



Technology Executive Committee

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Twenty-fifth meeting

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Draft policy brief on enabling environments and challenges to technology development and transfer identified in TNAs, NDCs and CTCN technical assistance

Cover note

I. Introduction

1. As per activity 1.c of the thematic area Enabling environment and capacity-building in its workplan for 2019–2022, the Technology Executive Committee (TEC) is to prepare a policy brief containing recommendation for enhancement of enabling environments and addressing various challenges to technology development and transfer, including those related to capacity building.
2. The policy brief draws upon information contained in the paper on enabling environments and challenges, including barriers, related to technology development and transfer, based on technology needs assessments (TNAs), NDCs, Climate Technology Centre and Network (CTCN) technical assistance (TA) and relevant TEC Briefs.
3. At TEC 25 the task force on enabling environment and capacity-building, supported by the secretariat, will be invited to present the policy brief.
4. Expected action: The TEC will be invited to consider and provide comments on the policy brief, with a view to providing guidance to the taskforce, and to finalizing it after the TEC-25.

II. Scope of the note

5. The Annex contains the policy brief on enabling environments and challenges to technology development and transfer identified in TNAs, NDCs, CTCN TA and relevant TEC briefs.

III. Possible action by the Technology Executive Committee

6. The TEC will be invited to consider and agree on the policy brief, to provide a possible guidance to the enabling environments taskforce, with a view to finalizing it after TEC-25.

Annex

Draft policy brief on enabling environments and challenges to technology development and transfer identified in TNAs, NDCs and CTCN technical assistance

I. Why this TEC brief?

1. This policy brief elaborates on enabling environments and challenges to technology development and transfer. Creating and advancing enabling environments for technology development and transfer to deploy innovative, sustainable technologies creates various opportunities related to an effective dialogue and new ways of thinking in order to raise awareness of the economic, social and environmental aspects of technology transition and potential development trajectories. Challenges about implementation of enabling environments for technology development and transfer were reported by countries in their TNAs, NDCs and CTCN TA documents for mitigation and adaptation technologies. The TEC brief is aiming to:

- (a) Examine enabling environments and challenges based on TNAs, NDCs, CTCN TA and relevant TEC Briefs;
- (b) Based on the resulting mapping, identify policies and strategies to improve enabling environments and address the challenges;
- (c) Assist the TEC in delivering enabling environment related policies and strategies to the policy makers.

II. Highlights

2. In order to achieve the objectives of the Paris Agreement, climate technologies must be implemented quickly and on a large scale. The Parties to the Convention reported multiple challenges within the different processes of technology development, deployment and transfer. As these challenges are evolving along with the technologies and their implementation, there is a need to consider the latest challenges reported by the Parties regarding different technology-related processes.

3. The TEC agreed, in its rolling workplan for 2019–2022, to an activity on examining enabling environments, including challenges and opportunities to incentivize the private and public sector in the development and transfer of technologies, building on previous work by the TEC on adaptation and mitigation technologies. An outcome of that activity includes a policy brief on examining enabling environments and challenges, including challenges based on TNAs, NDCs, CTCN TA and relevant TEC Briefs. Thus, this policy brief presents the most recent information on challenges and enablers reported in TNAs, NDCs and CTCN TA; it identifies challenges and opportunities to improve enabling environments to address the challenges; and it assists the TEC in delivering relevant key messages and recommendations to Parties at the twenty-sixth session of the Conference of the Parties.

4. As per activity 1.c of the thematic area Enabling environment and capacity-building in its workplan for 2019–2022, the TEC is to prepare a policy brief containing recommendation for enhancement of enabling environments and addressing various challenges to technology development and transfer, including those related to capacity building. The purpose of the policy brief is also to assist the TEC in delivering enabling environment related policies and strategies to the policy makers.

5. The policy brief draws upon information contained in the paper on enabling environments and challenges, including barriers, related to technology development and transfer, based on technology needs assessments (TNAs), NDCs, Climate Technology Centre and Network (CTCN) technical assistance (TA) and relevant TEC Briefs.

6. The findings of this policy brief suggest that:

(a) Overcoming economic and financial challenges is central to achieving technology development and transfer;¹

(b) Economic and financial challenges are not the only challenges for any of the prioritized technologies, which suggests that successfully implementing technologies must involve more than just overcoming economic and financial challenges;

(c) Efforts to realize technology development and transfer should not target economic and financial aspects narrowly as a single cause. Instead, multifaceted actions are recommended to ensure that all challenges hindering successful technology development and transfer are targeted;

(d) Governments have a major role to play in creating enabling environments to address the challenges to technology development and transfer by establishing and enforcing appropriate regulatory and institutional frameworks;

(e) To further stimulate the transition to improved enabling environment conditions for technology development and transfer, a combination of market stimulation and human capacity development is identified as key by developing country Parties;

(f) Support to programmes designed to strengthen the institutional and scientific capacities, with regard to technology development and transfer, of developing country Parties, in particular the least developed countries (LDCs), is reported as critical to creating the long-term enabling environments required for technology development and transfer within these countries;

(g) A need exists for education and training to assist countries in making early-stage decisions on financing, match countries' planned technology priorities with funding sources, and in general establish an essential bridge between the policy and finance communities.

7. In this TEC policy brief the following key messages are suggested:

(a) There are opportunities for extended cooperation between public and private institutions that have practical experience in evaluating, using, implementing and financing new technological innovations;

(b) Governments have a major role to play in creating enabling environments and enforcing the appropriate regulatory and institutional frameworks;

(c) Advancing and deploying innovative and sustainable approaches is crucial to facilitate technology transition, both for adaptation and mitigation, along with sustainable development trajectories;

(d) Sharing examples from countries that have effectively integrated actions on climate technologies, including the creation of their enabling environments, into government planning and policies could stimulate the adoption of a similar approach by other countries;

(e) The operating entities of the Financial Mechanism, along with other public and private institutions, have a key position in leveraging resources from the public and private sector to stimulate markets for technology development and transfer;

(f) To enable the development and transfer of adaptation technologies, it is important to acquire information and raise awareness about the potential of these to reduce climate vulnerabilities, and to strengthen institutional and organizational aspects;

(g) To enable the development and transfer of mitigation technologies, it is necessary to enhance technical capacities and to strengthen legal and regulatory frameworks;

(h) Incorporating gender considerations into the enabling frameworks created for technology development and transfer can help ensure that everyone, regardless of gender, can benefit from climate change adaptation and mitigation technologies, and that gender inequalities in those enabling activities and outcomes will be reduced or eliminated.

¹ References to dissemination of technology and transfer of, or access to, technology are to voluntary technology transfer on mutually agreed terms.

III. Background

8. In order to achieve the objectives of the Paris Agreement, climate technologies must be implemented quickly and on a large scale. Parties to the Convention report multiple challenges within the different processes preventing technology development and transfer. As these challenges evolve, along with the technologies and their implementation, there is a need to consider the latest challenges reported by the Parties with respect to different technology-related processes. There is also a need to examine the enabling environments that have helped and may continue to help countries overcome the existing challenges and achieve climate technology development and transfer at the speed and scale required. The challenges and opportunities encountered through the technology development and transfer process are a key consideration.

9. For some time, the TEC has engaged in several activities on enabling environments and challenges to technology development and transfer.

10. As part of its rolling workplan for 2012–2013, the TEC undertook the following work on enabling environments and challenges:

(a) In 2012, the TEC held two thematic dialogues on enabling environments and challenges to technology development and transfer, and called for inputs on this topic;²

(b) In 2013, the TEC prepared a report on the challenges and enablers identified in the TNA reports of 21 developing countries. Countries submitted these reports in 2012–2013.³

11. In its rolling workplan for 2014–2015,⁴ the TEC noted that it would initiate consideration of further work on enablers and challenges, taking into account the outcomes of the workshop on national systems of innovation. The TEC initiated this work at TEC 11.

12. At its twelfth meeting, held in 2016, the TEC held a thematic dialogue on enablers of and challenges to South–South cooperation regarding technologies for adaptation.

13. The TEC also incorporated a task to map TNAs, NDCs and CTCN TA documents regarding enabling environments and challenges into its rolling workplan for 2016–2018.⁵ This activity was also linked to the work of the TEC on activity 15.5 of this workplan, which, in relation to the Global Environment Facility, was intended to provide policy advice on measures to create enabling environments for technology development and transfer in developing countries and an analysis of the challenges that hamper project or programme implementation. The paper was presented at TEC 17.⁶

14. Furthermore, the TEC agreed, in its rolling workplan for 2019–2022, to an activity on examining enabling environments, including challenges and opportunities to incentivize the private and public sector in the development and transfer of technologies, building on previous work by the TEC on adaptation and mitigation technologies. An outcome of that activity includes a paper on enabling environments and challenges based on TNAs, NDCs, CTCN TA and relevant TEC Briefs.

A. Approaches and data

15. This policy brief follows the understanding of technology development and transfer set out in the Intergovernmental Panel on Climate Change special report on methodological and technological issues in technology transfer⁷ as “the broad set of processes covering the flows of knowledge, experience and equipment amongst different stakeholders, such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research institutions. Transfer encompasses diffusion of technologies and technology cooperation across and

² See TEC document TEC/2013/7/10.

³ See TEC document TEC/2013/6/10.

⁴ TEC document TEC/2015/10/12–an.III.

⁵ TEC/2016/12/13–an.

⁶ TEC/2018/17/4.

⁷ Intergovernmental Panel on Climate Change. 2000. *Methodological and Technological Issues in Technology Transfer*. B Metz, OR Davidson, J-W Martens, et al. (eds.). Cambridge: Cambridge University Press. Available at <https://www.ipcc.ch/report/methodological-and-technological-issues-in-technology-transfer/>.

within countries. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions”.

1. Approaches

16. The approach to identifying enablers and challenges builds on the methodology outlined in the guidebook *Overcoming barriers to the transfer and diffusion of climate technologies*.⁸ This methodology was adopted as standard in previous work by the TEC on challenges and enablers.⁹

17. NDCs vary greatly in their descriptions of enabling environments and challenges to technology development and transfer, which are thus mapped using broader criteria of inclusion than TNAs and CTCN TA were. Consequently, mapping the enablers and challenges listed in NDCs involves investigating the aspects that Parties report as necessary in implementing their NDCs through the application of technologies.

18. In TNAs, enablers and challenges are identified and assessed following the TNA methodology and are subsequently reported for each priority technology included in the TNAs. For all technologies in TNAs, between four and five enablers and two and nine challenges are reported per technology. An overview of the challenges and enabler categories, with explanatory text, is in annex.

19. In most cases the CTCN TA documents cover detailed technology-specific national or local initiatives. However, many CTCN TA documents do not identify enablers of and challenges to technology development and transfer, since the CTCN mandate covers more than these particular aspects.

2. Data

20. The current database for this policy brief includes information from:

- (a) 69 developing countries’ TNAs, in which challenges and enablers were identified for 787 technologies. Of the 787 technologies, 355 were for mitigation and 432 for adaptation;
- (b) 141 NDCs downloaded from the NDC registry, including new and updated NDCs;
- (c) 101 CTCN TA documents downloaded from the CTCN website¹⁰ that were available in February 2021 and supplemented with information provided by CTCN secretariat staff. Each TA document covers more than 1 technology; hence, 244 technologies are identified from the TA documents.

Table 1

Data overview

	Number	Technologies	Enablers	Challenges
TNAs	71	787	3905	4079
CTCN TA documents	101	244	567	556
NDCs	141*		1084	414
Total	313	1031	5556	5049

*See appendix for an overview of updated and new NDCs analyzed.

21. In view of the role of national designated entities (NDEs) to the Technology Mechanism, countries are encouraged to nominate their NDE as their national TNA coordinator. The role involves providing vision and leadership for the overall TNA effort; facilitating the tasks of communication, including with stakeholder groups; forming networks; information acquisition; and coordination and communication of all work products.

⁸ UNEP DTU Partnership. 2015. *Overcoming Barriers to the Transfer and Diffusion of Climate Technologies*. I Nygaard and UE Hansen (eds.). Copenhagen: UNEP DTU Partnership. Available at <https://tech-action.unepdtu.org/publications/overcoming-barriers-to-the-transfer-and-diffusion-of-climate-technologies-second-edition/>.

⁹ See TEC documents TEC/2013/6/10 and TEC/2018/17/4.

¹⁰ <https://www.ctc-n.org/technical-assistance/data>.

22. There is considerable overlap between NDEs and TNA coordinators. For 31% of Parties not included in Annex I to the Convention (non-Annex I Parties), the same person is both NDE and TNA coordinator, while for 76% of non-Annex I Parties, the TNA coordinator and the NDE are from the same government entity.

IV. Enabling environments and related challenges

23. Creating and advancing enabling environments for technology development and transfer to deploy innovative, sustainable technologies creates various opportunities related to an effective dialogue and new ways of thinking in order to raise awareness of the economic, social and environmental aspects of technology transition and potential development trajectories.

24. It makes possible extended cooperation between committed public and private organizations with practical experience in evaluating, using, implementing and financing technological innovations. A key opportunity for joint government and private research programmes lies in the development and demonstration of innovative technologies that address sustainable development objectives, are available at low cost and have a substantial impact on reducing emissions and increasing resilience to climate change.

25. While governments have a leading role in creating enabling environments for technology development and transfer by integrating these objectives into policies and planning, the majority of investments in technology come from the private sector, international donor programmes and financial institutions. In developing countries, the markets for climate technologies are rapidly expanding, creating new and improved opportunities for international exports and for domestic production and joint ventures across regional borders.

26. Another factor is leading by example, which creates opportunities to transfer good experiences and knowledge from one country to another. This could, for example, be achieved by showcasing good examples from countries that have integrated action on climate technologies, including creating enabling environments, into government planning and policies, and henceforth into their government's own operations. Sharing such experience could stimulate the adoption of similar approaches by other countries.

Box 1

Leading by example: sharing knowledge and experience about climate change adaptation and mitigation technologies diffusion, to stimulate the adoption of similar approaches by other countries

With over 1,300 registrations, a series of TNA webinars¹¹ titled "Climate Technologies and Technology Needs Assessments" have generated a lot of interest from governments, academia, businesses and NGOs worldwide.

Together with its regional TNA partners and country representatives, UNEP DTU Partnership, United Nations Environment Programme (UNEP) and the UNFCCC closely collaborated to organize the regional webinars to provide an overview of countries' climate technology priorities and activities to enhance their implementation.

The webinars were launched together with regional technology briefs and focused on Africa, Asia and the Pacific, and Latin America and the Caribbean. The objective of the briefs and webinars was to stimulate the adoption of similar approaches by additional countries, through knowledge and experience sharing from TNA countries that have integrated action on climate technologies.

A. Enabling environments

27. The information generated from the data extracted from NDCs, TNAs and CTCN TA documents reveals that the most frequently identified enablers across all technologies are in the economic and financial category, where 90% of the mitigation technologies are reported to require

¹¹ Available at <https://tech-action.unepdtu.org/webinars/>.

the implementation of enablers, as is the case for 85% of the technologies for adaptation. An overview is provided in Figure 1.

28. The data analysis shows that, in addition to financial resources, systematic and structural changes must be made to facilitate the development and transfer of technologies. Subsidization is often listed as a main enabler of technology development and transfer. Most developing country Parties identified the creation of enabling environments in the economic and financial sectors through regulations and policies, as necessary, to assist with the development and transfer of new technologies.

Box 2

Systematic and structural changes: establishment of appropriate frameworks for mitigation technology development and transfer in Tunisia

The transport sector in Tunisia is a large contributor to greenhouse gas (GHG) emissions in the country. According to the country's 2012 GHG emissions inventory, the sector accounts for 23.9% of GHG emissions attributable to energy.

It was estimated that this figure would increase considerably in the following years given the steady increase in the number of vehicles in Tunisia, which reached 2 million in 2016. The number of passenger cars is increasing especially quickly. Tunisia's TNA prioritized the technology of hybrid vehicles, particularly fully hybrid vehicles, because of its relevance to the Tunisian context. First, this technology has significant potential for reducing emissions, especially since traffic in Tunisian cities is characterized by braking and stopping, which considerably increases fuel consumption and CO₂ emissions. Second, it does not require huge investments because special infrastructure is not needed. Tunisia has emphasized the environmental and social co-benefits of the technology, such as a reduction in pollution and noise levels in urban areas, which would have a notable impact on the health of its inhabitants.

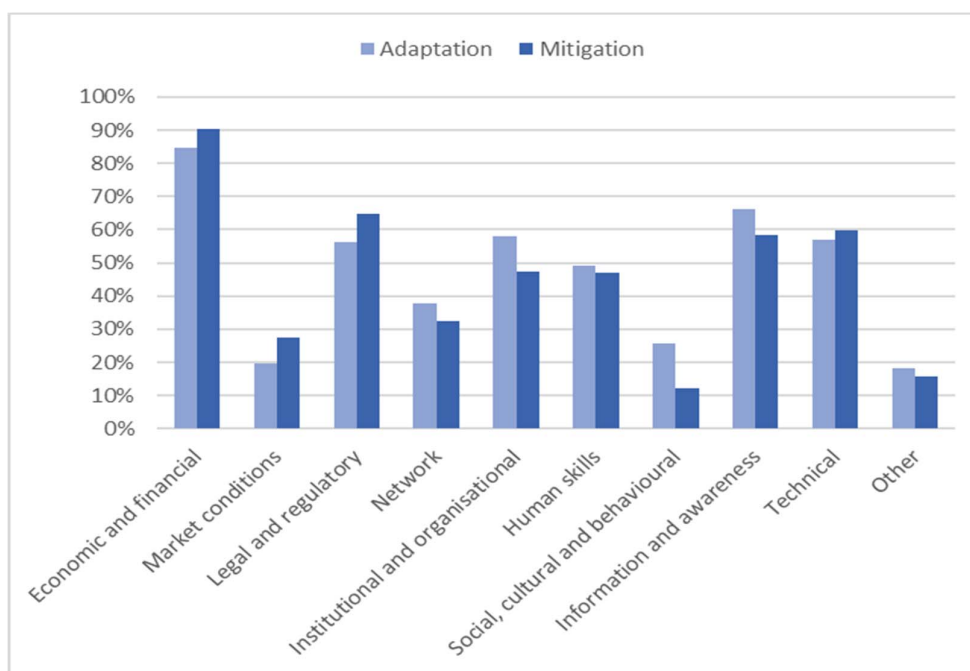
Hybrid cars are currently not largely used on the market in Tunisia, and through its TNA, the country identified challenges related to the lack of approved standards and lack of knowledge of the technology. Consequently, the Tunisian government, acting outside any international cooperation, has introduced a national programme to create an enabling environment for hybrid cars by establishing appropriate regulatory and legal framework and by building the capacity of relevant stakeholders.

29. Since inadequate human skills, institutions and organizations, as well as information and awareness, are frequently identified as challenges across all technologies, Parties highlight the need to enhance capacities by strengthening the structures, competencies and resources of individuals, institutions, organizations and sectors. The reported need to enhance human skills also reflects the necessity to establish and enhance related education policies, publicly funded research and development, and training programmes.

30. Specifically, for adaptation, enablers in the category information and awareness-raising are listed as the second most frequently reported, being registered for 66% of the technologies, while 58% are registered in the category institutional and organizational enablers, and 57% in the category technical aspects.

31. For mitigation, the second most reported category is legal and regulatory frameworks, which are reported for 65% of the technologies, while technical aspects are reported for 60%.

Figure 1
Overview of enablers for technology development and transfer



Box 3

Gender responsiveness

Since 2018, national TNA teams have taken a gender-responsive approach that follows recent TNA guidelines.¹² The guidelines make recommendations on how to increase gender equality alongside the implementation of climate change adaptation and mitigation technologies. This may include regulation, market creation and stimulation, gender-specific support such as subsidies and quotas, and financing. Countries integrate gender considerations when identifying enablers for technology development and transfer:

- “Both men and women can equally take advantage of prioritized climate mitigation technologies, if gender aspects are considered during all stages of supportive policies development. Taking into account existing inequalities, climate technologies should be deployed considering women’s access to technology value chains, dedicated trainings on climate technologies for women, the participation of women in stakeholder consultations and decision-making process to ensure that women can benefit from the diffusion of new technologies” (Ukraine mitigation TNA 2020);
- “Participation of women and men should be ensured recognizing their different needs, inputs, interests and benefits in the irrigation system including land and water use rights. Access and control over land and water is critical in irrigation and deliberate provisions are needed to ensure inclusion of disadvantaged groups such as women and persons with disabilities in community-based irrigation programs” (Uganda adaptation TNA 2021).

1. SIDS, LDCs and non-Annex I Parties

32. The most frequently reported enablers reported by small island developing States (SIDS), LDCs and non-Annex I Parties all fall within the economic and financial category. An overview is provided in Figure 2.

33. Different patterns occur among the enablers being reported across the three groups (SIDS, LDCs and non-Annex I Parties):

¹² See <https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2019/07/web-tna-gender-guidebook-01.pdf>.

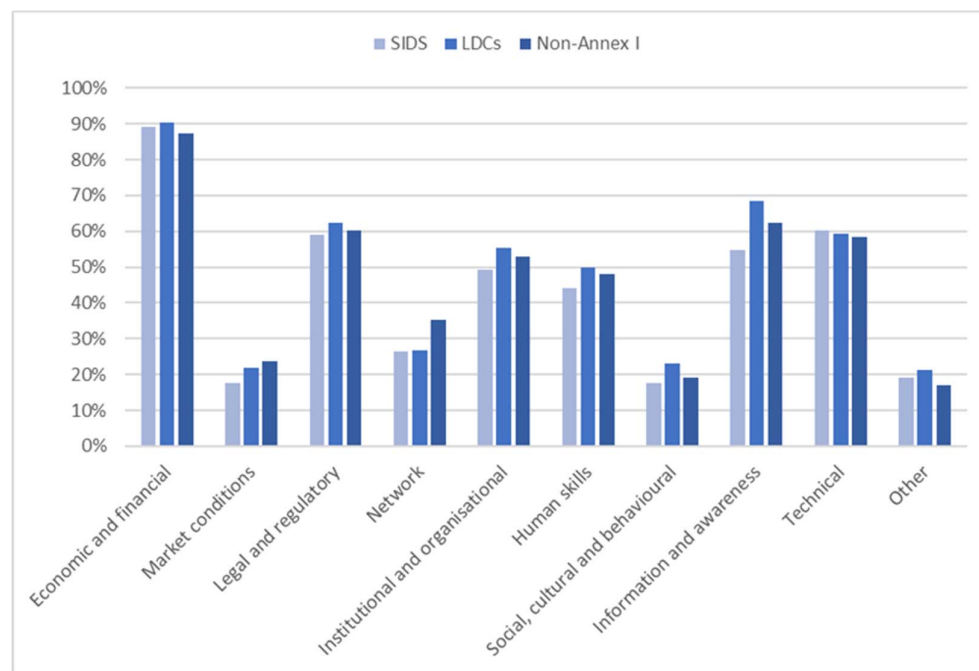
(a) For 89% of technologies, SIDS identify a need for enablers to be implemented in the financial and economic category, while enablers in the technical category are listed for 60% of the technologies. For 59% of technologies, required enablers are in the legal and regulatory category, while 55% are in the information and awareness category;

(b) LDCs report the most enablers required per technology and are hence ranked highest in the need for the implementation of enablers in 7 out of 10 enabler categories, including economic and financial enablers (for 90% of technologies), information and awareness-raising enablers (for 69% of technologies) and legal and regulatory enablers (for 62% of technologies);

(c) Non-Annex I Parties reported that enablers within the economic and financial category are required for 87% of their priority technologies in order to establish appropriate enabling environments. Also, required enablers are identified within the categories information and awareness for 62% of the technologies, legal and regulatory for 60% and technical for 58%.

Figure 2

Distribution of enablers identified by SIDS, LDCs and non-Annex I Parties



2. Regional analysis

34. A regional overview of enablers is provided in Figure 3.

35. In the Africa region, the most frequently identified enablers are economic and financial (89%), followed by information and awareness (66%), legal and regulatory (59%), and technical (55%).

36. In Latin America and the Caribbean, economic and financial (85%) enablers are also predominant and are followed by information and awareness (61%), technical (59%) and institutional and organizational (56%).

37. In the Asia region, economic and financial enablers (86%) predominate over legal and regulatory (70%) and technical (63%) enablers, which are closely followed by institutional and organizational capacities (61%).

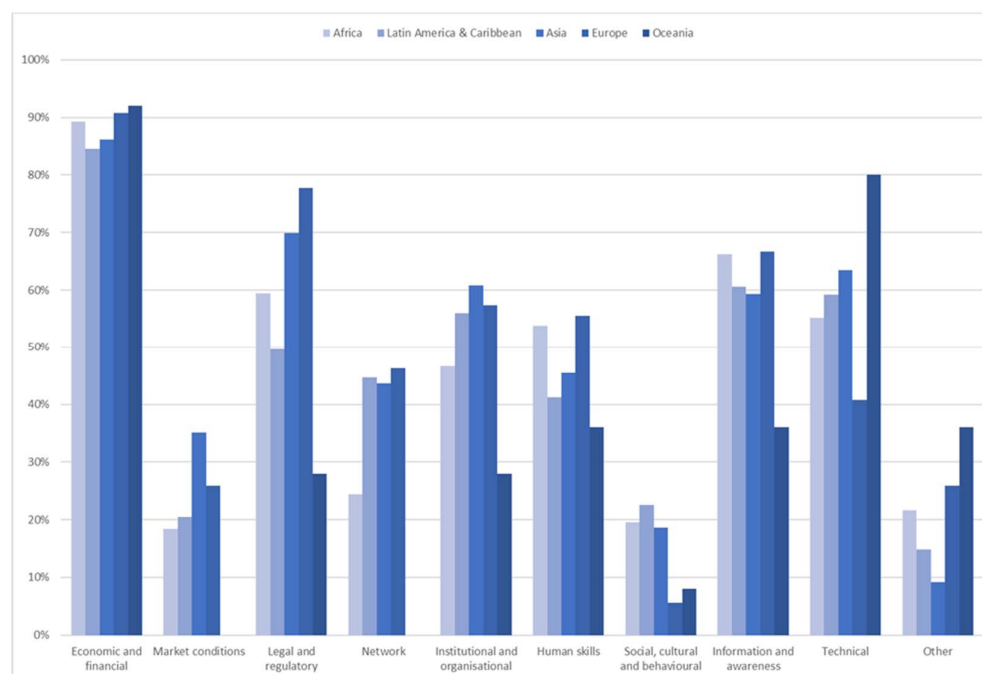
38. In Europe, economic and financial (91%) enablers are dominant as well. They are followed by legal and regulatory (78%) and information and awareness (67%).

39. In Oceania, economic and financial enablers are reported for 92% of the technologies. For 80% of the technologies, enablers in the technical category are reported as being necessary. Like the challenge overview, no enablers in the categories market conditions and network enablers were identified in Oceania. The reason for this may be that the data available from this region come from

CTCN TA documents and NDCs, for which challenges and enablers are reported for 13 countries only.

Figure 3

Regional distribution of reported enablers



3. Sectoral analysis of enablers

40. This section builds on CTCN TA data and TNA data only and focuses on energy and transport sectors in the case of mitigation, and water and agriculture sectors in the case of adaptation.

Enablers in mitigation sectors: energy and transport

41. In the energy sector, economic and financial enablers are identified as required for 89% of the technologies, and enablers in the legal and regulatory category for 76%. For example, by updating and enforcing technical regulations for appliances and strengthening the associated governance and legal frameworks, use of energy-efficient appliances in the residential and public sectors can be increased, thus contributing to climate change mitigation.

Box 4

Catalyzing private and public sector investments in Armenia to build a market for energy-efficient building retrofits

Armenia is highly vulnerable to the adverse impacts of climate change. Unsustainable energy use in buildings is one of the core problems for the Armenian population, as about one third of Armenian households are energy-poor, meaning that they spend more than 10% of their budget on energy. Imported fossil fuels provide half of the energy used in buildings, and 24% of the country's CO₂ emissions come from energy use in buildings, which makes domestic energy consumption a major GHG emitter in the country while also increasing energy dependence on foreign resources.

Armenia's TNA recognized these problems and identified improving energy efficiency in buildings as a high priority to reduce CO₂ emissions, energy poverty and dependence on fossil fuel imports. One project focusing on improving energy efficiency through building retrofits has received funding from the Green Climate Fund alongside co-financing from other sources, resulting in a total project value of USD 29.8 million. The aim of the project is to build a market for energy-efficient building retrofits in Armenia, simultaneously catalysing private and public sector investments of up to USD 100 million.

The project will combat the three problems identified above simultaneously: first, by achieving sizeable energy savings and emission reductions of up to 5.8 t CO₂ both directly and indirectly

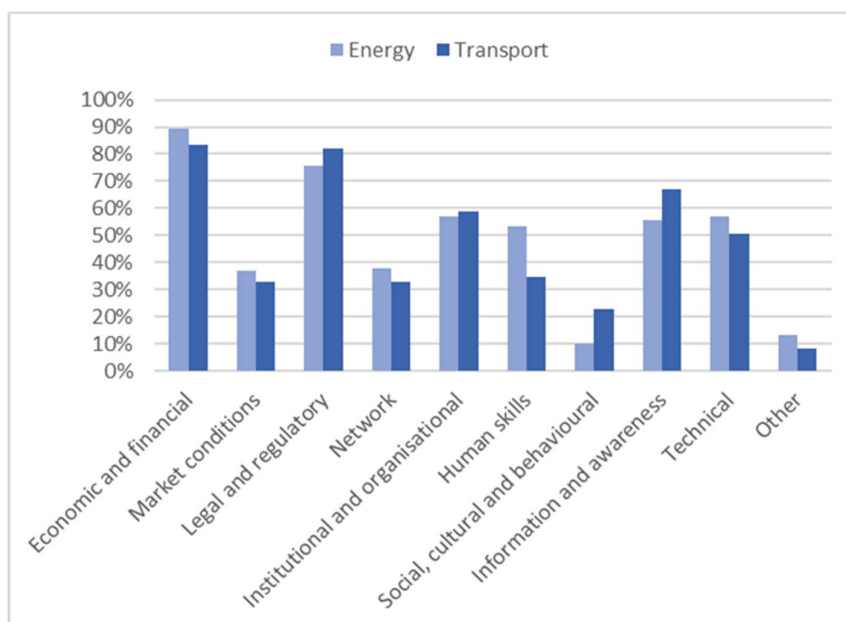
over the lifetime of the project; second, by reducing dependence on energy imports while creating green jobs; and third, by reducing energy poverty and thus directly benefiting over 200,000 people. This lays the basis for a more climate-sustainable energy sector and more energy-efficient buildings in accordance with Armenia's NDC.

42. In the transport sector, economic and financial enablers are most dominant, being identified for 84% of the technologies, and legal and regulatory enablers are identified for 82%. For example, hybrid cars may not be currently available because of a lack of approved standards and a lack of knowledge of the technology. Hence, enablers put in place by a government could include implementation of an appropriate regulatory and legal framework and building the capacity of relevant stakeholders by introducing a national program in support of hybrid cars, for example.

43. For both sectors, the implementation of enablers related to information and awareness, institutional and organizational, and technical aspects is key for many technologies to create the required enabling environments for technology development and transfer.

Figure 4

Enablers in the mitigation sectors: energy and transport



Enablers in adaptation sectors: agriculture and water

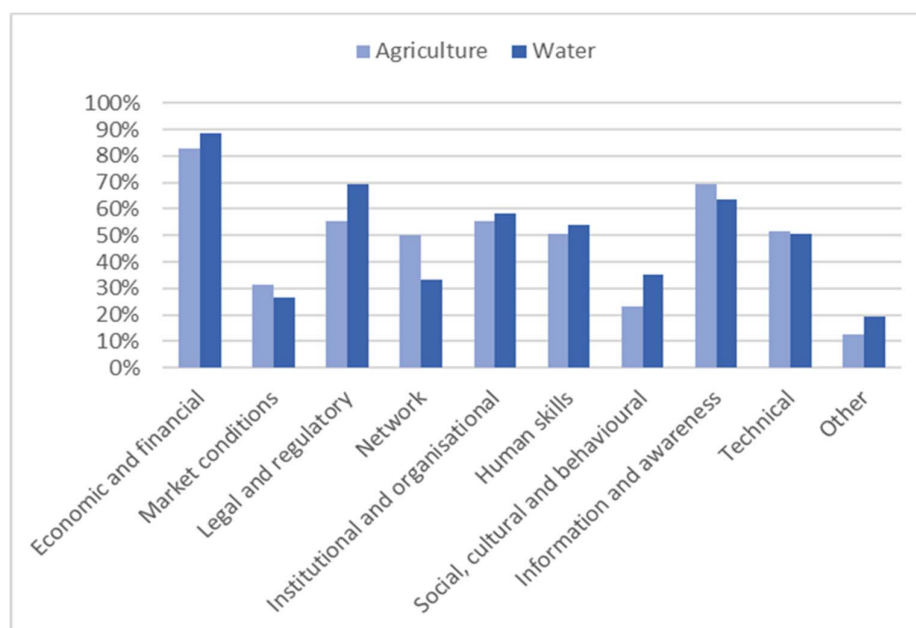
44. An overview of enablers identified for technologies in the respective sectors of agriculture and water for adaptation is provided in Figure 5.

45. In the agriculture sector, economic and financial (83%) and information and awareness (69%) are the most commonly identified enablers, followed by legal and regulatory (55%) and institutional and organizational (55%).

46. In the water sector, enablers in the economic and financial category are reported for 89% of the technologies, followed by legal and regulatory (69%), information and awareness (64%) and institutional and organizational (58%) enablers.

47. For example, strengthening a country's human skills and capacity to build an early warning system for droughts will increase its capacity to adapt to climate change and increased climate variability in both the agriculture and water sectors. Building this capacity will also facilitate future interventions that will have positive impacts on organizations and stakeholders involved in dry-season management, including local farmers.

Figure 5
Enablers identified in the adaptation sectors: agriculture and water



B. Challenges

48. An overview of the distribution of all challenges reported for technology development and transfer in TNAs, NDCs and CTCN TA documents for mitigation and adaptation technologies is provided in Figure 6.

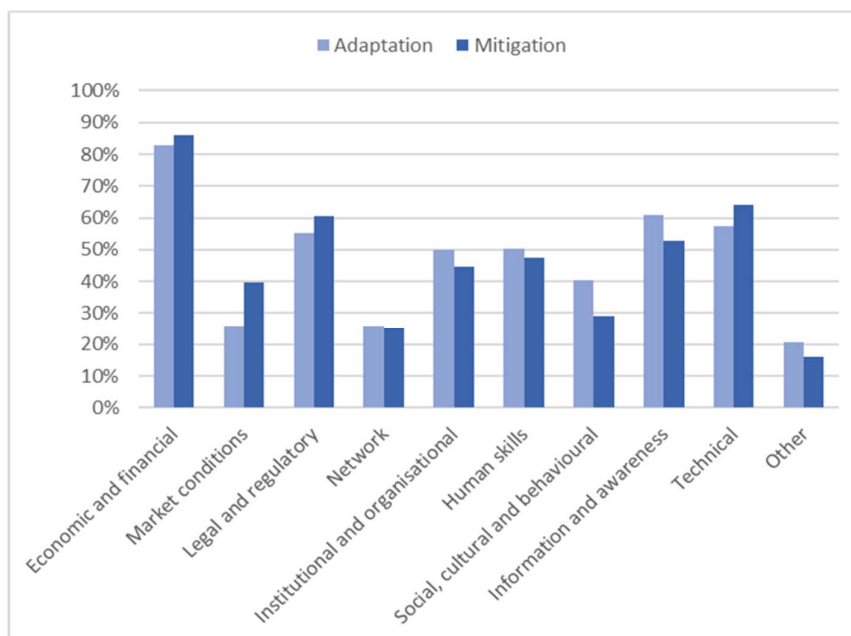
49. Challenges in the economic and financial category are the most frequently reported for both adaptation and mitigation technologies. Challenges in this category are related to, for example, the high initial cost of technologies, difficulties in obtaining loans, uncertainties regarding returns on investment and a general lack of financial resources. Specifically, the economic and financial challenges listed for some technologies at the household level are the high upfront costs and high capital costs.

50. Even though technologies are inherently dependent on or affected by national or regional conditions, specific economic and financial challenges are associated with most types of technology. For instance, among the most commonly reported challenges to the diffusion of solar energy technology are high initial costs and interest rates on loans for purchasing the systems. Despite technological improvements and lower prices, most Parties still identify high installation costs as a challenge. Some Parties explain how high interest rates on loans for solar technologies hinder the penetration of solar photovoltaics, while operating and maintenance costs are cited as an additional challenge, especially for small-scale, decentralized or off-grid solar photovoltaic projects. For 58% of the technologies across mitigation and adaptation, challenges are also reported in the category legal and regulatory frameworks, which highlights a need for improved, strengthened and streamlined domestic policy frameworks to facilitate the development and transfer of technologies.

51. Specifically, in relation to adaptation, economic and financial challenges are reported for 83% of the technologies, whereas challenges in the category information and awareness are reported for 61%. Technical challenges are reported for 57% of the technologies, and challenges related to legal and regulatory frameworks are reported for 55%.

52. In relation to mitigation, economic and financial challenges are identified for 86% of the technologies, while challenges are reported in the technical category for 64%. Legal and regulatory challenges are identified for 61% of the technologies.

Figure 6
Challenges to technology development and transfer



1. SIDS, LDCs and non-Annex I Parties

53. With respect to how challenges to technology development and transfer are reported by the groups of SIDS, LDCs and non-Annex I Parties, differences are related especially to the categories institutional and organizational challenges; human skills; and social, cultural and behavioural aspects. In summary:

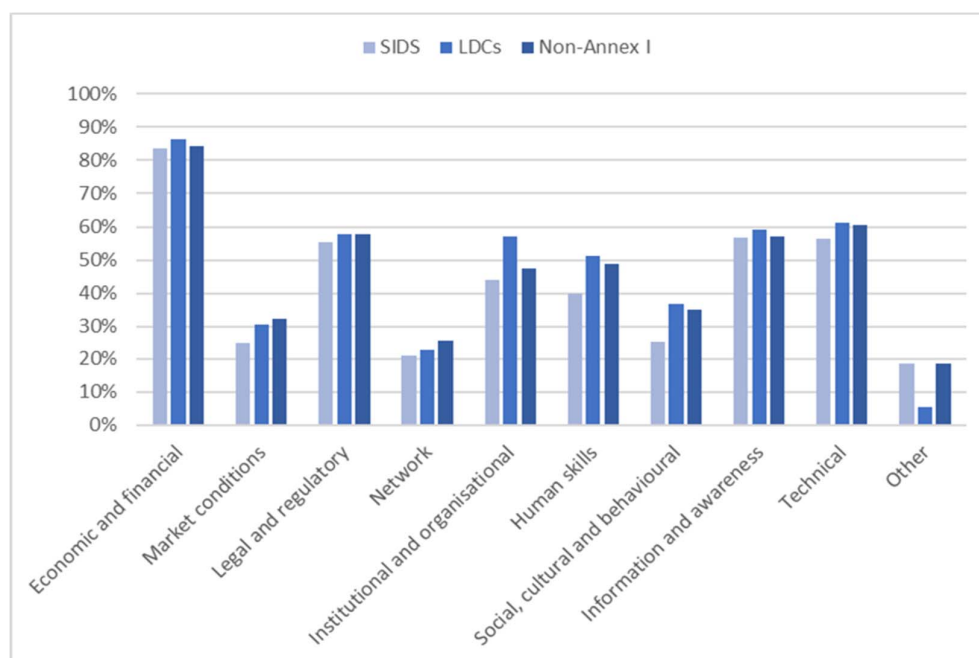
(a) SIDS report the majority of challenges in the economic and financial (83%), information and awareness (57%) and technical (56%) categories. SIDS report fewer challenges per technology than do LDCs and non-Annex I Parties;

(b) LDCs report the majority of the challenges in the economic and financial (87%), technical (61%) and information and awareness (59%) categories;

(c) Non-Annex I Parties report the majority of challenges in the economic and financial (84%), technical (61%), legal and regulatory (58%) and information and awareness (58%) categories. Non-Annex I Parties also report more challenges related to market conditions and network development, compared with SIDS and LDCs.

54. Across non-Annex I Parties, LDCs and SIDS, economic and financial challenges stand out as the most important category. An overview is provided in Figure 7.

Figure 7
Distribution of challenges identified by SIDS, LDCs and non-Annex I Parties



55. Looking into the challenges reported within the information and awareness category, the availability of and access to information on technology costs, performance and effects are key. The CTCN, while providing TA to Parties upon request, plays a role in closing this information gap.

56. For example, complete information is needed to identify and understand the impacts and effectiveness of technologies, their requirements for enabling environments and the potential scale of their applications. While the lack of sufficient data is a global problem, this challenge is particularly pronounced in developing countries where such data are often unavailable or unreliable. Building skills in data gathering, analysis, management, presentation, verification, standardization and harmonization removes uncertainty and is therefore a key aspect of overcoming the challenges that are critical in creating an effective enabling environment for technology development and transfer.

2. Regional analysis

57. In the Africa region, the most frequently identified challenges are economic and financial (85%), technical (58%), legal and regulatory (52%) and information and awareness (52%).

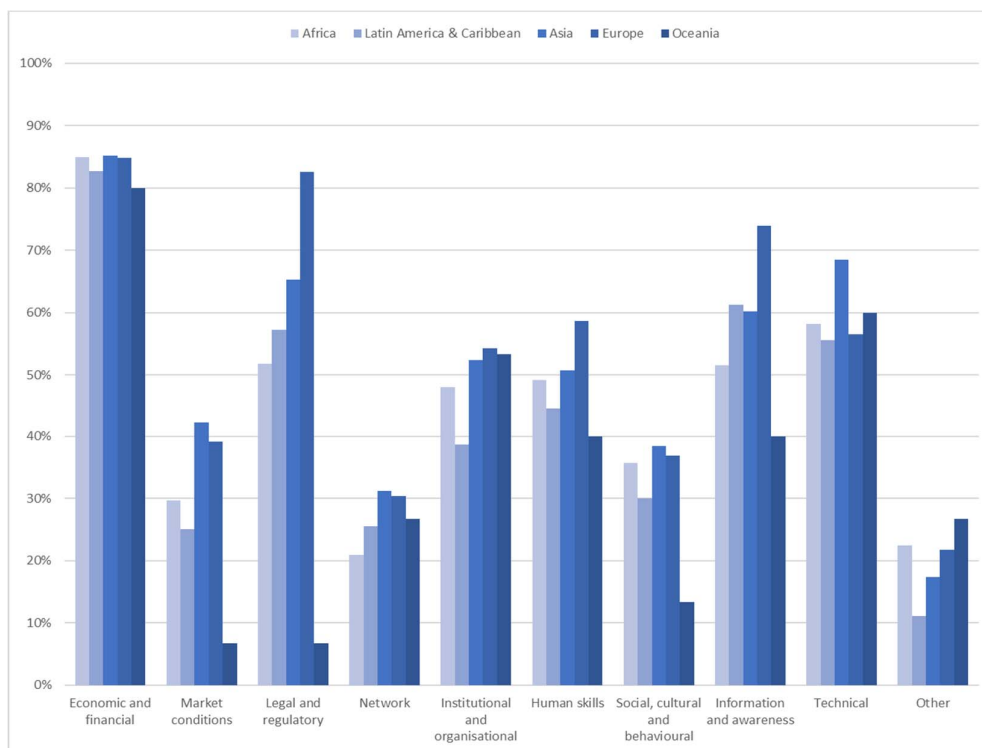
58. In the Latin America and Caribbean region, economic and financial (83%) challenges are also predominant, followed by information and awareness (61%), legal and regulatory (57%) and technical (56%) challenges.

59. In the Asia region, economic and financial (85%) challenges predominate over technical (68%), legal and regulatory (65%), and information and awareness (60%) challenges.

60. In the Europe region, legal and regulatory (83%) challenges are almost as important as economic and financial challenges (85%) and are followed by information and awareness (74%) challenges.

61. In the Oceania region, economic and financial (80%), technical (60%) and institutional and organizational (53%) challenges are the three most commonly identified categories.

Figure 8
Challenges identified per region



62. Across regions, economic and financial, technical, and information and awareness challenges are frequently reported. In all regions, the Parties have identified economic and financial challenges as the most common challenges to technology development and transfer. Similarly, in three of the five regions, technical challenges are the second most frequently identified challenge. Legal and regulatory challenges are the third most commonly reported challenges in four of the five regions.

Box 5

Regional challenges: Southern Africa

In Southern Africa, Parties have reported multiple challenges regarding energy-efficient technologies, such as energy-efficient lightning technologies, air conditioning, transformers, motors and refrigerators. Hence, with respect to economic and financial challenges, countries in the region highlighted the limited support available for project preparation and the limited exposure to local financial institutions supporting the development of renewable energy and energy-efficient investment projects.

Furthermore, regarding legal and regulatory challenges, Parties report inadequate or a lack of enabling domestic policies and regulations aimed at increasing market stimulation regarding, for example, the uptake of renewable energy and energy-efficient technologies. In many instances, Parties reported that if private sector companies are not provided with economic and financial incentives, they may not implement energy-efficient technologies that require upfront capital investment. The private sector is often identified as a main actor along the entire pathway from technology development to diffusion, in addressing both shorter- and longer-term technological needs. Market opportunities, investment procedures and profitability criteria are key terms used in discussing the incentives and behaviour of both providers and recipients of technology.

The isolation of energy policy development, which has created disharmony with regional and international policies, was noted as another major challenge to the successful deployment of technology, alongside the inability to create an integrated market owing to a lack of harmonization in labelling technologies.

In addition, countries in Southern Africa identified limited capacity and awareness among stakeholders regarding the technical and economic potential of deploying renewable energy and energy-efficient technologies. Similarly, the positive social and environmental impacts of such technologies are not widely acknowledged across countries. This lack of information

and awareness directly influences decision-making processes regarding investment and therefore often leads to ‘business as usual’ purchasing scenarios.

Finally, countries in Southern Africa identified other challenges, such as shortages of skilled technical personnel (technical capacity for the installation, operation and management of the concerned technologies) and lack of knowledge at vocational and university levels, which limit the successful deployment of technologies. To overcome shortages of skilled technical personnel, countries often include, as part of their technology action plan, training programmes and capacity-building of personnel.

3. Sectoral analysis

63. As NDCs often do not list specific challenges at the sector level but only do so generally with respect to technology transfer issues, this section builds on CTCN TA and TNA data only. The most commonly identified sectors across the database are energy and transport in the case of mitigation, and water and agriculture in the case of adaptation.

Challenges in the mitigation sectors: energy and transport

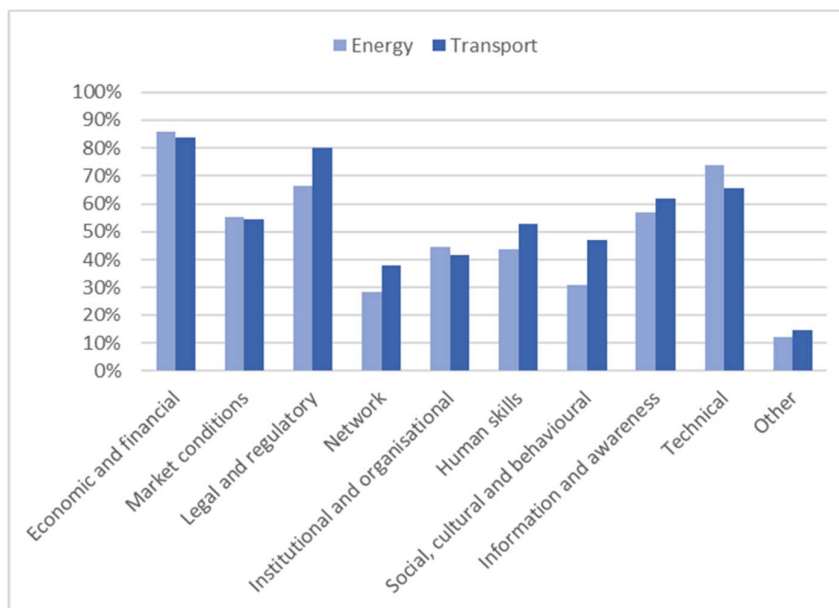
64. Economic and financial challenges are the most commonly identified challenges in the energy sector (86%), followed by technical (74%) and legal and regulatory (66%) challenges.

65. In the transport sector, economic and financial challenges are dominant, being reported for 84% of the technologies, while legal and regulatory challenges are reported for 80%.

66. There are considerable differences between the challenges listed for the technologies in the two sectors. Hence, challenges in legal and regulatory frameworks, networks, human skills, and social, cultural and behavioural aspects are more frequently reported for technologies in the transport sector than in the energy sector. An overview of the challenges reported in the two sectors is provided in Figure 9.

Figure 9

Challenges in the mitigation sectors: energy and transport



Challenges in the adaptation sectors: agriculture and water

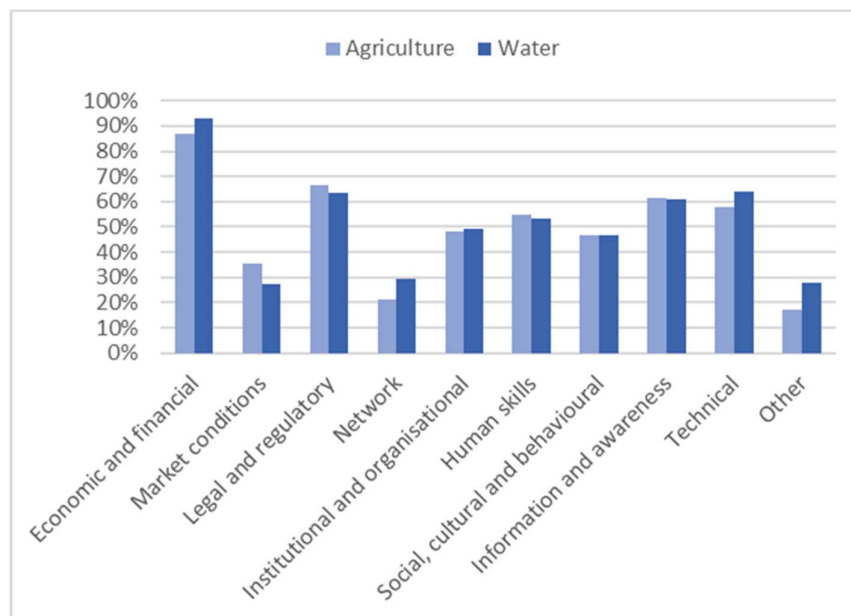
67. An overview of the challenges in the agriculture and water sectors is provided in Figure 10.

68. In the agriculture sector, economic and financial challenges are listed for 87% of all technologies in the sector. Legal and regulatory challenges are also frequently encountered in this sector, as they are reported for 67% of the technologies. The other two main challenges reported for technologies in the agriculture sector are in information and awareness (61%) and technical (58%).

69. In the water sector, 93% of the technologies are reported as facing challenges in the economic and financial category. These challenges are followed by technical (64%), legal and regulatory (63%), and information and awareness (61%) challenges.

Figure 10

Challenges in the adaptation sectors: agriculture and water



C. Policies and strategies to create enabling environments for technology development and transfer

70. Given the multidimensional nature of the challenges and opportunities for technology development and transfer, creating enabling environments involves processes that are deeply embedded in differing social, economic and development contexts.

71. Technology development and transfer should therefore be understood not as a one-off event, but as an ongoing process that depends upon, and influences, other ongoing national and international processes. The pathways for technology development and transfer are generally government driven, private sector driven or community driven. However, an integrated governance structure is also central to the success of technology development and transfer.¹³ For example, a coordinated effort on awareness-building throughout government, private sector and community groups is likely to greatly improve the likelihood of the technologies in question being successfully transferred.

72. Also, academia and research play an important role in the process of technology development and transfer. A review of developing countries' NDCs¹⁴ revealed that almost 50% of all developing countries specifically referred to the importance of technological innovation, research and development for achieving their climate objectives. Hence, strengthening institutional and scientific capacities is critical for creating long-term enabling conditions for technology development and transfer. Joint research and development efforts between countries that have well-developed research and development infrastructure and countries that are still constrained by lack of access to finance and information related to this may address some of the challenges relating to development and transfer of technologies.

73. This section explores the role of governments, the private sector and communities in the design and implementation of policies and strategies to enhance enabling environments for technology development and transfer.

¹³ See FCCC/TP/2006/2.

¹⁴ Charlery and Traerup (2018).

1. Governments

74. Experience shows that, to make a significant impact on the development and transfer of a specific technology, it is necessary to apply a relatively broad set of complementary enablers to address the challenges at various levels.

75. The choice of one set of enablers over another is generally strategic. The proposed sets of enablers are discussed, negotiated and agreed upon by relevant stakeholders nationally so as to be consistent with domestic objectives, and finally discussed at the highest level in the ministries involved before selecting the final set of enablers to be included in a programme for technology development and transfer, such as a technology action plan.

76. Limited financial resources to cover capital costs are typically listed as the main obstacle to technology development and transfer across NDCs, TNAs and CTCN TA documents. This is supplemented with enablers to address lacking or inadequate regulatory frameworks, market conditions, and institutional and organizational capacities. Insufficient human skills are often also identified as challenges, with a response measure often identified through a need for tailored capacity-building.

77. Another role of governments is related to the design and implementation of policies to incentivize the adoption of technologies, for example, through financial incentives such as seed funding, financial guarantees, tax exemptions and low-interest loans, in addition to the provision of financial support to research, innovation and technological development.

78. The role of governments in creating enabling environments for technology development and transfer is further emphasized through their influence on legal and regulatory frameworks for international technology development and transfers and foreign financial flows, including introducing market-based instruments for market regulation and development. Thus, macroeconomic policy frameworks also play a central role in creating the enabling conditions for technology development and transfer.

79. In their TNAs, NDCs and CTCN TA documents, Parties also identify the role of governments in providing non-fiscal measures such as establishing specific technology standards. Market interventions, such as correcting subsidy distortions or disincentivizing ingrained industries and processes that have created challenges to the uptake of technologies, are also listed as a key role for governments.

80. An effective enabling environment for technology development and transfer is often characterized by greater coordination and communication among government departments and agencies, with the goal of streamlining and easing the way for investment in technologies and presenting international efforts with an integrated approach at the national and subnational level.

2. Private sector

81. To ensure the best possible results, most technology development and transfer involves cooperation between governments, the private sector and research and development institutions. There is a continuous need to improve involvement by the private sector and to harness private investments in technological cooperation.

82. The private sector is often identified as a main actor along the entire pathway from technology development to diffusion, in addressing both shorter- and longer-term technological needs. Market opportunities, investment procedures and profitability criteria are key words used in discussing the incentives and behaviour of both the providers and recipients of technology. In the analysis of TNAs, NDCs and CTCN TA documents, many Parties identify a lack of incentives for the private sector to invest in climate technologies, as well as poor institutional linkages, particularly between the public and private sector, as key challenges to technology development and transfer. This also underpins one of the functions of the CTCN, namely to facilitate international partnerships among public and private stakeholders to accelerate the innovation of environmentally sound technologies and their diffusion to developing country Parties.¹⁵

83. The role of the private sector in developing and transferring technology could be extended if provided with the right incentives. This leads back to the role of national governments in creating

¹⁵ See decision 1/CP.16.

the right enabling conditions for both domestic and international technology development and transfer. The introduction of incentives, such as subsidies for investment and tax exemptions, would likely result in an increase in profitability for the private sector by investing in the required implementation of technology, thereby encouraging further investment. In this case, the role of the private sector could be extended by implementing regulations adopted by governments.

Box 6

Public–private cooperation: cooperation between public and private institutions for scaling up adaptation technologies in Indonesia

In Indonesia, coastal zones are greatly impacted by flooding owing to a combination of rising sea levels, land subsidence and higher river levels because of extreme weather aggravated by climate change. Indonesia prioritized, in its TNA, technologies for coastal protection and, building on this, requested TA from the CTCN for flood-hazard mapping and forecasting systems and hydrological modelling in the city of Jakarta.

The TA brought technology experts together with government agencies to help reduce flooding risks, increased local capacity in high-resolution hydrodynamic modelling, created a hydrodynamic flood model and helped shape the design of climate-resilient infrastructure projects, including but not limited to constructing a giant seawall to reduce the risk of flooding and coastal inundation in Jakarta. The TA also included anticipated financial support in the amount of USD 5 million through bilateral funding to scale up the technological approach to polders in Jakarta.

3. Communities

84. Government, the private sector and community stakeholders all play integral roles in the process of transferring technology in all sectors. Although the process of transfer varies, the importance of considering the entire governance structure (government, private sector and community) is clear. This includes consideration of strategies to overcome the challenges to technology development and transfer related to investment costs, research, development, awareness-raising, institutional capacity and so forth.

85. Given that many Parties identify challenges related to social, cultural and institutional aspects of technology development and transfer in their TNAs, NDCs and CTCN TA documents, these aspects must be appropriately considered when assessing the potential for technology development and transfer. The challenges can only be addressed through the inclusion of all stakeholders in the governance system, as described above. For example, community groups and individuals have an important role to play in the design and implementation of urban planning and management in order to transcend cultural challenges.

86. There is a long history of participatory approaches being essential in creating efficient technology development and transfer processes, including establishing the appropriate enabling environments. A participatory approach results in a process that is needs-driven and appropriate to the local context. The process should be in line with community perceptions of local problems and should draw on local knowledge.

87. Governments may have a strategy to increase the capacity for the local and in-country production of technologies. Communities should be invited into the process through active participation by, for example, reaching out to community-based organizations, awareness-raising campaigns and empowerment through capacity-building. Capacity-building should be designed both for participation in decision-making processes and to increase the capacity of stakeholders throughout the technology production chain. This will improve local productive capacity and have a positive impact on local living conditions.

88. Purely community-driven pathways may be found in places where a local need for technology is recognized but no government or private sector interest is anticipated.

V. Key findings

89. The key findings from the analysis of challenges and enabling environments as reported by Parties in their nationally driven TNAs, NDCs and CTCN TA documents are presented below.

Comparing findings from previous TEC work¹⁶ on challenges and enabling environments to technology development and transfer provides additional opportunities for reflecting on these issues.

90. The findings of this policy brief suggest that:

(a) Overcoming economic and financial challenges is central to achieving technology development and transfer;

(b) Economic and financial challenges are not listed as the only challenges for any of the prioritized technologies, which indicates that the successful implementation of technologies must be achieved by doing more than overcoming just economic and financial challenges;

(c) Efforts to realize technology development and transfer should not target economic and financial challenges as a single cause. Instead, multifaceted actions are recommended to ensure that all challenges that hinder successful development and transfer are targeted;

(d) Governments have a major role to play in creating enabling environments to address the challenges to technology development and transfer by establishing and enforcing the appropriate regulatory and institutional frameworks;

(e) To further stimulate the transition to improved enabling environment conditions for technology development and transfer, a combination of market stimulation and human capacity development is identified as key by developing country Parties;

(f) Support to programmes designed to strengthen institutional and scientific capacities, with regard to technology development and transfer, of developing country Parties, and in particular LDCs, is reported as critical to creating the long-term enabling environments required for technology development and transfer within these countries;

(g) There is a need for education and training to assist countries in making early-stage decisions on financing, match countries' planned technology priorities with funding sources, and in general establish an essential bridge between the policy and finance communities.

91. These findings are supplementary to, and closely aligned with, previous work by the TEC¹⁷ on the challenges to and enabling environments for technology development and transfer, which highlighted the need to:

(a) Engage the financial and business community in enhancing access to financing;

(b) Strengthen collaboration on research and development;

(c) Find efficient ways of developing national capacities;

(d) Initiate activities related to policy and regulatory frameworks.

92. In addition, the findings of this policy brief align well with the results from the survey on the endogenous capacities developed by the TEC as per activity 2 of the thematic area Enabling environment and capacity-building of the workplan for 2019–2022. Financing issues were identified as top enablers and challenges in both workstreams. Technical skills were viewed as highly important, as were information, awareness and communication issues. The endogenous capacities and technologies survey results reflect the perceptions of national representatives, members and observers of various constituted bodies, as well as CTCN Network members, whereas this policy brief builds on data on enablers and challenges reported by countries in their national efforts (TNAs, NDCs, and CTCN TA documents) under the UNFCCC.

93. Finally, the findings of the policy brief show the crucial role of the operating entities of the Financial Mechanism in ensuring a strong collaboration between the financial mechanisms, private sector entities, and local and national governments. The findings also highlight the importance of the Financial Mechanism in leveraging resources from the public and private sector in order to stimulate markets for technology development and transfer.

¹⁶ See TEC documents TEC/2013/7/10, TEC/2013/6/10, TEC/2017/15/14 and TEC/2018/17/4.

¹⁷ See TEC documents TEC/2013/7/10 and TEC/2013/6/10.

VI. Key messages

94. From the findings presented in the policy brief, the following key messages are suggested:

(a) There are opportunities for extended cooperation between public and private institutions that have practical experience in evaluating, using, implementing and financing new technological innovations;

(b) Governments have a major role to play in creating enabling environments and enforcing the appropriate regulatory and institutional frameworks;

(c) Advancing and deploying innovative and sustainable approaches is crucial to facilitating technology transition, both for adaptation and mitigation, along with sustainable development trajectories;

(d) Sharing good examples from countries that have integrated actions on climate technologies, including the creation of their enabling environments, into government planning and policies could stimulate the adoption of a similar approach in other countries;

(e) The operating entities of the Financial Mechanism, along with other public and private institutions, have a key position leveraging resources from the public and the private sector to stimulate markets for technology development and transfer;

(f) To enable the development and transfer of adaptation technologies, it is key to acquire information and raise awareness about the potential of these to reduce climate vulnerabilities, and to strengthen institutional and organizational aspects;

(g) To enable the development and transfer of mitigation technologies, it is necessary to enhance technical capacities, and to strengthen legal and regulatory frameworks;

(h) Incorporating gender considerations into the enabling frameworks created for technology development and transfer can help to ensure that both women and men can benefit from climate change adaptation and mitigation technologies, and that gender inequalities in those enabling activities and outcomes will be reduced or eliminated.