) **Innovation**: The Paris Agreement emphasizes the role of innovation in pursuing its goals (UNFCCC, 2016, pp. 9, Art. 10.5). The Technology Framework interprets innovation broadly by considering actions in all stages of the technology cycle (UNFCCC, 2018b), thereby covering both RD&D and innovative, collaborative approaches and technology implementation in developing countries;

(b) **Implementation**: Under this theme, the Technology Framework promotes the link or alignment of technology needs assessments (TNAs) with nationally determined contributions (NDC) and national adaptation plans (NAP). With that, the Technology Framework establishes a direct link between the acceleration and scaling up of climate technologies and national strategies for meeting the goals of the Paris Agreement;

(c) **Enabling environment and capacity-building**: Successful implementation of technology development and transfer requires enabling environments and capacity building. Enabling actions can range from enhancing public awareness, promotion of endogenous and gender-responsive technologies, enhancing the capacity of national designated entities (NDEs), to fostering private sector involvement in creating favourable market conditions for climate technologies;

(d) **Collaboration and stakeholder engagement**: the Technology Framework acknowledges that stakeholders are crucial for climate technology success as they add expertise, experience and knowledge on all aspects of technology development and transfer. The Technology Mechanism is guided by the Technology Framework to harmonise stakeholder engagement in order to avoid duplication and ensure consistency and coherence;

(e) **Support**: while the above themes address the what, how and who questions of technology development and transfer, with this theme, the Technology Mechanism is guided to explore ways to mobilize climate technology support to developing countries. Importantly, the support is to be country-driven and includes facilitating access to finance, capacity-building, technology implementation, stakeholder engagement and strengthening organisations and institutions.

52. The TEC rolling workplan for 2019-2022 has been the first opportunity for the TEC to incorporate the mandate of the Paris Agreement for the Technology Mechanism and the guidance from the Technology Framework in its action agenda (TEC, 2021a). The activities in the rolling workplan are organised in the five thematic areas of the Technology Framework as explained above. For each theme, the TEC agreed to establish a task force (TEC, 2019a).

53. Activities are subsequently linked to each of the TEC's workstreams: mitigation, adaptation and cross-cutting issues. Impacts of the activities undertaken by the TEC in its rolling workplan are monitored and evaluated.[3] For that, a system is used which has been developed in collaboration with the CTCN, with a view to ensuring coherence of activities within the Technology Mechanism.

54. In the next chapters, the output, outcomes and impacts of the activities of the TEC under the rolling workplan will be synthesised.

III. Achievements by the TEC on climate technology development and transfer

55. This chapter addresses the following guiding questions for the GST developed by the SB Chairs (SB, 2021):

(a) What is the state of progress on the provision of means of implementation and support and mobilization and provision of support, including the information referred to in Article 10.6?

[3] In response to decision 13/CP.24 and paragraph 24 and 25 of the Annex to the decision 15/CMA.1.

(b) What is the overall progress made towards achieving the long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions referred to in Article 10.1?

(c) What is the state of cooperative action on technology development and transfer (Article 10.2)?

56. In this chapter, these questions are addressed based on the joint annual reports of the TEC and the CTCN, as well as background papers, policy briefs and other publications by the TEC. Progress is highlighted for each of the key themes of the Technology Framework: innovation, implementation, enabling environment and capacity-building, collaboration and stakeholder engagement, and support.

57. Achievements are described in terms of inclusion of key findings in COP and CMA Decisions, as well as progress made on, i.a., improvement technology action plans, collaboration with GCF, joint activities with the CTCN, and mainstreaming gender considerations. Annex I summarises the actions by the TEC (reports, events) and achievements (e.g., inclusions of findings in COP/CMA decisions).

58. The findings in this chapter, as well as in the next chapter, follow, to the extent feasible (i.e. measurable) the concept of Theory of Change (TEC, 2019g, pp. 6-10), which enables analysis of how activities under each theme of the Technology Framework result in outputs (e.g., policy recommendations), outcomes (e.g., accelerated technology innovation) and impacts (e.g., deployment of new and existing climate technologies included in plans for NDC and NAP implementation). Box 2 provides further background of the monitoring and evaluation system, as it is jointly being developed by the TEC and the CTCN.

Box 2. Monitoring and evaluation

In response to a mandate from COP-23 and guidance contained in the Technology Framework (decision 15/COP.23 and CMA guidance contained in the Technology Framework paragraph 25), the TEC and the CTCN developed in 2019 a consistent and robust **monitoring and evaluation system** to report on the activities of the two bodies and their contributions to the transformational changes envisioned in the Paris Agreement. The system includes a Theory of Change, a Logical Framework Analysis and a Performance Measurement Framework. The two bodies implemented the monitoring and evaluation system in 2020 and conducted outreach to NDEs to contribute to the process of monitoring and evaluating the impact of the TEC and the CTCN activities through a joint survey to be conducted bi-annually. The focus of the survey was on long-term impacts and actions taken after support was provided, with the aim of strengthening the capacity of the TEC and the CTCN to fulfil their mandate of enhancing climate technology development and transfer, based on lessons learned and recommendations received by the NDEs.

A. Innovation

59. On innovation, the TEC has undertaken several activities on the following topics:

(a) International collaboration on RD&D for climate technologies;

(b) Innovative approaches to adaptation technologies, and

(c) Emerging climate technologies.

60. On **international collaboration on RD&D** for climate technologies, the TEC prepared a report with a compilation of good practices and lessons learned (TEC, 2020a). It contained a selection of eight bilateral and multilateral collaborative programmes in key sectors, such as energy, water and drought management, agriculture, and cross-sectoral actions. Three of the selected programmes are focused on mitigation specifically, two mainly on adaptation, with the remaining ones covering both mitigation and adaptation technologies. All identified programmes (four small- and four large-scale) are based on collaboration between developed and developing countries.

61. Disseminating the finding of the report, the TEC organised a virtual event (in 2021) with the participation of experts from national governments, research institutes and private sector organisations. Moreover, executive summaries have been prepared for different target groups:

policymakers, academic and research institutes, international organisations, and private sector actors.

62. Based on these outputs, the TEC prepared key messages and recommendations for COP-26 and CMA-3, thereby highlighting:

(a) The role of policymakers in defining patterns for international collaboration on RD&D and creating supportive environments for climate technology innovation;

(b) The contribution of international organisations, via their dedicated networks, to worldwide exchange of knowledge and best practice of technology RD&D;

(c) The central role of academic and research institutions in climate technology RD&D and dissemination of results to a non-technical audience;

(d) The role of the private sector in translating RD&D results into market-deployable technologies, while observing that the involvement of the private sector in the early stages of the technology cycle remains limited.

63. In November 2021, CMA-3 and COP-26 invited Parties and relevant stakeholders to consider key messages and recommendations of the TEC for 2020 and 2021 on technology policy including in areas of international collaborative RD&D (UNFCCC, 2021a, p. para. 8; UNFCCC, 2021b, pp. 1, para. 9).

64. In 2018, the TEC and the CTCN collaborated with the Green Climate Fund (GCF) to organize a thematic dialogue on the promotion of **climate technology incubators and accelerators** in developing countries and prepared a policy brief on that topic. These initiatives assisted the GCF in identifying ways of financing such incubators and accelerators with the aim of improving countries' ability to innovate climate technologies. The TEC, the CTCN and the GCF also participated in a CTCN expert meeting on **national systems of innovation** and in a TEC task force on innovation and RD&D.

65. On **adaptation**, the TEC took the initiative, further to its official launch at the Climate Dialogues, to organise a series of virtual events to promote innovative approaches for upscaling technologies for adaptation (owing to the COVID-19 pandemic, the originally planned in-person Technology Day was replaced with a series of virtual and hybrid events; including the COP-26 Technology Day event on 8 November 2021 (TEC, 2021b)).

66. Upon invitation by the international conference G-STIC 2020 (hosted virtually from Brussels), the TEC organised a deep-dive session on innovative approaches to adaptation technologies. The outcomes of the session have been reflected in the G-STIC Chairperson summary, for consideration by the Multi-stakeholder Forum on Science, Technology, and Innovation for the Sustainable Development Goals (New York, 2021) (UN DESA, 2021).

67. In 2021, the TEC organised another deep-dive session on innovative approaches on adaptation, but this time with a specific focus on strengthening coastal and ocean adaptation. In September 2021, a session was held in conjunction with the IUCN World Conservation Congress, and in collaboration with the expert group on oceans of the Nairobi Work Programme on impacts, vulnerability and adaptation to climate change, and Friends of Ecosystem-based Adaptation (UNFCCC, et al., 2021).

68. Finally, within the thematic area of innovation, the TEC published a technical paper on **emerging technologies** for low-emission energy supply (TEC, 2021d). It provides an overview of technology options and assesses their potential impacts on mitigation and adaptation, as well as social, institutional, economic, and business challenges and solutions related to their development and deployment, with policy options and recommendations. With that, policymakers are provided with ways to effectively support the deployment of these technologies in energy markets.

69. Input to the technical paper was provided by the three events that the TEC organised during the 2021 Asia-Pacific Climate Week (TEC, 2021e). These events focussed on low-emission energy technology transitions in the region Asia-Pacific. The events were organised with the International Renewable Energy Agency (IRENA), the Marrakech Partnership for Global Climate Action/High Level Champions, the Regional Collaboration Centre Bangkok and UNEP.

B. Implementation

70. Between 2016 – 2018, the TEC, in collaboration with the CTCN, supported activities related to **technology needs assessments (TNAs)** by considering how assistance could be provided to Parties to align their TNAs with their process to formulate and implement national climate action plans. The TEC and the CTCN also collaborated on the preparation and implementation of technology action plans (TAPs), which are key deliverables towards technology implementation in developing countries. With the UNEP DTU Partnership (UDP), the TEC co-organized a workshop on TNAs in conjunction with the CTCN Regional Forum for NDEs in Africa (in 2018). This was followed by a side event at SB50 (in 2019) on supporting the implementation of technologies through TNAs and NDCs.

71. In 2019, the TEC prepared a paper on experiences, lessons learned and good practices during phases I and II of the global TNA project (TEC, 2019b). The paper was followed by a policy brief in 2020 with a specific focus on the implementation of technologies prioritised in TNAs (TEC, 2020b). These outputs followed earlier TEC work on TNAs such as the guidebooks developed with UDP on enhancing the implementation of TNA results (TEC & UDP, 2017).

72. With these guidebooks the TEC was able to contribute to improvement of the quality of TAPs. While in 2015 it was concluded that many TAPs were insufficiently bankable (TEC, 2015b), many of the countries in TNA Phase II followed the new guidance meticulously (TEC, 2019d). This resulted in TAPs containing clear and consistent information on roles and responsibilities for stakeholders, action pathways, budgets, and potential funding sources. Moreover, "TAPs are seen by stakeholders as useful documents to get TNA results towards implementation" (TEC, 2019b, p. 3).

73. The TEC also underlined the importance of learning from TNA processes, nationally within TNA countries, as well as regionally, *e.g.*, via regional TNA workshops. Tracking of TNA results supports this learning (TEC, 2017e). As implementation of prioritised technologies usually takes place after completion of a TNA, the TNA process does not contain an evaluation of implementation success. Nevertheless, learning from implementation experiences can help other countries to improve their technology action plans.

74. With that in mind, the TEC recommended that COP and CMA encourage:

(a) Developing countries to engage well-selected project development teams and relevant decision makers for successful TNA preparation and implementation of results;

(b) Developing countries to promote their TNA results regionally with a view to enhancing their implementation;

(c) Further engaging the public and private sectors with TNA implementation plans and in project preparation teams;

(d) Relevant stakeholders to promote lessons learned, success stories and challenges in relation to implementation of climate technologies; and

(e) International cooperation and support on meeting technology needs to enhance implementation of TNA results.

75. COP-26 and CMA-3, in their Decision-/CP.26 and Decision-/CMA.3, respectively, invited Parties and relevant stakeholders to consider the key messages and recommendation of the TEC on technology policy, including on TNAs.

76. Together with the CTCN the TEC engaged in and provided inputs to the **technical examination processes (TEP)** on mitigation and adaptation to facilitate the implementation of policies, practices, and actions. In response to decision 13/CP.23 (UNFCCC, 2018e), the TEC and the CTCN provided inputs on topics for the TEP on mitigation for the period until 2020 and co-hosted various regional **technical expert meetings (TEM)** which were organized in conjunction with the Africa Climate Week, Latin America, and Caribbean Climate Week and the CTCN Regional Forum for national designated entities (NDEs) in Asia-Pacific. During Climate Dialogues 2020, the TEC vice-chair shared reflections on the achievements of the TEMs on mitigation (UNFCCC, 2020).

77. The TEC and the CTCN also met, on the margins of SB 48 and SB 50 with the Chairs of the SBSTA and the SBI, the high-level champions and the Co-Chairs of the Adaptation Committee (AC) to exchange views on the TEP. The outcomes of this work were incorporated into the respective workplans and activities of the TEC and the CTCN (SBSTA & SB, 2021a, pp. 31-32). COP-26 invited Parties and relevant stakeholders to consider these recommendations (UNFCCC, 2021b, pp. 1, para.8).

78. Combining the themes of innovation and implementation, the TEC took the initiative to prepare a technical paper on **Innovative approaches to stimulating the uptake of existing technologies for mitigation and adaptation** (TEC, 2020c). With the paper, the TEC took a broad perspective of innovation, as explained above, by stating that this also refers to improvements in different stages of the technology cycle, including the implementation of matured technologies. These are technologies for mitigation and adaptation that have successfully been demonstrated and deployed in markets in international markets, but for different reasons have yet been successfully entered markets in least developed countries.

79. Innovative approaches have been introduced by the TEC (2020c) in terms of: planning and strategies for climate technology implementation, engaging stakeholders in decision-making for stronger social acceptance of technologies, ways to mitigate financial risks so that a wider pallet of financial products can be utilised in developing countries, and public-private partnerships.

80. Further to the paper, the TEC prepared a policy brief on this topic (TEC, 2021f) and formulated key messages for consideration by COP-26 and CMA-3. The TEC emphasised that innovative approaches enable markets to 'pull' technologies in the market alongside governmental 'push' actions. The role of stakeholders has been highlighted to enable co-design of technology decisions and technology 'champions'. With help of innovative financial products and interventions, including blending of public and private funds, the introduction of financial benchmarks that incorporate climate considerations and the use of classification schemes (TEC, 2021f, pp. 8-9), revenues from climate technology investments can be increased while risks can be mitigated. Finally, the TEC highlighted that public-private partnerships make technology diffusion more effective, including via climate innovation centres and incubators.

81. COP-26 and CMA-3, in their Decision-/CP.26 and Decision-/CMA.3, respectively, invited Parties and relevant stakeholders to consider the key messages and recommendation of the TEC on technology policy, including innovative approaches to stimulating the uptake of existing clean technology solutions (UNFCCC, 2021b, pp. 2, para 9) (UNFCCC, 2021a, pp. 2, para 8)

82. Finally, the TEC continued work on technology issues within the context of **nationally determined contributions (NDCs)**. It prepared a paper on **linkages between TNA and NDC processes** (TEC, 2021g), thereby building further on earlier work such as TEC (2013a) (2014) (2016) (2018e) which had demonstrated how TNA outputs can be useful inputs for different stages of NAMAs and NAPs.

83. Exploring how developing countries who communicated NDCs between 2018 and 2021 have aligned their TNA and NDC processes, the TEC (2021g) suggest ways to increase coherence between multiple planning processes for mitigation and adaptation in order to enhance implementation of climate technology options. For the paper, collaboration was sought with the NDC Partnership, while UDP supported a questionnaire among TNA coordinators.

84. Jointly with the CTCN, the TEC prepared a paper on **stimulating the uptake of technologies in support of NDC implementation** (TEC & CTCN, 2021). It contains a comprehensive analysis and synthesis of information pertaining to technology needs and challenges, the linkages between policy and implementation, and linkages with NAPs regarding NDCs.

85. Building on this joint work, the TEC and the CTCN delivered recommendations to Parties on how to stimulate the uptake of climate technology solutions to support the implementation of NDCs. CMA.3 invited the TEC and the CTCN to continue their work on technology and NDCs in 2022–2023, in particular by implementing relevant recommendations in the joint publication on technology and NDC (UNFCCC, 2021a, pp. 1, para. 6a). The recommendations emanating from this work for the Technology Mechanism include work on **technology roadmaps** and **regular updates of the joint publications.**

C. Enabling environment and capacity-building

86. Within the theme of enabling environment and capacity building, the TEC continued work on strengthening **endogenous capacities and technologies**. Earlier, in response to a request from COP-21 and CMA-1, the TEC had prepared a report on developing and enhancing endogenous capacities and technologies from a technology stakeholders' perspectives (TEC, 2018a) on which it collected feedback from other bodies. This led to the insight that stakeholders have different understandings of what is meant by endogenous capacities and technologies, as well as key findings on endogenous capacity development and enhancement, and operating entities of the Financial Mechanism could support this (SBSTA & SB, 2019, pp. 11, para 51-55). Moreover, the TEC agreed to collaborate on this topic with the Paris Committee on Capacity-building.

87. Based on this work, the TEC collected views on relevant endogenous capacity needs, gaps, challenges and enabling environments from national representatives (NDEs and TNA focal points), constituted body members, and technology practitioners. It concluded that capacity needs and challenges differ across these stakeholder groups and enabling strategies and measures for enhancing national endogenous capacity broadly converge (TEC, 2020d).

88. The analysis on this has been concluded in 2021 with the formulation of key findings for consideration by COP-26 and CMA-3 (SBSTA & SBI, 2021b, pp. 13, para 54 a-e). These highlighted the conclusions by the TEC on:

(a) The capacity of stakeholders to participate in planning activities involving climate technologies;

(b) The need to create and promote good governance at different levels, including legal, regulatory and policy frameworks that support endogenous innovation;

(c) Ensuring that NDEs and TNA focal points have the necessary capacity to support technology prioritization, planning and implementation activities;

(d) The need to identify innovative, effective, and flexible ways of acquiring and managing public and private funding for climate technology development and transfer;

(e) Developing and implementing strategies for effective research, development and innovation systems for climate technologies, including training and promotion of domestic and international collaboration for enhanced capacities and technologies.

89. CMA-3 and COP-26 invited Parties and relevant stakeholders to consider the key messages and recommendations by the TEC on endogenous capacities and technologies (UNFCCC, 2021a, pp. 2, para. 8) (UNFCCC, 2021b, pp. 2, para.9).

90. On the topic of **enabling environments and challenges,** the TEC prepared a paper examining enabling environments to incentivize the private and public sector to engage in technology development and transfer (TEC, 2021c). Prepared in collaboration with the NDC Partnership, CTCN, NDEs and other relevant organisations, the paper identified policies and strategies for improving enabling environments, which were formulated as key messages and recommendations for consideration by COP-26 and CMA-3 (UNFCCC, 2021b, pp. 2, para. 16) (UNFCCC, 2021a, pp. 2, para. 14).

D. Collaboration and stakeholder engagement

91. Through the implementation of its activities, the TEC engages with a large group of organisations (over 50 in 2021), including governments, observer organisations, NDEs, the private sector, academic institutions, financial institutions, and international organisations (SBSTA & SBI, 2021b, pp. 8, para. 33).

92. With the **Executive Committee of the Warsaw International Mechanism** (WIM Excom) the TEC collaborated on an expert dialogue on loss and damage associated with impacts of climate change. This dialogue was held on 17 June 2019 in conjunction with SB50 and convened leading experts, practitioners, and policymakers on this topic. Participants discussed the status of knowledge of climate change impacts on coastal zones, technology options for coastal zone risk assessments,

technology options for coastal zone risk retention, and technology options for recovery and rehabilitation in coastal zones (UNFCCC, 2019a).

93. The joint policy brief that the TEC and WIM Excom prepared based on the above activities (WIMExcom & TEC, 2020), for consideration by COP-26, highlighted:

(a) The availability of solutions to assess and manage climate change-related risks, including recovery and rehabilitation measures;

(b) Areas for further improvement such as awareness of existing technologies, and availability and accessibility of high-quality and timely data, methods for considering multiple hazards, and appropriate scales of governance;

(c) The need for an integrated cross-sectoral approach to coastal zone management, and

(d) The need for different technologies for recovery and rehabilitation to cope with the complex nature of efforts to avert, minimize and address loss and damage in coastal zones.

94. COP-26 and CMA-3 invited Parties and relevant stakeholders to consider these key messages and recommendations on technologies for averting, minimizing and addressing loss and damage in coastal zones (UNFCCC, 2021a, pp. 1-2, para. 9) (UNFCCC, 2021b, pp. 8, para. 8).

95. The TEC reported on the diverse expertise it has benefited from in implementing its work (SBSTA & SB, 2021a). This expertise is offered by a wide range of **stakeholder groups** with whom the TEC collaborates when implementing its activities and through the work of the TEC task forces. The over 50 organisations and institutions include observer organisations, NDEs, NGOs, local communities and authorities, national planners, private sector entities, academia, financial institutions, and international and UN organisations. The TEC has regularly collaborated with stakeholder groups on the organisation of events, such as the January 2022 G-STIC session organised with the YOUNGO constituency (TEC & G-STIC, 2022).

96. Through these interactions, the TEC has tapped into a wide array of practitioners' knowledge on technology-related issues, while utilising these contacts for dissemination of TEC results. Based on its engagement with and contribution to the technical examination processes on mitigation and adaptation during 2016-2020, the TEC concludes that this has been useful in bringing Parties and non-Party stakeholders together. The TEC intends to strengthen its collaboration and engagement with stakeholders, including through partnerships and enhanced use of social media (SBSTA & SBI, 2021b, pp. 8, para. 34).

97. Finally, under this theme, the TEC explored, with the CTCN, opportunities to **promote South–South cooperation and triangular cooperation** on technologies for adaptation, in collaboration with the United Nations Office for South-South Cooperation (UNOSSC) and relevant stakeholders in 2016 (TEC, 2017b).

98. In terms of collaboration with other bodies under the Convention, the TEC, often through its Chair or Vice-Chair, has regularly participated in the meetings and events of other UNFCCC bodies and processes, including the CTCN AB, the GCF, the Least Developed Countries Expert Group, WIM Excom, the Paris Committee on Capacity-Building, the Adaptation Fund, the Nairobi Work Programme, the Ocean and Climate Dialogue and the Second Periodic Review of the Long-term Global Goal.

E. Support

99. The understanding of **support** under this key theme is broader than just financial support, as it may include all aspects of support for the implementation of Article 10 of the Paris Agreement. The support should be provided for all key themes of the Technology Framework, considering the gender perspective and endogenous and indigenous aspects. To achieve the objective of the thematic area of support, the TEC undertakes a number of activities aimed to continue the work of the TEC on climate technology financing to assist countries on support related to technology development and transfer (TEC, 2022, pp. 12, para. 22-23).

100. The TEC, together with CTCN, will continue engaging with the **Green Climate Fund (GCF)**. Together, TEC, CTCN, and GCF explored opportunities for cooperation during the first

GCF replenishment period (2020-2023) (GCF, 2020, pp. 8, para. 20(d)). The TEC via its Chair and/or Vice-Chair participated in the 3rd, 4th, and 5th meetings of the GCF (in 2019, 2020, 2021).

101. The focus of the collaboration is on supporting countries in submitting and implementing their NDCs and operationalising support for climate technology incubators and accelerators, following the 2018 dialogue and publications developed jointly with the CTCN and GCF (UNFCCC, 2018c). The TEC will continue engaging with the GCF in the process of operationalizing support for climate technology incubators and accelerators (see also elsewhere in this chapter) (SBSTA & SB, 2021a, pp. 10, para. 43).

102. The TEC has collaborated with the **Global Environment Facility** (GEF) via a dialogue on experiences and lessons learned from the **Poznan Strategic Programme** (PSP). For that, the TEC updated its evaluation of the PSP, including finance centres and pilot projects that have been part of the fourth replenishment of the GEF. Other participants in the dialogue were the regional centres supported by the GEF (under the PSP) and the CTCN. The updated evaluation was considered by SBI 50 (SBI, 2019).

103. The TEC collaborates on support with the **Standing Committee on Finance** (SCF), by providing input to the draft guidance by SCF for entities operating the Financial Mechanism. Such draft guidance is regularly considered in the development of guidance to the operating entities. The most recent inputs to the draft guidance were aimed for consideration by COP-26 and CMA-3, but SCF was not able to produce this draft guidance (UNFCCC, 2021c, pp. 3, para. 24).

104. Via a concept note, the TEC has provided an overview of possible work that it may undertake on **innovative financing and investment options** at different stages of the technology cycle (TEC, 2021l). Possible activities are the preparation of a technical paper, the development of a TEC Brief and recommendations to the COP, and dissemination of the brief and recommendations to key stakeholders. At its 22nd meeting, the TEC provided guidance on further work on this issue by agreeing on follow-up activities, as proposed in the concept note (TEC, 2021k) (TEC, 2022, p. 13).

F. Gender mainstreaming

105. Regarding the joint work on gender and technology, Parties have provided guidance and mandates on gender-related matters to constituted bodies through various decisions. The Technology Framework also includes provisions referring to gender. In 2019, the TEC (2019f) agreed to mainstream gender consideration into its workplan and subsequently appointed its first-ever gender focal points in 2020.

106. The TEC (2019f) suggested building a network of gender expertise by inviting organizations to nominate gender and technology experts. It highlighted the importance of considering gender aspects and equality when pursuing technology development and transfer. In addition, the TEC strives for balanced gender participation at its event and placing gender consideration on the meeting agenda's. At its 21st meeting, the TEC (2020e) reported on its initial work on gender mainstreaming and provided guidance for further work on this matter, including preparing a policy brief, adding indicators for monitoring gender mainstreaming, and elaborating methodological approaches. In 2021, the TEC achieved gender balance in its events for the first time in the TEC's history, with more women participating in TEC events than men.

107. On mainstreaming gender considerations in the work of the Technology Mechanism, the TEC collaborates with the CTCN. During SB 48 and 50, both bodies participated in the gender dialogues and UNFCCC gender workshops to discuss how to integrate gender considerations into their work. The CTCN has already undertaken extensive work on gender since its inception, including establishing gender focal points, implementing a gender policy and action plan, and developing a gender knowledge hub.

108. This presents opportunities for synergies between the two bodies on gender mainstreaming as it relates to technology development and transfer. In 2021 the two bodies liaised with the gender team of the UNFCCC secretariat to support the integration of gender considerations into the UNFCCC process, including by disseminating briefs prepared by the gender team about gender integration under the UNFCCC process, raising awareness of gender equality issues on International Women's Day and organizing a meeting with other UNFCCC constituted bodies to share experience

on mainstreaming gender in their respective activities. The TEC and the CTCN also initiated a discussion with the gender team on operationalizing an online gender expert roster in 2022.

G. TEC-CTCN joint activities

109. While there had been an established practice between the TEC and the CTCN to collaborate on specific areas of mutual interest, in line with the respective functions of each body (see Box 3), in 2020 the bodies formalised a list of joint activities to be developed, designed and executed jointly in 2021–2022, under the guidance of their Chairs and Vice Chairs and with the support from the two secretariats (UNFCCC, 2019b) (UNFCCC, 2018d).

110. Noting the resource constraints, the TEC and the CTCN agreed that the plan for joint activities needed to strike a balance between identifying readily implementable ("low hanging fruits"), impactful and visible activities while ensuring the two bodies collaborate across the full spectrum of guidance provided by the Technology Framework.

111. The Chairs and Vice Chairs also noted that emphasis should be given to areas where there was successful collaboration in the past and/or work-in-progress may be considered. Emphasis was also given to activities that could be implemented immediately in 2020, to ensure that these could be included in the 2020 joint annual report of the TEC and the CTCN, thereby responding to the CMA mandate from Madrid.

112. The first set of joint activities agreed by both bodies for implementation in 2021-2022 were on technology issues in NDCs and gender and technology (see elsewhere in this paper). This work is guided by a joint task force composed of members of the TEC and the CTCN Advisory Board, and representatives of observer organisations (SBSTA & SBI, 2021b, pp. 5, para. 9).

113. The TEC and the CTCN have concluded that their joint work (SBSTA & SBI, 2021b, pp. 5-6, para. 13):

(a) Enhances collaboration and deepens engagement on issues of mutual relevance for the two bodies;

(b) Strengthens coherence and synergy of work on common issues;

(c) Enables TEC policy work to be more systematically grounded in case studies and lessons learned from the CTCN's operational activities and vice versa;

(d) Has resulted in a monitoring and evaluation system which is useful for tracking impacts of activities under the Technology Mechanism.

Box 3. Organisational collaboration between the TEC and the CTCN

In response to the mandate for the TEC and the CTCN to implement the Technology Framework, the TEC and the CTCN Advisory Board have convened **back-to-back meetings and at least one joint session a year** since March 2019. The joint sessions have sought to identify possible activities to undertake jointly and take stock of progress made and guide their implementation. The two secretariats have continued to work through the exchange of technical data and information to ensure synergies and overall coherence of the work of the Technology Mechanism, i.a.:

CTCN technical assistance data is being used by the TEC to analyse enablers and barriers in technology development and transfer;

A TEC survey on endogenous capacities and technologies to identify needs, gaps, challenges and enabling environments, was shared with CTCN network members as key respondents representing practitioners' perspectives on climate technologies;

TEC policy briefs have been used by countries to help identify priorities and develop requests for technical assistance from the CTCN;

NDE database and CTCN Gender-Just Solutions Awards and Up-Scaling Programme data are used to identify experts for events of the TEC and joint events. Since 2017, upon invitation of the CTCN, the Secretariat and TEC members have participated at the regional forums for NDEs from the African, Asia-Pacific, and Latin America and the Caribbean regions (organized by the CTCN as part of the UNFCCC regional climate weeks); and

Since 2017, the TEC and the CTCN have jointly organised **Technology Mechanism side events** at SBs and COPs.

H. Decisions of COP-26 and CMA-3 on work of TEC

114. COP-26 and CMA-3 expressed their appreciation regarding the collaboration of the TEC with other constituted bodies and relevant organisations in implementing its workplan (UNFCCC, 2021b, pp. 2, para. 10) (UNFCCC, 2021a, pp. 2, para.9). The COP also welcomed the activities of the TEC to engage the private sector in the translation of RD&D results into market-deployable climate technologies (para. 11). Furthermore, the COP and CMA encouraged the TEC to continue using events, such as the Technology Days, to strengthen the impacts of its work workplan (UNFCCC, 2021b, pp. 2, para. 12) (UNFCCC, 2021a, pp. 2, para. 10) and increasing its activities on outreach and stakeholder engagement to disseminate its policy and publications workplan (UNFCCC, 2021b, pp. 2, para. 14) (UNFCCC, 2021a, pp. 2, para. 12). The COP and CMA commended the TEC on its efforts to mainstream gender considerations in its work workplan (UNFCCC, 2021b, pp. 2, para. 13) (UNFCCC, 2021a, pp. 2, para. 11). Finally, the COP and CMA noted with concern that the TEC membership composition prevents certain Parties from fully participating in its work workplan (UNFCCC, 2021b, pp. 2, para. 15) (UNFCCC, 2021a, pp. 2, para. 13).

IV. Knowledge building on solutions – good practice of coping with climate technology challenges

115. This chapter addresses the following guiding question for the GST, as formulated by the SB Chairs (focussing on technology development and transfer): What are the barriers and challenges, including finance, technology development and transfer and capacity-building gaps, faced by developing countries (Decision 19/CMA.1 para. 36(f))? Following the overview in Chapter 3 of TEC achievements, the objective of this chapter is to assess the TEC's contribution to extending the knowledge base on climate technology development and transfer in developing countries.

116. The analysis in this chapter, as in Chapter III, considers the five themes of the Technology Framework. Of these, activities on 'innovation' have been largely focussed on technology RD&D, while 'implementation' addresses aspects related to technology deployment and diffusion (see Figure 1). The themes of 'enabling environments and capacity building', and 'support' are addressed both for the stages of RD&D and market deployment and diffusion. Good practice on 'Collaboration and stakeholder engagement' is not separately discussed in this chapter. As a clearly cross-cutting theme, aspects on collaboration and engagement are discussed, when applicable, under the other themes. The findings will be taken to the next chapter as a basis for a forward-looking perspective on international collaboration for climate technology development and transfer.

Figure 2
Technology Framework themes for technology development and transfer (source: authors)

117. Examples of key topics on which the TEC has gathered experience and broadened the knowledge base on climate technology development and transfer are: acceleration and scaling up the deployment of climate technologies in developing countries; innovations in each stage of the technology development chain (from RD&D to deployment and diffusion in developing country

markets); interlinkages between processes under the Convention such as NDC, NAP, TNA, etc.; and cross-cutting topics (e.g. capacity, system requirements for innovation, risk mitigation).

118. The analysis will consider a range of papers, briefs and events produced and organised by the TEC and available at **TT:CLEAR**. Based on these sources, for each theme the following information will be considered:

(a) Challenges identified by TEC outputs with relevance for different steps in the process of technology development and transfer, such as limited funding for technology research in least developed countries, lack of incubators for employment of technologies in developing country markets, (perceptions of) high technology investment risks and insufficient inclusion of stakeholders in technology decision making;

(b) Solutions identified by TEC outputs to overcome these challenges, based on good practice with innovative approaches for technology identification and implementation, creating enabling implementation environments and building capacity, inclusive processes with stakeholders, and stimulating (multilateral) country collaboration, as well as the replicability of this good practice to other developing countries.

119. Documents consulted for this paper are referenced throughout the paper and listed in the reference list.

A. Innovation

120. Since its inception, the TEC has explored how countries and the international community may enhance climate technology innovation, including RD&D (TEC, 2017a). On the topic of innovation, the TEC has focussed extensively on the stages of research, development, and demonstration (RD&D) of climate technologies. Key points of attention have been:

(a) International collaborative initiatives for climate technology RD&D;

(b) The role of entrepreneurs in stimulating innovation;

(c) The role of incubators and accelerators in RD&D;

(d) Enhancing financing for RD&D, and

(e) Systemic aspects of technology innovation.

1. International collaborative initiatives for climate technology RD&D

121. In a compilation of good practices and lessons learned on countries' RD&D, the TEC (2021h) analysed selected bilateral and multilateral projects and programmes in Asia and the Pacific, Africa, Latin America and the Caribbean, Europe, and North America. Sectors covered are energy supply, agriculture, and water management. The paper elaborates on, i.a., the collaborative designs, policy and financial drivers, intellectual property rights, and approaches to communication and outreach.

122. For the paper, the TEC, first, compiled a long list with 57 international collaborative RD&D initiatives on climate technology, thereby considering scope (mitigation or adaptation, sector, technology, and geography), maturity, objectives, and type of activities (e.g., research, development, demonstration, or deployment in a market). Of these, 25 initiatives were shortlisted and, eventually, eight were selected for detailed analysis. Criteria for selecting these initiatives are explained in detail in TEC (2021h).

123. Based on the initiatives studied, the TEC has identified the following good practice aspects to strengthen the success of international collaboration on technology RD&D:

124. **High-level support/buy-in** increases the likelihood of success of an initiative as it makes it more likely that RD&D resources are adequate and that high-level key actors are engaged throughout the processes of programme design, support, and implementation. This addresses the challenge that programmes, without high-level buy-in, run the risk of not or insufficiently being linked to policy and/or political priorities of participating countries or regions.

125. It also supports a collaborative programme to become more sustainable, especially when embedded in an existing, long-term process (e.g., the CYTED programme being embedded in the

Ibero-American Summit of Heads of States and Government process). Good practice examples in this respect are programmes that are **aligned with national priorities, needs and capabilities** of participating (developing) countries, *e.g.*, through joint priority setting. Related to this, success stories identified in TEC (2021h) considered the varying nature and needs of the relevant technology or sector in the design of a programme.

126. Long-term sustainability of RD&D collaborative programmes can also be strengthened through **structural entities**, processes, and funding sources to keep an initiative active and effective (TEC, 2021h, p. 56). An example of this is the ERANet-LAC project which established an interest group to continue the work of the outgoing project consortium at the end of the project.

127. Ensuring that programmes are executed in line with countries' priorities, needs, and capabilities, the TEC (2021h, p. 56) recommends **structured review and continual adjustment procedures**. Good practice experience can be found in dedicated programme units (e.g., standing panels in the programmes analysed) with the responsibility to review progress and make modifications where needed. Of key importance in this respect is flexibility so that changes can be made swiftly.

128. The TEC (2021h, p. 4) identifies the challenge that it is often more difficult for researchers in developing countries to cooperate in international RD&D collaboration on **an equal footing** with their colleagues from developed countries. Often in developing countries, innovation systems and funding of academics and researchers are insufficient for that. Collaborative programmes which facilitate developing country (research) involvement from the earliest stages of programme decision-making better utilise their RD&D output potential.

129. An important success factor in this respect is that co-decision-making from the very beginning strengthens the links of a programme with locally identified objectives. This is supported by practical arrangements such as appointing representatives from participating regions in a programme as (co-)chairs of sub-programmes or working groups. Also, joint funding of collaborative programmes contributes to collaboration on an equal footing. The case studies examined in TEC (2021h, p. 56) contain examples of developing country regions (increasingly) contributing funding to joint research activities (through their national funding agencies).

130. While it is acknowledged by the TEC (2021h) that **private sector entities** are of key importance for bringing climate technologies to the market, the analysis of collaborative programmes shows that in most initiatives private sector involvement in RD&D is limited. Often, private companies become involved when a technology has moved into stages of incubation, commercialisation, and dissemination. Good practice is gathered from programmes that allocate funding to promote private sector engagement in the earliest stage of the technology development cycle (such as in the Mission Innovation which had enhanced private sector participation as a key goal).

131. Effective collaborative programmes for climate technology RD&D require **suitable governance and management processes**. The challenge is that governance is required both at the level of the programme (whether it is in line with agreed priorities and goals) and the technology (is technology RD&D satisfactory?).

132. A related challenge is that in many, especially in least developing countries management support to collaborative programmes is often problematic, with is often due to limited RD&D capacity and funding, as well as overstretched researchers (TEC, 2021h, p. 58). Good practice examples are those programmes with provisions for developing country research institutes to provide management support to collaborative RD&D programmes.

133. The TEC (2021h) notices that only a limited number of international RD&D collaborations are focused on hardware technologies. Instead, most programmes focus on providing strategic, policy, knowledge-sharing, and capacity-building support. To address the challenge that hardware technology development remains insufficiently supported, the TEC has recommended implementing this **support alongside hardware technology RD&D**. As a result, RD&D processes would be put in a broader, real-world context (TEC, 2021h, p. 62).

2. The role of entrepreneurs in stimulating innovation

134. Above, it has been observed that private sector entities are often limitedly involved in RD&D of climate technology programmes. Specifically focussing on **entrepreneurs**, the TEC (2019c)

concludes that often their role is to bring new and improved climate technologies into broad usage. At the same time, the TEC (2019c, p. 7) recognises the need for 'the right encouragement, guidance and support' to entrepreneurs to support climate technology innovation. Entrepreneurs may, for instance, support the development of new and adaptation of existing, proven climate technologies to the needs of a developing country community, as well as the development of innovative business models to make a technology affordable for the local community and, thus, scaling up market penetration.

135. Particularly on this point, the TEC (2019c) concludes that successful entrepreneurship on climate technology innovation, particularly in developing countries, is often hampered. Examples of such challenges are insufficient encouragement to undertake entrepreneurial activities, limited incentives to work on climate action, and a lack of support, including limited access to funding.

136. According to the TEC (2019c, pp. 7-8), these challenges exist worldwide but apply in particular to situations in developing countries. As a result, "would-be entrepreneurs end up working in other professions, since the risks associated with becoming an entrepreneur are too high." The lack of encouragement can come from societal pressure, local culture, and a lack of economic incentives. The TEC (2018c) also highlights the need to develop a greater understanding of challenges related to business development for adaptation technologies.

137. Other factors applicable to developing countries are lack of education and skills, weak integration into global value chains, lack of venture capitalists and angel investors, and additional hurdles, especially for female entrepreneurs. Especially, low-income entrepreneurs in developing countries lack access to non-dilutive low-cost capital and financial instruments so that they do not have the capacity to leverage loans and private capital (TEC, 2018c, p. 8).

138. Towards solutions for that, the TEC (2019c) (2018b) recommends improving countries' entrepreneurial ecosystems, which contain, next to entrepreneurs, institutions, social networks, and cultural values. Such ecosystems do not target individual entities, but provide holistic, systemic support to whole groups of enterprises and entrepreneurs. In these, "governments work alongside other agents while shaping the institutional framework" (TEC, 2019c, p. 6).

139. While improved ecosystems for entrepreneurs create improved business conditions, unlocks finance, and increases awareness and capacity on both the supply and demand side (TEC, 2018c), the next step is to create favourable market conditions for actions on climate technologies.

140. Here, the TEC (2019c) sees an important role for public entities (including local, regional and national governments and authorities) as they can formulate ('push' and 'pull')[4] policies, regulations and standards for that, such as pricing emissions of GHGs, subsidising low-emission or climate resilient solutions, but also enabling societal recognition and prestige for entrepreneurs engaging in climate-friendly business activities.

3. The role of incubators in technology RD&D

141. As a more tailored intervention, in parallel to improving ecosystems for entrepreneurs more broadly, the TEC (2019c) highlights 'incubation' and 'acceleration' as a mechanism to help entrepreneurs to develop their ideas into usable and practical solutions. Incubation supports start-up organisations, usually for a period of one to five years, by providing them with a physical location, as well as business, marketing, technical, financial, and networking and information services. Accelerators (traditionally focussed on the ICT sector) usually offer a shorter (usually less than half a year), more intensive support programme, including mentoring, peer review of conceptual ideas, and transfer of skills (TEC, 2019c, p. 13). Examples of climate technology incubators and accelerators are the EU Climate-KIC, the World Bank's Climate Innovation Centers (located in countries such as Ghana, Kenya, and Viet Nam), and UNIDO's Global Cleantech Innovation Programme (TEC, 2018b).

[4] Technology 'push' actions are public policies and direct public funding on climate technology RD&D, such as fiscal incentives, technology mandates, capital grants for demonstration projects and programmes, direct subsidies, and loan guarantees. Technology 'pull' actions are policies focussed on technology deployment and diffusion, to attract the private sector to climate technology markets, such as carbon pricing and carbon taxing, standards, regulations, consumer education and labelling, quota-based schemes; tenders for tranches of output, and public procurement policies (TEC, 2017a).

142. Generally, the TEC (2019c, p. 13) concludes that incubators and accelerators rarely are financially self-supportive and that it is particularly difficult to devise models for incubation and acceleration that would work effectively in developing countries. Out of around 2000 technology incubators and 150 accelerators worldwide, fewer than 70 have a focus on climate technology, and only 25 are in developing countries (TEC, 2018c). Incubators obtain (financial) support from a variety of sources, including government funding, international sponsorship, private investment, and revenues from equity TEC (2018c). Incubators in developing countries typically rely on the first two sources, which implies their continued reliance on public support.

143. Therefore, the TEC (2018c) recommends that new incubator and accelerator models are designed for climate technologies in developing countries, including the need for strengthening the entrepreneurial ecosystem, as explained above. This would enable incubators and accelerators to better address the specific investment conditions in developing countries for climate technologies.

144. Possible solutions are to be sought in different timeframes (longer than the Silicon Valley 'norms') and enabling entrepreneurs access to different types of (public) funding. For instance, as identified by the TEC (2018c, p. 7), new, climate technology incubators and accelerators can be co-created by public and private financial institutions "with a value proposition for a broader range of actors."

145. The focus of these new models will be on creating linkages with supply chains (including small and large firms, universities, and governmental organisations) and markets for climate technologies (TEC, 2018b). Hence, the focus will not only be on technology development, as in traditional incubators, but also on the embedding of technologies in market structures, including connecting with potential users (TEC, 2018c). As such, incubators and accelerators act as "local intermediary institutions" supporting the local entrepreneurial ecosystems.

146. With a view to the above challenges and directions for solutions, the TEC (2018b) recommends that international communities pilot new incubator and accelerator models for developing country contexts. These would consider "the diverse needs of entrepreneurs and technology users in relation to different cultural contexts, local communities, income levels and gender considerations" (TEC, 2018b, p. 11).

147. This could stimulate global networks for learning, mentoring, and exchanging good practices on incubators and accelerators in developing countries (TEC, 2018b, p. 11). It can also lead to the creation of multi-country incubators and accelerators, which can tap into an international pool of entrepreneurs, funding providers, supply chains, potential markets.

4. Enhancing financing for RD&D

148. The TEC (2018c) concludes that generally, but mostly in developing countries, private funding for climate technology RD&D is scarce. As climate technologies can take a long time to mature and are often capital-intensive and inherently risky, it can take more than ten years for a technology to reach profitability at a large scale (TEC, 2018b). Hence, for investors, opportunity costs of climate technology investments are relatively high (i.e., quicker returns on investments can be realised elsewhere).

149. This challenge is exacerbated by the limited access of developing country entrepreneurs to low-cost capital, especially for those from the poorest communities (TEC, 2018c). Also, uncertainty about what climate policies will look like in many (developing) countries in the medium to long run is considered a hindering factor. Without a clear climate policy backdrop, it is complex for potential investors how to value climate technology benefits against costs.

150. As argued above, low-income entrepreneurs in developing countries have difficulties in leveraging loans and private capital due to their lack of access to non-dilutive low-cost capital (TEC, 2018c). The TEC (2018c) concludes that "public funding and effective financial instruments are crucial as many developing countries have little or no venture capital." For example, providing performance guarantees by public institutions could underwrite the risks of local bank loans and reduce the interest rates for entrepreneurs and technology buyers. Typical examples of such

instruments are first-loss tranches[5] and blending of public and private finance (see also elsewhere in this paper on innovative approaches for technology deployment and diffusion) (TEC, 2018b).

151. Other solutions to enable access to finance, as identified by the TEC (2018b) are:

(a) the provision of 'patient' capital offering longer payback periods to climate technology start-ups with high capital expenditures;

(b) better access to foreign exchange when climate technologies are not available in national markets and need to be imported;

(c) education of, e.g., angel investors and venture capitalists, as well as public funders. on the nature of climate technologies for their strengthened familiarity with climate technology investment characteristics. For example, while climate technologies may have longer payback times, they could deliver a broader array of environmental, social, and economic benefits in the short, medium, as well as long term.

152. Finally, the TEC (2017a, p. 24) highlights the complementary sets of knowledge and experience of the TEC, the CTCN, the SCF, the GCF, and the GEF to develop recommendations on RD&D financing policies that could support developing countries to enhance their RD&D efforts on climate technologies. It is hereby emphasised that activities to increase RD&D funding focus on multiple 'climate sectors', instead of only energy and agriculture (TEC, 2017a, p. 25).

5. Systemic aspects of technology innovation

153. The above-described aspects have in common that they are aimed at strengthening the systems of innovation for climate technologies in developing countries. It is thereby understood that innovation is a systemic process where actors interact for technology development and transfer, thereby utilising available resources (TEC, 2017a). Moreover, it is acknowledged that innovation processes for climate technologies may differ between countries "to address different problems in different contexts" (TEC, 2017c).

154. Facilitating entrepreneurial activities for technology deployment and diffusion, supported by incubators and accelerators, and better access to funding and financial instruments are solutions identified by the TEC for improved innovation systems. The TEC has also recommended that developing countries update and align their national development and innovation strategies with NDCs and NAPs (TEC, 2018b), as this provides an overarching country vision for pursuing climate and development goals.

155. It is thereby acknowledged that since NDCs and NAPs generally refer to shorter-term targets (i.e., to 2030), the innovation focus may tend to be on technologies in later stages of technology development and transfer, i.e., mature technologies (TEC, 2017c). Similarly, visions leading to mid-century strategies would need to focus more on RD&D investments.

156. Hence, as is also explained below, innovation and innovation systems go beyond facilitating technology RD&D, as they also imply new approaches for planning, stakeholder engagement, financial instruments, and private-public partnership in support of technologies' market entry (deployment) and scaling-up (diffusion). Innovation systems are also aimed at identifying market barriers and solutions to clear these (TEC, 2017c).

157. The theoretical concept for these systemic approaches is called national systems of innovation (NSI). These constitute networks of actors, institutional contexts and linkages and relations between actors and an institutional context (TEC, 2015a). Effective NSIs are essential for developing countries to absorb, distribute, and deploy climate technologies, adapt these to the needs of countries, and implement and maintain them.

158. To strengthen NSIs in developing countries for climate technology innovation, the TEC (2015a) identified the following actions. First, fundamental NSI elements such as education systems, RD&D capacity and enabling policies need to be developed. Second, NSIs are to be focussed on climate technologies that help to meet national climate and development objectives. A third recommendation is to strengthen the strategic and coordination capacities of relevant national actors in climate technology development and transfer. The strengthening of NSIs, while primarily being

[5] The amount of loss an entrepreneur will absorb itself first before loss sharing between funding provider and entrepreneur starts. This reduces the risk for the funding provider.

a national responsibility and prerogative, could be supported by the experiences and expertise of international organisations.

6. Emerging climate technologies in the energy supply sector

159. Responding to the need for a global decarbonisation of electricity supply, against the backdrop of a required increase of electricity output for meeting development needs (e.g., developing economies will have to triple to quintuple electricity output), the TEC analysed a group of key emerging primary energy supply technologies and elaborated on aspects of their successful deployment, commercialisation and long-term sustainability (TEC, 2021j).

160. The technologies analysed in the publication are those with a tested potential for mitigation and adaptation and which have reached the technology development phases of 'early prototype/proven in test conditions' through 'first-of-a-kind commercial demonstration.[6] Technology options that are still in the conceptualisation phase or undertaking preliminary laboratory analytical measurement have not been considered by the publication. Analysed technologies are in the areas of electricity generation', transformation (e.g., green hydrogen) and storage (e.g., batteries).

161. Next to considering the mitigation benefits, the paper also assesses non-climate impacts of the technologies, such as environmental impacts and social benefits (e.g., employment and income generation). This broadening of the assessment enables the identification of viable approaches for the social acceptability of emerging energy supply technologies, as well as consideration of their adaptation impacts.

162. When analysing emerging technologies for energy supply, the TEC has specifically focussed on the broader ecosystem that supports their market entry (see also elsewhere in this paper), especially in developing countries. According to the TEC, low penetration levels can be the result of, e.g., political risks, limited access to finance, insufficient infrastructure (TEC, 2021j, p. 10). With this system perspective, the paper also investigates technology transfer models and sustainable development efforts with the objective to identify enabling socio-political, economic, and business conditions for emerging low-emission energy supply technologies. The paper calls for a systemic innovation and market uptake approach to avoid "ad hoc, start and stop innovation" (TEC, 2021j, p. 56).

163. The paper concludes that many of the markets for emerging energy supply technologies will be in developing countries or countries with economies in transition. To enable these countries to adopt the technologies, "ambitious and fast research, development, piloting, and early commercialization programmes are needed to test whether these technologies are viable in the short term, and worth investing in for the long term" (TEC, 2021j, p. 55).

164. Furthermore, the paper recommends collaboration and partnerships between countries, for example, to overcome barriers that a country may have when trying to make a technology happen, e.g., in terms of physical resources or institutions. The paper also recommends sharing of accelerator projects and saving of accumulated technology knowledge to prevent failure and loss of knowledge when funding of individual technology companies runs out.

B. Implementation

165. The discussion on 'innovation' above, while primarily focussing on the stages of technology RD&D, already offered insights on issues concerning deploying and diffusing climate technologies in markets in developing countries. In this section, challenges and solutions for climate technology implementation are discussed based on the knowledge gathered by the TEC.

1. Embedding climate technology decisions in national planning processes for climate and development

166. As an overarching topic related to the implementation of climate technologies, the TEC is focusing on linking national processes for pursuing climate and sustainable development goals. In its joint publication on **technology and NDCs**, the TEC & the CTCN (2021) conclude that while

[6] These phases correspond with Technology Readiness Levels (TRL) 4-8.

the majority of NDCs mention technology, there are significant differences in terms of structure and level of detail provided. In most cases, NDCs refer to technology in qualitative terms, such as generic or specific technologies to be deployed, policy, regulatory or legal aspects, and support to be provided to other Parties for technology development and transfer.

167. From different geographical regions and country contexts, good practice examples can be identified of where the uptake of climate technologies directly supports the planning and implementation of NDCs. Success is hereby driven by different innovative approaches (e.g., innovative policies and business models, participatory, and gender-responsive processes) which enable countries to clear technical, financial, institutional, and social barriers that arise in taking up technologies.

168. In particular, the participatory element in technology planning and implementation is highlighted. From NDCs the TEC & the CTCN (2021) conclude that stakeholders, e.g., in their capacity as local champions, play a crucial role in ensuring that technology solutions are technically, economically, institutionally, and socially viable.

169. The thus identified good practice of considering technology aspects in NDCs can be helpful for other Parties in their technology planning and implementation. The TEC & the CTCN (2021) suggest producing technology roadmaps based on the good practice data which can be widely used by countries as guidance for specifying climate technologies within the context of NDC targets and creating enabling environments for their successful uptake during NDC implementation.

170. In support of that, the TEC & the CTCN (2021) recommend that Parties make more use of the Technology Mechanism, by utilizing knowledge generated by the TEC and actively engaging with the CTCN to benefit from its provisions, as well as sharing more information on technology needs and support with the TEC and the CTCN.

171. Next to analysing how communicated NDCs contain information on planning and implementing technologies for meeting NDC goals for mitigation and adaptation, the TEC has specifically analysed **how technology needs assessment (TNA) processes are linked to developing country NDC processes**. In its analysis of good practices on TNAs, the TEC (2019d, p. 21) concludes that "TNAs, with their detailed, participatory assessments on climate technologies, can be an important 'planning tool' for NDC design, which could also enhance implementation success of TNA results through NDC support programmes."

172. This conclusion has been reiterated in the TEC's works on **interlinkages between TNA and NDC processes** (TEC, 2021g). Analysis of the latest NDCs and TNAs shows frequent connections between both processes, albeit to different extents and often in a non-explicit, informal way. In many of these cases, NDCs are the starting point for TNA analysis, while TNAs have the potential to holistically combine 'bottom-up technology realism' to national climate setting, especially in least developed countries.

173. Based on consultation among TNA coordinators, the TEC (2021g) concludes that strengthening interlinkages between TNAs and NDCs requires regular TNA updates. TNA coordinators expressed a preference for keeping TNA and NDCs as separate processes, whereby TNA updates are carried out within the existing structure of the Global TNA Project.

174. Next to the benefits of these interlinkages, the TEC has also worked on improving the guidance for developing country stakeholders on formulating Technology Action Plans (TAPs) (TEC & UDP, 2017). With that, the TEC responded to an observation that, at least initially during the Global TNA Project, TAPs were insufficiently bankable (TEC, 2015b). The updated guidance has resulted in more robust TAPs, **including detailed timelines** (such as Gantt charts)**, budgets and indications of the responsible organizations**, as well as benefit-to-cost ratios to facilitate well-informed decisions and increase the chances of securing funding (TEC, 2015b)

175. In the same work, the TEC remarks that the development of a climate technology **implementation plan is specific to a certain location**, and these particularities have to be considered when elaborating implementation plans, in terms of timelines, cost, rate of return and funding mechanisms. The development of reliable plans stimulates the confidence of private investors, who are more willing to take the risk of investing in climate technologies, therefore enhancing the enabling environment.

176. Following this argumentation, it is also good practice to show stakeholders and private investors **examples of successful past projects** with the objective of **creating confidence** and increasing support towards the implementation of that technology (TEC, 2019d). For that, the TEC is planning to improve the tracking of implementation results of prioritised TNA technologies and TAPs (TEC, 2021g).

2. Innovative approaches for strengthened implementation of climate technologies

177. Realising that existing and mature technologies, at least given their deployment and diffusion in developed and high-income developing countries, often do not get off the ground on a large scale in many developing countries, the TEC (2020c) explored the (innovative) enabling environment for technologies in developing countries. For that, it elaborated on good practice examples in the areas of technology planning, stakeholder engagement, finance, public-private collaboration (see Figure 3).

178. Concerning planning, the TEC (2020c) highlights the embedding of climate decisions in countries' overarching sustainable development visions and policies, such as NDC and NAP (as discussed above). It particularly points at the **importance of effective stakeholder engagement in the technology planning and diffusion stages** through co-design. The role of 'champions', including youth (TEC, 2021g), emerges as a key facilitator in decision-making, as these stakeholders have the position and capability to promote climate technology solutions within private and public institutions, through familiarisation, lobbying and connecting other stakeholders.

179. This insight is in line with an assessment of good practices of TNAs (TEC, 2019d), highlighting that engagement of stakeholders and ministries during TNA and post-TNA stages facilitates the inclusion of prioritised technologies in new or ongoing governmental programmes. This also helps substantiate requests for funding from international funding programmes.

180. With a view to private sector engagement, the TEC (2020c) has seen growing momentum through the establishment of multi-stakeholder partnerships and multi-stakeholder initiatives. The success of multi-stakeholder partnerships in catalysing private sector participation can be attributed to the fact that it allows all collaborators to align their interests and leverage resources around a complex issue such as food security. Growing trends in incorporating corporate social responsibility within business models has further motivated the engagement of the private sector. This is especially true of insurance, logistics, and technology service providers who have been contributing with expertise and knowledge products in the field of disaster management and relief.

181. While the TEC (2020c) concludes that **involvement of the private sector** is a crucial factor for accelerating the deployment and diffusion of climate technologies into markets, it is also acknowledged that, especially in least developed countries, a key factor is how and to what extent public and private sector entities collaborate. The TEC (2020c) has identified key conditions for that thereby distinguishing governmental 'push' and market-led 'pull' conditions. The paper presumes that, in general, least developed countries would rely more on government 'push' actions than do other developing countries.

182. Good practice examples, gathered by the TEC (2020c), indicate how stronger public-private collaboration can be achieved by:

(a) Private investors leveraging public funding to mitigate investment risks;

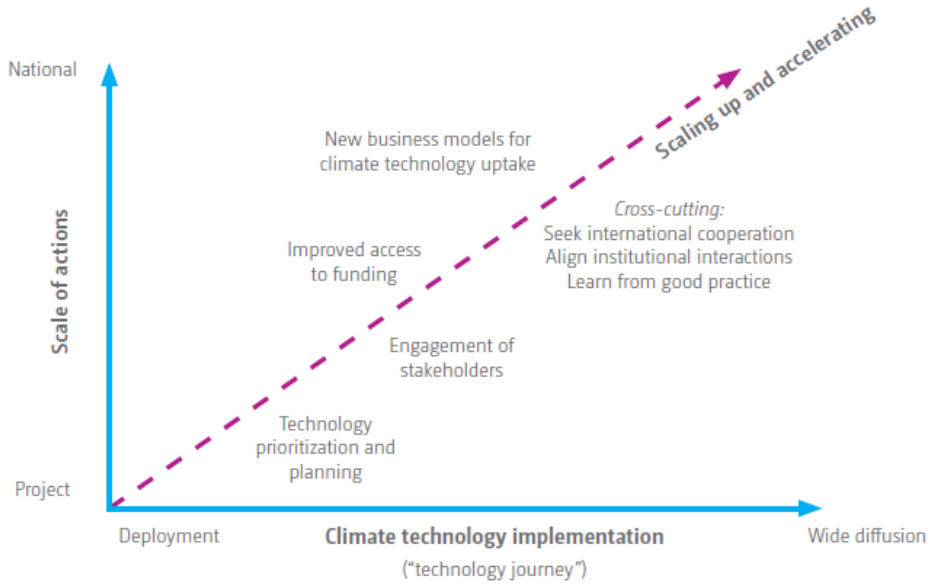
(b) Mitigating risks for private investors so they have incentives for leveraging public funding with private capital;

(c) Establishing government-led collaboration with international funding agencies;

(d) Promoting and active participation of key ministries and fostering their collaboration with international enterprises, and

(e) Designing policies and measures to ensure the benefits from the implemented projects are redistributed both among the investors and the community.

Figure 3
Parameters for accelerating climate technology implementation (TEC, 2020c)



3. South-South and triangular cooperation

183. Further to the multi-stakeholder collaboration explained above, also internationally, the TEC elaborated on collaboration programmes between countries to exchange knowledge and experience on climate technology and transfer. A particular example of this is "South to South Collaboration" (SSC) which enables cooperation among developing countries. This collaboration can have a variety of forms, ranging from the exchange of good practices, field trips, workshops, the establishment of policies and institutions or the joint implementation of climate technology projects (TEC, 2018d). When SSC is extended with developing countries, the cooperation is called South-South-North or triangular.

184. SSC and triangular cooperation are proven to be an effective way of mobilizing and engaging a broad range of stakeholders from the civil society, academia and public and private sectors. These collaborations include components such as peer-to-peer learning and cultural exchange and help build trust and a spirit of cooperation between stakeholders from different countries. Also, the involvement of the research and academic sectors contributes a science-based approach to the projects and enhance multi-sectoral collaboration.

185. Despite several successful SSC initiatives are being carried out globally, information about the approaches, mechanisms and tools to initiate collaborations is limited and often difficult to access. However, when it comes to triangular collaboration, this information is often more readily available. Therefore, a higher emphasis on the dissemination of these projects is recommended, including via dedicated platforms for SSC on climate technologies. Proposed solutions to these issues, as identified by the TEC (2018d) are:

(a) Creating dedicated sections for sharing SSC climate technologies information in existing platforms, such as the CTCN website, the FAO South-South Cooperation Gateway, the UNOSSC website or the South-South world;

(b) Ensuring the easy accessibility of this information via mobile platforms, as they are more widely available in developing countries;

(c) Creating an exchange platform with information demand and supply between participating countries;

(d) Adding documentation on implemented models;

(e) Provide information on lessons learned.

186. Despite not being yet institutionalized by the UNFCCC, platforms for the exchange of SSC climate projects already exist, i.a., the Asia Pacific Adaptation Network (APAN), the Regional Gateway for Technology Transfer and Climate Action, the AfriCAN Climate Portal, The Pacific

Climate Change Portal, and the Least Developed Countries Universities Consortium for Climate Change (LUCCC).

187. Another challenge in SSC collaboration is the difficult communication between regions in different time zones, different languages, cultures and business practices. However, these difficulties can be overcome by specialized training on the cultural specifics of participating countries, effective planning and informal cultural exchanges (TEC, 2018d). Also, finance remains a blockage for effective cooperation between developing countries, which constraints upscaling and diffusion of climate technologies in developing countries. Finally, the lack of sustainability of SSC can be an impediment to creating partnerships, which can be improved by transparent monitoring and evaluation frameworks so that lessons learned, good practices and collaboration models can be shared.

C. Enabling environments and capacity building

188. In response to the request by COP-21 (UNFCCC, 2015, pp. 9, para. 66) to the TEC and the CTCN to undertake further work on the development and enhancement of endogenous capacities and technologies, the TEC (2018a) looked at definitions of the term ‘endogenous’ and explored the concept of endogenous capacities and technologies. The TEC found a lack of common understanding of the term and an absence of standardised ways for endogenous capacity development and enhancement.

189. With help of a survey among NDE officials and current and former TEC members and observers, the TEC (2018a) collected examples of endogenous capacities. For instance, capacity can be seen as endogenous when a country is able to adapt technologies to local conditions or when it identifies appropriate technologies for a country's climate and development needs at multiple levels. As examples of endogenous technologies, the TEC (2018a) survey mentions technologies developed within a country, or those developed elsewhere, but adapted to local needs and conditions.

190. The TEC (2018a) concludes that endogenous capacities and technologies are mostly not an explicit goal in programmes of the GEF, GCF, AC, PCCB and LDCEG. Yet, implicitly, through the activities of these programmes, there is a strong potential to support endogenous capacities and technologies.

191. In order to strengthen endogenous capacities in developing countries, the TEC (2018a) has recommended that countries are supported in conducting participatory approaches which facilitate understanding of internal conditions, partnerships with multiple sectors and improvement of local and indigenous knowledge building and sharing. Moreover, capacities are strengthened by facilitating access to funding and providing tailored, multilevel training support to a country’s market actors and other stakeholders, as well as monitoring of progress. As NDEs can play a major role in enhancing endogenous capacities and technologies, the TEC (2018a) recommends the development of NDEs own capacity.

192. In a consecutive survey among a wide range of developing country practitioners and former TEC members and observers, the TEC (2021i) has explored needs and gaps concerning endogenous climate technology capacities and enabling environments in developing countries. In particular, the needs of local communities for climate technologies and making development more sustainable have been emphasised in the survey. Moreover, the paper identifies as the most significant capacity building blocks: collaboration across sectors and disciplines, adequate financing and other resources for technology development and modification, and technical skill developments.

193. With respect to the latter, the TEC (2021i) considers national education more of an enabler than international education. Moreover, legal, regulatory (including handling intellectual property rights) and policy frameworks, consideration of gender aspects, and coordination between national and local communities to make technologies meet local needs and conditions are considered important capacity-building factors.

194. In a paper based on experience with TNAs, NDCs and CTCN Technical Assistance, the TEC (2021c) has examined challenges and enablers for technology development and transfer in a broad set of developing countries. A central lesson from the paper is to consider an enabling environment as a process, with an integrated governance structure and coordinated efforts on awareness-building throughout government and private and community groups, as well as academia. This can be

supported through joint research and development efforts between countries whereby countries with well-established RD&D infrastructures support more constrained countries.

195. The suggested integrated approach builds further on the experience that action plans for climate technologies often contain a set of enabling actions for their scaled-up implementation (TEC, 2021c). These are to be carried out by governments, the private sector or within communities and it is important that, together, they form a coherent whole and are consistent with other domestic objectives.

196. In this respect, governments have a role in modifying legal and regulatory frameworks for climate technologies and introducing policy instruments for market regulation and development, including incentives for low-emission technologies (or correcting market distortions that benefit fossil-fuel-based technologies). Moreover, governments can specify standards for climate technologies, to be supported, as emphasised by the TEC (2021c), by greater coordination and communication among government departments and agencies for effective enabling environments.

197. As social, cultural, and institutional aspects have been identified in TNAs, NDCs and CTCN TA as potential challenges for climate technologies, the TEC (2021c) highlights the role of communities as a key enabling factor in the overarching governance structure for climate technologies. Hence, engaging stakeholders, such as community groups, in climate technology decision processes contribute to robust technology portfolios and implementation plans.

D. Support

198. This chapter has elaborated on challenges and solutions for innovation on and implementation of climate technologies in developing countries, as well as for creating enabling environments for that, with the engagement of stakeholders throughout all stages of technology development and transfer. Where applicable, support to technology RD&D, deployment and diffusion has been highlighted, such as through the GEF, GCF, and CTCN.

199. A key role in supporting climate technology development and transfer in developing countries has been played by the Poznan Strategy Programme on technology transfer (PSP) (TEC, 2019e). Established in 2008 and with funding from the GEF, PSP has been a supporting programme for TNAs, pilot priority technology projects linked to TNAs and dissemination of GEF experience and successfully demonstrated climate technologies.

200. Through the PSP, four regional pilot centres have been established for climate technology transfer and finance in Europe (hosted by the EBRD), Latin America and the Caribbean (IADB), Africa (African Development Bank), and Asia-Pacific (Asian Development Bank). The TEC (2019e) concludes, i.a., that:

(a) the regional pilot centres strengthened countries' overall knowledge base of technology development and transfer, including financing needs, ownership, long-term engagement of stakeholders, capacity building, and realising technology action planning. Attention has been drawn to the need for long-term engagement with policymakers and government agencies, including NDEs, in particular on policy issues;

(b) in effect, the regional pilot centres have operated as climate technology project accelerators and climate innovation system builders in their regions;

(c) based on the experience of the regional pilot centres, the climate technology financing needs could be integrated into the country partnership strategies and operations business plans of the regional multilateral banks;

(d) instruments and tools such as pre-feasibility studies, technology assessments and maps are essential as early-stage support for scaling up investment.

201. In addition to the supporting mechanisms under the Convention, support tools and mechanisms can be provided by other international stakeholders (TEC, 2015c). These stakeholders can be grouped into public and private sector actors, whereby international public support can help to cover incremental costs and provide risk capital and risk mitigation instruments. Typically, international public stakeholders can also enable capacity building and policy support for climate technologies.

202. International private stakeholders, such as banks and pension funds, can enhance developing countries' access to climate technology financing. Examples of innovative approaches for attracting venture as well as commercial funding for climate technology RD&D and implementation in developing countries have been explained elsewhere in this chapter (under innovation and implementation).

E. Further reading of publications produced by the TEC

203. In this chapter, good practice assessment has been discussed under the themes of the Technology Framework, with references to documents produced by the TEC (or jointly with the CTCN). This assessment, however, while extensive, is not an exhaustive overview of the breadth of the TEC's work. Other publications that may be considered for further reading are:

(a) Background paper on distributed renewable energy generation and integration (Komor & Molnar, 2015);

(b) Background paper on technology roadmaps (TEC, 2013b);

(c) Executive Summaries for target groups – Industrial energy and material efficiency (TEC, 2017d).

Figure 4
Challenges and solutions for climate technologies (source: authors)

V. Forward looking – Opportunities for enhanced international cooperation

204. In the former chapter, challenges of climate technology development and transfer have been discussed, followed by solutions based on assessment of good practice by the TEC. This chapter focusses on how the thus identified good practices, experience, and potential opportunities to enhance climate action, can be strengthened through international cooperation on mitigation and adaptation. With that, this chapter completes addressing the three questions of the SB Chairs, as explained in Chapter III.

205. An important rationale for establishing the Technology Mechanism with the TEC and the CTCN as policy and operational bodies has been that for effective mitigation and adaptation international development and transfer of climate technologies is indispensable. The global targets for limiting global warming as set by the Paris Agreement (and strengthened by COP-26) have emphasised this urgency. De Coninck, et al. (2018) concluded that for reaching the 1.5ºC target, the adoption of new climate technologies needs to be widespread. This is enabled by national innovation policies fostering the innovative uptake of climate technologies and capabilities for their deployment (e.g., industry and finance), and international cooperation. These policies may be more effective when they combine support for all stages of technology development and transfer, from RD&D, via technology deployment in markets towards incentives for technology diffusion.

206. IPCC (2018, p. 23) particularly highlights **international cooperation** as a "critical enabler for developing countries and vulnerable regions to strengthen their action for the implementation of 1.5°C-consistent climate responses, including through enhancing access to finance and technology". This chapter elaborates on the potential of international cooperation between countries to strengthen climate technology development and transfer. The chapter thereby builds further on the challenges and identified good practice solutions, as discussed in Chapter IV.

207. Based on the former chapter, the following main challenges (or gaps when compared to the enabling conditions in De Coninck, et al. (2018)) can be identified:

(a) In international **RD&D collaboration** programmes developing countries researchers often find it difficult to participate on an equal footing with international colleagues, due to capacity limitations (TEC, 2020a, pp. 54-57);

(b) In many developing countries there is insufficient encouragement to undertake **entrepreneurial activities**, and a lack of (financial) support for entrepreneurs, leading to limited incentives to work on climate action (TEC, 2019c, p. 3);

(c) **Incubators and accelerators** are internationally proven concepts to support start-ups, but in developing countries and particularly for climate technologies, there are only a few of them (TEC, 2018c, p. 6);

(d) **Access to finance** by developing country innovators is in many cases restricted due to perceived risks and investment uncertainties, which restricts not only access to commercial funding but also to angel and venture capital (TEC, 2018b, p. 8);

(e) There is an **insufficient exchange of knowledge and experience** between countries on market uptake of emerging technologies, which prevents immediate efficiency gains and accelerated action (TEC & CTCN, 2021, p. 35).

208. In terms of solutions, the TEC (2020a) illustrates how climate technology RD&D collaboration between research institutes from developed and developing countries helps to align research activities with national priorities, needs and capabilities of the participating, including developing countries.

209. It has also been argued that collaborative programmes which facilitate developing country (research) involvement from the earliest stages of programme decision-making, better utilise their RD&D output potential. This enables developing country researchers to collaborate with developed country colleagues on an equal footing. Suitable governance and management processes, while engaging high-level policymakers, are good practices to sustain RD&D collaboration and keep programme goals aligned with sustainable development goals of the participating developed and developing countries.

210. The TEC (2020a), therefore, delivers the following recommendations for enhanced international RD&D collaboration:

(a) Strengthen assessments and learning on successful collaborative RD&D initiatives;

(b) Facilitate flexible and evolving participation of countries in line with national needs and capacities;

(c) Pay particular attention to the "how" of private sector participation, in support of interactions with private investors in collaborative technological RD&D;

(d) Enhance collaborative technological RD&D and put it in a broader ecosystem-level context, so that RD&D focuses on technology hardware, as well as on the software and orgware;

(e) Make specific capacity-building arrangements to enable equal and more productive partnerships with developing countries.

211. Whereas the share of **incubators and accelerators** that focus on climate technologies is already small (around 3% of globally existing technology incubators and accelerators), slightly over one percent of these are in developing countries. Generally, the TEC (2019c) concludes that it is particularly difficult to devise effective models for climate technology incubation and acceleration in developing countries (TEC, 2018c). Next to the recommendations of making incubators and accelerators more feasible for climate technologies, the TEC (2018b, p. 11) recommends that the international communities collaborate on the development of **new incubator and accelerator models** for developing country contexts.

212. In their publication on **technology and NDCs**, the TEC & the CTCN (2021) observe, based on analysis of success stories in Dominican Republic and India, that experience-sharing and capacity-building collaboration between countries can stimulate the uptake of climate technologies domestically or in another country. This requires documentation of all hard-, soft- and orgware aspects of the uptake of a technology, so that exchange of experience "can result in immediate efficiency gains and therefore accelerated action" (TEC & CTCN, 2021, p. 35).

213. A concrete example of sharing experience, as mentioned by the TEC & the CTCN (2021, p. 38), is via technology roadmaps, containing best available information on aspects of technology market uptake. At the same time, the TEC & the CTCN (2021, p. 36) observe that for many technologies, in particular for adaptation, roadmaps are not available. The TEC and the CTCN both can partake in development of such roadmaps, in their respective capacities.

214. Regularly and systematically updating the publication on technology and NDCs enables the TEC and CTCN to observe progress made with technology planning in support of NDCs. Using the concept of Theory of Change, as contained the monitoring and evaluation framework of the TEC and the CTCN (see Chapter III), the impact of (joint) work by the TEC and the CTCN on technology and NDC can be analysed and, where necessary, activities initiated or modified.

215. Work on creating entrepreneurial ecosystems for proven existing climate technologies in developing countries can be further supported by already existing forms of collaboration. For example, the **regional TNA collaboration** that helps developing countries conduct TNA and train stakeholders on preparing TAPs (TEC, 2021g, p. 19), could also serve as regional knowledge and good practice hubs. These are facilitated by regional organisations, and supported by the Global TNA Project, through UDP.

216. In a similar vein, building further on the insights on interlinkages between TNAs and NDCs, technology decision making in developing countries can benefit from the international collaboration that the **NDC Partnership** facilitates (TEC, 2021g, p. 20). This could also support collaboration on technologies for NDC as recommended by the TEC & the CTCN (2021).

217. With a view to **emerging climate technologies for energy supply**, the TEC (2021d, p. 49) highlights the bottleneck of high initial capital expenditures for most types of renewable energy technologies, which is particularly acute in developing countries. The TEC suggests that a global facility could help develop reduce the risk-weighted cost of capital in developing countries for investments in emerging climate technologies.

218. The TEC (2021d) distinguishes between emerging technologies with global application and others with more locally specific applications, e.g., wave or tidal energy. Countries and regions with specific regional resources could benefit from partnerships and collaboration to pursue the

commercialisation of these emerging technologies. Moreover, as fully commercialising some emerging technologies may be beyond any one country, the TEC (2021d, p. 51) calls for partnerships for RD&D and commercialisation, "with the necessary resources and interest".

219. In support of the business model for emerging climate technologies, the TEC (2021d, p. 52) notes the need for a collaboration between countries to phase-out high-emitting, not retrofittable technologies, as "it will be difficult for low-GHG power sources to build economies of scale and innovation until there are widespread coal, oil and then gas power phase-outs."

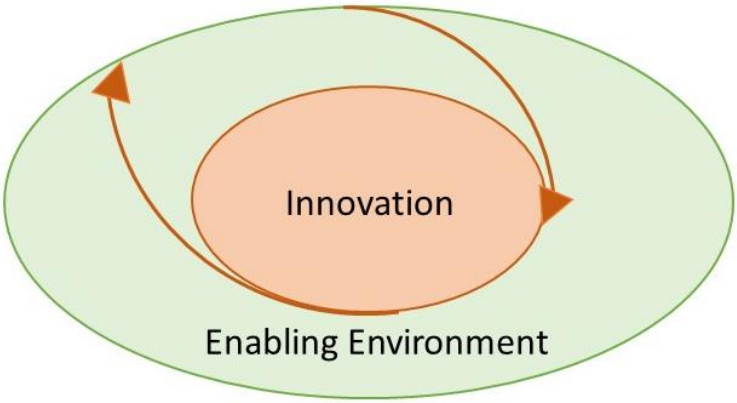
220. The above observations on international collaboration in support of market take-up of emerging technologies can tap into the good practice examples gathered by the TEC (2018d) on **South-to-South Collaboration** (SSC) between developing countries and triangular collaboration with developed countries. Based on identified good practice, the TEC (2018d, p. 29) has recommended the further development of dedicated platforms for SSC on climate technologies, building further on work of already existing regional platforms such as APAN, AfriCAN, and LUCCC.

221. Concerning **finance**, the TEC (2018c) (2020c) has assessed the potential role international development banks to enable stakeholders from developing countries better access to international funding for scaling up and accelerating uptake of proven climate technologies. Through that, barriers such as the long time for technologies to maturity and profitability, policy uncertainties due to political instability, and limited availability of public finance, can be cleared for developing country stakeholders.

222. The TEC (2018c) has revealed good practice examples of how collaboration between national organisations and multinational enterprises could leverage public investment, as well as improve confidence among domestic investors and stakeholders in developing countries. For example, the TEC (2019d, p. 12) describes the example of how GCF financial support triggered a commercial bank to leverage this funding for a climate technology programme in Mongolia, at a lower interest rate.

223. Finally, in the preceding chapters, good practice has been discussed on **enabling environments and capacity building**. While the capacity needs for prioritising and implementing climate technologies depend on country contexts, international collaboration can provide tailored, multilevel training support to developing countries. NDEs are likely to have a key role in identifying capacity needs and enabling action for climate technologies in developing countries (TEC, 2018a). Enhancing capacity in developing countries for climate technology innovation has the potential to become a self-supporting process. While capacity building drives innovation, innovative actions on RD&D and implementation add technology hardware, software, training, funding, and social acceptance to countries' capacity (see Figure 5).

Figure 5
The self-supporting interplay between innovation and enabling environments and capacity



224. The work by the TEC on innovation, implementation, enabling environments and capacity, collaboration and stakeholder engagement, and support has demonstrated a wide range of good practice examples of how developing countries can successfully undertake climate technology

RD&D, market deployment and diffusion actions. Based on the publications produced by the TEC and discussed in this paper, ways to enhance country collaboration can be categorised as follows:

(a) Country to country collaboration for knowledge exchanging and improving market conditions for climate technologies, such as through the examples of South-South and Triangular cooperation;

(b) Regional cooperation, such as carried under the Poznan Strategic Programme and the TNA training programme for Europe, Latin America, Africa, and South-East Asia, both for mitigation and adaptation and with management and financial support from Multilateral Banks or other international organisations;

(c) Processes under the Convention, such as the Technology Mechanism, GCF, GEF, and SCF.

225. For each of these categories, the TEC will continue to assess challenges and solutions as input for its future rolling workplans.

VI. Key findings

226. This chapter contains key findings from this paper based on achievements by the TEC, thereby building knowledge of good practice for coping with climate technology challenges and identifying ways of international cooperation to disseminate this good practice within developing countries.

Innovation

(a) International cooperation for climate technology RD&D supports technology development and transfer in developing countries, in particular when the programmes are aligned with national priorities, needs and capacities of participating (developing) countries. Collaborative programmes which facilitate developing country (research) involvement from the earliest stages of programme decision-making better utilise their RD&D output potential;

(b) Entrepreneurs can bring new and improved climate technologies into broad usage. Improved entrepreneurial ecosystems can provide holistic, systemic support to whole groups of entrepreneurs in developing countries. This can support, i.a., market entry of emerging climate technologies in the energy supply sector;

(c) New incubator and accelerator models are recommended for climate technologies within developing country contexts, which can lead to the creation of multi-country incubators and accelerators;

(d) To enhance access to finance for climate technologies in developing countries, public institutions could provide performance guarantees to underwrite the risks of local bank loans. The complementary sets of knowledge and experience of the TEC, the CTCN, the SCF, the GCF, and the GEF could support this.

Implementation

(a) Analysis of climate technologies within the context of NDCs shows that the uptake of climate technologies directly supports the planning and implementation of NDCs, including through the role of national stakeholders (e.g., champions). Across technology and NDC analysis, common experiences can be gathered and exchanged among developing countries (such as technology road maps);

(b) Through innovative approaches in planning, public-private financial collaboration and engaging people, developing countries are helped to enable market pulling of technologies, next to governmental technology push;

(c) Collaboration among developing countries (South-South) and with developed countries is proven to be an effective way of mobilizing and engaging a broad range of stakeholders from the civil society, academia, and public and private sectors.

Enabling environments and capacity building

(a) **Endogenous capacities** in developing countries can be strengthened by supporting countries in conducting participatory approaches to better understand internal conditions, establish partnerships with multiple sectors and improve local and indigenous knowledge building and sharing;

(b) **National education** is a stronger enabler than international education when it comes to skills development for technology development and transfer in developing countries;

(c) Building an **enabling environment** requires a process, with an integrated governance structure, coordinated efforts on awareness-building. This can be supported by joint research and development efforts between countries, thereby considering good practice with policies and regulations on this topic;

(d) **Communities** are a key enabling factor in climate technology governance as engaging community groups contributes to robust climate technology portfolios and implementation plans.

Support

(a) The Poznan Strategic Programme has been a supporting programme for TNAs, pilot priority technology projects linked to TNAs and dissemination of GEF experience and successfully demonstrated climate technologies;

(b) The regional pilot centres for climate technology transfer and finance in Europe, Latin America and the Caribbean, Africa, and Asia-Pacific have strengthened the overall climate technology knowledge base and operated as climate technology project accelerators and innovation system builders;

(c) International private stakeholders, such as banks and pension funds, can enhance developing countries' access to climate technology financing, thereby utilising innovative approaches for attracting venture as well as commercial funding for climate technology RD&D and deployment in developing country markets.

International collaboration

(a) International collaboration is a critical enabler for developing countries and vulnerable regions to strengthen their action for the implementation of 1.5°C-consistent climate responses;

(b) Experience-sharing and capacity-building collaboration between countries require documentation of all hard-, soft- and orgware aspects of the uptake of a technology, so that exchange of experience can result in immediate efficiency gains and therefore accelerated action;

(c) A global facility could help develop reduce the risk-weighted cost of capital in developing countries for investments in emerging climate technologies, thereby clearing the common barrier of high initial capital expenditures for most types of emerging renewable energy technologies;

(d) In the case of emerging technologies with more locally specific application, e.g., wave or tidal energy, regions or countries with specific regional resources could benefit from partnerships and collaboration to pursue commercialisation of these emerging technologies.

Consideration of gender aspects

(a) The TEC highlights the importance of considering gender aspects and equality when pursuing technology development and transfer. In collaboration with the CTCN, the TEC participates in the gender dialogues and UNFCCC gender workshops to discuss how to integrate gender considerations into their work;

(b) The CTCN has undertaken extensive work on gender since its inception, including establishing gender focal points, implementing a gender policy and action plan, and developing a gender knowledge hub.

Annex 1. Summary of Achievements by Thematic Area

	Topic	Achievements
Innovation	International collaboration on RD&D	- The request to produce a report with key messages and recommendations resulted in Decision-/CMA.3, para.8, Decision-/COP.26, para. 9 - Ways of financing incubators and accelerators in developing countries were identified in a joint dialogue with the GCF.
	Adaptation	- A wider audience for adaptation was reached through virtual and hybrid events. - A Deep Dive session at G-STIC produced a Report to Multi-stakeholder Forum on Science, Technology, and Innovation for the Sustainable Development Goals
	Emerging energy technologies	A report with key messages and recommendations was elaborated from the Asia-Pacific Climate Week
Implementation	TNA	- Decision-/CP.26, para 24, Decision-/CMA.3, para. 8 and key messages and recommendations based on a paper on experience, lessons learned and good practice of TNA and a policy brief
	TEM	6 regional TEMs, 1 in-session TEM at SB50, and 2 global TEM produced Decision-/CP.26, para. 8 and recommendations on ways forward (Annex III Joint report 2020 TEC-CTCN)
	Innovative approaches to stimulating the uptake of existing technologies	Decision-/CP.26, para 9, Decision-/CMA.3, para. 8 and key messages and recommendations, based on a paper and a policy brief.
	Technology Action Plan improvement	The TNA synthesis report of 2019 concluded that the quality of TAPs has improved.
	Technology and NDC	A paper on interlinkages between TNAs and NDCs and a Joint TEC-CTCN paper on Technology issues in NDC implementation resulted in Decision-/CMA.3, para. 6a and key findings on streamlining TNA implementation for more robust NDCs, especially in least developed countries and Small Island Development States.
Enabling environments and capacity building	Endogenous capacities and technologies	- Decision-/CP.26, para 9 and decision-/CMA.3, para. 8 resulted from a report on developing and enhancing endogenous capacities and technologies and the identification of relevant needs, gaps, challenges and enabling environments
	Enabling environment and challenges	A paper examining enabling environments resulted in Decision-/CP.26, para 16 and Decision-/CMA.3, para. 14
Collaboration and stakeholder engagement	Collaboration with WIM Excom	A joint policy brief resulted in Decision-/CP.26, para 8, Decision-/CMA.3, para. 9 and key messages and recommendations
	Technical examination process on mitigation	The TEC participated in TEM on mitigation and contributed to round-table discussion on waste-to-energy and circular economy options, resulting in key takeaways from regional TEMs-M to global TEMs-M

	Technical expert meetings on adaptation	The TEC's contribution to work of Adaptation Committee produced input to technical examination process on adaptation
	Stakeholder engagement	The Engagement with over 60 organisations throughout TECs activities improved the access to practitioners' knowledge of technology-related topics, and allowed stakeholder groups to have better access to the TEC's work, key messages and recommendations
Support	Collaboration with Green Climate Fund	Joint activities achieved: - Inputs to development of GCF support for climate technologies, including via climate technology incubators and accelerators - Climate technology stakeholders increasingly familiar with climate technology support instruments under the Convention - Better support for developing countries in meeting their commitments under the Convention and the Paris Agreement
	Collaboration with Global Environment Facility	The Evaluation of the GEF Poznan Strategic Programme and dialogues between the TEC, regional centres under PSP, and the CTCN produced recommendations and follow up actions included in the TEC rolling workplan 2019-2022 and follow-up activities initiated in 2021.
	Standing Committee on Finance	TEC's input to draft guidance for Financial Mechanism operating entities resulted in Draft guidance to be considered by the COP and CMA (to be completed by SCF)
	Innovative financing	The concept note *Planned achievement*: Technical paper, TEC Brief and recommendation for COP, and dissemination to key stakeholders was prepared

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