Framework Convention on Climate Change

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Technology Executive Committee

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Virtual meeting, 7–10 and 13 September 2021 (TEC-CTCN joint session)

Draft joint publication on Technology and NDC - Stimulating the Uptake of Technologies in Support of NDC Implementation

Cover note

I. Background

1. In response to decision 8/CMA.2, para. 3, at TEC21 and AB16 (November 2020) the TEC and the CTCN Advisory Board agreed on activities to be undertaken jointly in the period of 2021–2022 in two areas: i) technology and nationally determined contributions (NDCs), including the development of a joint publication on technology issues related to NDCs; and ii) gender and technology. The two bodies subsequently reported on this matter in their joint annual report to the COP and CMA for 2020.[1]

2. At a joint session of TEC22 and AB17 (April 2021), the TEC and the CTCN Advisory Board considered the draft outline of the joint publication and established a joint taskforce, comprising members from both bodies and representatives of observer organizations. During this joint session, a panel discussion[2] was held with national experts and relevant stakeholders sharing experiences and lessons learned with regard to climate technology actions set out in countries NDCs. Information relevant to the joint work discussed during this panel discussion was fed into the development of the joint publication.

3. At TEC 23, the TEC and the CTCN Advisory Board will meet in a joint session on 13 September 2021 to take stock of the progress of the joint activities by the TEC and the CTCN and consider the draft joint chapter of the joint annual report of the TEC and the CTCN for 2021.

4. During the joint session, the joint taskforce with the support from the secretariat and the consultant, will be invited to present the draft joint publication on technology and NDCs.

II. Scope of the note

5. The annex to this note contains the draft joint publication on technology and NDCs.

III. Expected action by the Technology Executive Committee

6. The TEC and CTCN Advisory Board will be invited to consider the joint publication on technology and NDCs and provide guidance to the joint taskforce to finalize it after TEC 23.

[1] FCCC/SB/2020/4, para. 15 and annex I, available at https://unfccc.int/documents/267476.

[2] https://unfccc.int/ttclear/events/2021/2021_event02.

Annex

Draft joint publication on Technology and NDCs - Stimulating the Uptake of Technologies in Support of NDC Implementation

I. Foreword

1. The Paris Agreement highlights the importance of technology for the implementation of mitigation and adaptation actions. It also established the technology framework, which was finalized in 2018 to provide overarching guidance to the work of the TEC and the CTCN in promoting and facilitating enhanced action on technology development and transfer in support of the implementation of the Paris Agreement.

2. Since 2019, the TEC and the CTCN Advisory Board (CTCN AB) have been identifying areas for collaboration and activities that can be undertaken jointly between the TEC and the CTCN throughout the year in line with the technology framework. In 2020, the TEC and the CTCN AB agreed to jointly develop a publication that analyses technology issues related to NDCs.

3. The TEC and the CTCN AB joined force on this publication with a focus on technology needs, technology challenges, linkages between policy and implementation and linkages between NDCs and national adaptation plans with the intention to advance insights on these key issues, identify lessons learned and develop recommendations on how to address these issues.

4. We are pleased to present our joint findings on the role of technology for NDC implementation as well as our joint recommendation on how to further stimulate the uptake of climate technologies to accelerate Parties' efforts towards achieving their NDC targets. We would like to express our heartfelt appreciation to all NDEs, external experts and members of the Joint TEC-CTCN Taskforce on Technology and NDCs, who have provided valuable contributions to this publication.

5. This is the first time that the TEC and the CTCN have prepared a joint publication. We greatly look forward to continuing our fruitful collaboration in other areas in the future towards further accelerating technology-driven climate action under the Paris Agreement for a post-COVID 19 global recovery and the shift towards a climate-resilient and "net zero" world.

II. Key findings

6. The vast majority (90%) of Parties mentioned technology in their revised NDCs. However, the structure and depth of information provided on technology aspects varies significantly. While some Parties included a dedicated section on technology, many mentioned or referred to aspects of technology in other sections of their NDCs. Most Parties included qualitative aspects in their technology references, while some Parties also included quantitative aspects in this regard, in some cases with detailed information on the required scope of technologies and estimated costs.

7. Information included by Parties on climate technology related matters in their revised NDCs mainly falls into the areas of technology needs; specific technologies to be deployed; technology innovation, research and development; policy, regulatory and legal aspects; and support to be provided to other Parties for technology development and transfer.

8. Information on technology needs expressed in revised NDCs range from generic needs on support for technology development and transfer to references regarding specific technology sectors and types of technologies, in particular in the areas of agriculture, energy-efficiency and renewable energy, climate observation and early warning, infrastructure and urban planning, transportation, water and industry.

9. Only a few Parties included information in their NDC on technology challenges. However, existing references confirm common challenges identified in the previous work of the TEC and the CTCN, including on financing, enabling environments and stakeholder engagement and coordination.

10. An analysis of linkages between policy and implementation in the context of technology issues and NDCs shows that strong interlinkages are needed for the effective uptake of climate technologies. In addition, fostering interlinkages between the NDC and NAP policy processes on technology issues can be of great mutual benefit for both processes, avoiding duplication of work and accelerating implementation.

11. The success stories presented in this publication have shown that there is a great variety of examples from different geographic regions and country contexts where the uptake of technologies is directly supporting the implementation of NDCs. Examples include government-, private sector-, and community-driven technology solutions and showcase different approaches for overcoming technical, financial, institutional and social challenges to the uptake of the technologies, including through innovative policies and business models as well as gender-responsive and effective stakeholder engagement approaches.

12. Lessons learned regarding the uptake of technologies include the importance of recognizing the crucial role that stakeholders play in technology planning and implementation to ensure that technology solutions are technically, economically, institutionally and socially viable. Creating local champions that showcase the successful uptake of technology solutions can play an important role in securing the economic, institutional and social support that is needed for upscaling the technology in a country. These success stories can stimulate the uptake of the same or other technologies domestically or in another country, if experiences are documented and made publicly available.

13. To stimulate the uptake of technologies in support of NDC implementation, the TEC and the CTCN could:

(a) Catalyze the development and use of action-oriented technology roadmaps for different sectors at the global, regional and national levels, in line with NDC targets and the goals of the Paris Agreement, through facilitating cooperation between Parties and relevant organization;

(b) Use the technology roadmaps as guidance for their further work, including on supporting the transition to specific environmentally sound technologies identified for different sectors, focusing efforts on supporting the creation of enabling environments for the uptake of these technologies, including through effective stakeholder engagement and financing approaches;

(c) Consider the update of this joint publication on a regular basis to reflect more precisely latest developments and trends regarding the role of technology for NDC implementation.

14. To stimulate the uptake of technologies in support of NDC implementation, Parties could:

(a) Foster gender-responsive, inclusive, participatory and equitable processes and approaches for the uptake of climate technologies that take into account the needs, priorities, knowledge and capacities of all technology stakeholders, generate awareness of technology benefits and result in the co-ownership of these processes and technologies. In particular, technology uptake needs to lead to a just transition that protects workers and communities, including indigenous peoples and women, and ensures a more socially-equitable distribution of benefits and risks;

(b) Create success stories that demonstrate local economic and social benefits achieved through the uptake of environmentally sound technologies and their contribution to NDC implementation with a view to leveraging broader financial, institutional and social support for replication and upscaling of those technologies;

(c) Support market creation and expansion for prioritized technologies by putting in place enabling legal and regulatory environments and by enhancing capacities of technology stakeholders to benefit from those environments, taking into account that in many cases adaptation technologies require more public support as market-based approaches are more difficult to develop than for mitigation technologies;

(d) Systematically document and disseminate information on pursued policies, schemes and programmes to foster the uptake of a technology, including information on challenges and lessons learned regarding meeting NDC targets, to inform future policies and prioritization of technologies, including for revised NDCs and NAPs;

(e) Including more detailed information on technology in NDC, for example on technology needs and support, to foster a clearer understanding of policy targets by domestic technology stakeholders, facilitate international cooperation, and enable a more targeted provision

of support by the TEC and the CTCN, according to their respective functions, and other support providers, as appropriate;

(f) Make more use of the Technology Mechanism to carry out the above recommendations, including by utilizing technical documents and recommendations on climate technology policies prepared by the TEC,[1] and in addition for developing country Parties, by actively engaging with the CTCN[2] to benefit from its provision of technology solutions, capacity-building and advice on policy, legal and regulatory frameworks, and support for the development of technology roadmaps, tailored to the needs of individual country contexts.

III. Background

A. Mandate and objectives

15. In response to a request by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA),[3] the TEC and the CTCN agreed to jointly develop a publication on technology and NDCs (UNFCCC 2021a) that analyses technology issues related to NDCs, including revised NDCs. Building on previous work by the TEC and the CTCN and insights gathered from technology stakeholders through interviews, this publication also identifies success stories and lessons learned regarding the uptake of technologies in support of NDC implementation. The publication presents a number of observations and concludes with recommendations. The publication is addressed at policy-makers with the aim of supporting them with the identification of ways for stimulating technology uptake in support of NDC implementation.

B. Methodology

16. The publication is based on a methodology, presented and approved in April 2021 (TEC 2021b), containing desk review of information sources pre-identified by the TEC and CTCN AB as contained in the "References" chapter, including reports, surveys and assessments by the TEC, the CTCN and the UNFCCC secretariat, as well as on semi-structured interviews conducted with CTCN Regional Technical Assistance Teams, NDEs and CTCN technical assistance implementers[4] from April to July 2021.

17. The desk review resulted in a synthesis of technology issues related to NDCs with a focus on technology needs, challenges, linkages between policy and implementation and linkages with national adaptation plans. The desk review further identified success stories regarding the uptake of technologies in support of NDC implementation. The selection and presentation of the success stories was guided by diversity and balance in terms of geographic regions, LDCs and SIDS, adaptation and mitigation-focused technologies, technology sectors, implementing partners, and cross-cutting issues such as innovation and gender.

18. The semi-structured interviews focussed on identifying lessons learned regarding the uptake of technologies in support of NDC implementation and on gaining further insights on the success stories included in this publication.

19. The publication also reflects the outcomes of the panel discussion on technology and NDCs held at the TEC-CTCN Joint Session in April 2021 (UNFCCC 2021d).

[1] https://unfccc.int/ttclear/policies.
[2] https://www.ctc-n.org/technical-assistance.
[3] Decision 8/CMA.2, paragraph 3.
[4] Technical assistances funded by the CTCN in response to developing country requests is implemented by members of the CTCN's network of technology stakeholders. A full list of network members is available at: https://www.ctc-n.org/network/network-members.

IV. Technology and Nationally Determined Contributions

A. Overview of technology issues in revised NDCs

20. This overview[5] presents a synthesis and analysis of information on technology contained in 48 revised NDCs, representing 75 Parties, received by 31 December 2020 (UNFCCC 2021e) in line with the approach taken by the UNFCCC secretariat for the preparation of its Initial Synthesis Report on NDCs (UNFCCC 2021b) in response to requests from the COP and CMA.[6]

21. The 75 Parties that submitted the 48 NDCs represent only 39% of the 189 Parties to the Paris Agreement.[7] These Parties are shown by regional groups in Figure 1 and by developed and developing country Parties in Figure 2 below. Out of the 39 developing country Parties, 7 are LDCs and 10 are SIDS.

Figure 1: Parties by Regional Group

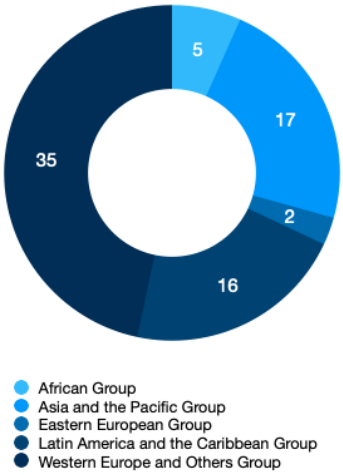
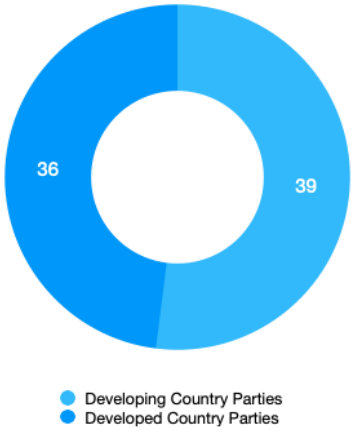


Figure 2: Developed and Developing Country Parties



22. The 48 NDCs analysed and synthesized in this section represent a relatively small sample size, given that the 39 developing country Parties only constitute 26% of developing country Parties that are Party to the Paris Agreement. This is particularly apparent when looking at specific groups of developing country Parties: 10% of Parties from the African Group and 16% of LDCs had submitted their NDCs by 31 December 2020.

23. 43 NDCs (90%) include references to technology even though there is no provision in the Paris Agreement or related decisions by the COP or CMA that requests Parties to provide such information in their NDCs. However, the structure and depth of information provided on technology in NDCs varies significantly. Out of the 43 Parties[8] that refer to technology in their NDCs, 11 NDCs (26%) have a dedicated section on technology, while 32 NDCs (74%) only refer to technology in one or some of their sections. 40 NDCs (93%) included qualitative aspects of technology, while 16 NDCs (37%) included qualitative and quantitative information in this regard. Five NDCs (12%) further included specific projects on technology development and transfer, some with detailed information on technical and financial requirements, implementing entities and time frames.

24. Most of the 43 Parties that included a reference to technology in their NDC did so in the context of actions that inherently address both adaptation and mitigation (32 Parties) or focus on

[5] The overview is based on a working paper prepared by the UNFCCC secretariat in March 2021 (UNFCCC 2021c).

[6] Decision 1/CP.21, paragraph 25 and decision 1/CMA.2, paragraph 10.

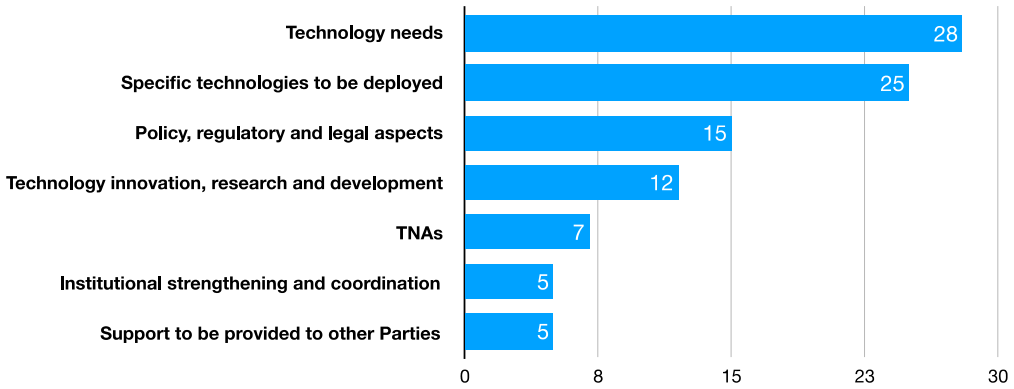
[7] Status of ratification of the Paris Agreement as of 31 December 2020. See: https://unfccc.int/process/the-paris-agreement/status-of-ratification.

[8] The NDC submitted by the European Union is the only NDC considered for this report that represents a group of Parties. Given that this NDC does not make any reference to technology, the number of NDCs referring to technology equals the number of Parties referring to technology in their NDCs.

mitigation (31 Parties). Some Parties also made reference to climate technology for adaptation (20 Parties).

25. Information on technology in NDCs mainly focussed on the following aspect as shown in Figure 3 below: Overall technology needs (28 Parties), including TNAs (7 Parties); specific technologies to be deployed (25 Parties); policy, regulatory and legal aspects (15 Parties); technology innovation, research and development (12 Parties); institutional strengthening and coordination (5 Parties) and support to be provided to other Parties for technology development and transfer (5 Parties). Some technology references in NDCs also focussed on cross-cutting and other issues, such as strengthening market preparation, business planning and investment to promote the deployment of prioritized technologies; promoting social acceptance of new technologies; and ensuring gender responsiveness of technology development and transfer (3 Parties).

Figure 3: Number of revised NDCs mentioning technology issue



26. Overall technology needs mentioned by Parties were mainly in agriculture, climate observation and early warning, energy, industry, infrastructure and buildings, transport and water. In terms of specific technologies that Parties intend to use for achieving their adaptation and mitigation targets, the most frequently identified were energy- efficient appliances and processes, renewable energy technologies, low- or zero-emission vehicles and hydrogen technologies.

27. Actions on policy, regulatory and legal aspects commonly referred to by Parties in their NDCs include developing or updating policies to promote technology innovation, energy-efficiency and the accelerated adoption and transfer of climate technologies through private investments.

28. In the context of technology innovation, research and development, some Parties included information on promoting institutions, mechanisms, tools and business models that foster national innovation capacity. Examples of actions in the area of institutional strengthening and coordination include building institutional capacities and specific technical skills as well as improving coordination between the local and national levels and among different stakeholders.

29. Some Parties also included specific information on their intended support to developing country Parties on the development and diffusion of climate technologies. South-South cooperation, triangular cooperation or regional cooperation was highlighted by three developing country Parties as support mechanisms for example in the areas of renewable energy and energy efficiency.

30. Only three Parties included in their NDCs financial information on their planned actions with reference to technology. Two of these Parties provided finance requirements for specific projects that include the development or transfer of climate technologies.

31. Specific examples of information on technology in NDCs as per the above-mentioned categories is provided in Table 1 below.

Table 1
Examples of information on technology in NDCs

Category	Information on technology in NDC
Technology needs	• Climate-resilient building construction technology and low-cost affordable housing technology (Cambodia) • Modernization of the country's hydrometeorological services, allowing for the maintenance of accurate forecasts and early warning systems for an effective and efficient response, which includes modernization in observation, assimilation and forecasting systems, access to sensors and technologies (Nicaragua) • Enhancement of access to, development and transfer at different stages of the technology cycle, promotion of innovation and implementation of prioritized technologies in the areas of agriculture, renewable energy and transport among others (Thailand) • Technologies for water savings, recycling and irrigation for sustainable water management for households, agriculture and industrial purposes (Zambia)
Specific technologies to be deployed	• Establish first regional hydrogen export hub to boost the country's hydrogen industry and fund research collaborations and supply chain studies to enable demonstration and deployment (Australia) • Increase electric vehicle, including in the areas of private vehicles, commercial vehicles, taxis & buses (Chile) • Ensure smooth transition towards a nationwide adoption and use of renewable energy technologies mainly solar photovoltaic will be critical (Brunei Darussalam) • Increase of energy efficiency in industrial sectors (Japan)
Policy, regulatory and legal aspects	• Develop and update energy efficiency standards and regulations for end-use technologies, including for refrigeration and air conditioning equipment, boilers, heat pumps, vehicles, machinery and other energy-intensive equipment (Costa Rica) • Prepare and implement a strategy and action plan on gender-responsive climate-smart technologies and practices (Nepal) • Promote clean fuel technology regulations to set standards for the GHG emissions and economic incentives for fuel-efficient vehicles & e-mobility (Papua New Guinea) • Adjust country regulatory framework to create stronger incentives for private investment in technologies that will increase climate resilience (Republic of Moldova)
Innovation and R&D	• Design an inventory system for climate technologies that facilitates the development of local technologies and the adoption of technologies existing worldwide (Dominican Republic) • Promote research and development focusing on climate smart agriculture technologies and practices to address challenges facing the sector due to climate variabilities, seasonal changes and extreme events (Maldives) • Significantly scale up R&D investments for core emission reduction technologies, e.g., renewable energy, zero emission vehicles and hydrogen technologies (Republic of Korea)
Institutional strengthening	• Generate, focus and link the supporting tools for technology development and transfer, both for the local development and for the transfer of existing technologies at the local and global level in mitigation and adaptation for the various and/or different prioritized productive sectors at national and regional level. Strengthen cooperation and exchange among local actors in country and overseas including on technology transfer (Chile) • Build institutional capacities to support the transfer of climate and environmentally sound technologies (Republic of Moldova) • Support research, technological development and innovation through alliances with academia, think tanks and research centres that contribute to the generation of new knowledge, development of new technologies, transfer processes and technological appropriation (Colombia)
Support to be provided to other Parties	• Committed to foster South-South and triangular cooperation, with a focus on scientific and technological cooperation, in order to support other countries in achieving more ambitious adaptation and mitigation goals in accordance with national development priorities for each country (Mexico) • Continue to deepen and broaden technical cooperation programmes with other developing countries (Singapore) • Support renewable energy projects in developing countries (United Arab Emirates)

B. Technology needs

32. The level of information on technology needs provided by developing country Parties in their revised NDCs varies significantly. As described in section 2.1. above, while some of the developing country Parties only have generic references regarding their technology needs, most of them include information on needs regarding specific technology sectors and types of technology, in particular in the areas of agriculture, energy-efficiency and renewable energy, climate observation and early warning, infrastructure and urban planning, transportation, water and industry (UNFCCC 2021b).

In some cases, needs are further qualified and quantified to detailed technology interventions, including information on type and scope of required technologies and estimated implementation costs. For example, advancing low-emission transportation through the introduction of "more than 55 000 electric vehicles and the installation of around 25 thousand recharge stations by 2030" at an estimated cost of USD 1479 million (NDC Cuba, see UNFCCC 2021e) or reducing emissions from electricity generation through "68 MWp of solar mini-grids to be installed in off-grid rural areas by 2030" at an estimated cost of USD 206 million (NDC Rwanda, see UNFCCC 2021e). Overall, solar and wind energy technologies and low- or zero emission vehicles and as well as energy-efficient appliance and processes are among the most frequently referred to specific technologies for achieving adaptation and mitigation targets.

33. Seven Parties referred in their revised NDCs to TNAs. Some Parties referred to TNAs with regard to support needs. Cambodia and Mongolia stated that they require support for conducting updated TNAs (NDC Cambodia, NDC Mongolia, see UNFCCC 2021e) that address certain components of the NDC. The Dominican Republic and Papua New Guinea highlighted their needs for support to conduct a TNA for their NDCs as a whole (NDC Dominican Republic, NDC Papua New Guinea, see UNFCCC 2021e). Other Parties reported that previously conducted or ongoing TNAs informed the development of the revised NDC (NDC Republic of Moldova, NDC Panama, NDC Suriname, see UNFCCC 2021e). This confirms the finding of the latest synthesis report on TNAs that most Parties consider the TNA not as a stand-alone process, but as complementary to national policies and plans, such as NDCs and NAPs (UNFCCC 2020a).

34. The review of CTCN Technical Assistance (TA) projects undertaken since the adoption of the Paris Agreement in 2015 shows an increasing number of TA projects that focus on directly contributing to the implementation of the NDC of the respective country. Those TAs reflect technology needs predominantly in the areas of agriculture, energy-efficiency, water, climate observation and early warning, infrastructure and urban planning and renewable energy, which is in line with common areas of technology needs in revised NDCs (CTCN 2021a).

C. Technology challenges

35. The analysis of technology challenges related to NDCs based on the review of revised NDCs and the previous work of the TEC and the CTCN related to NDCs resulted in the following findings. Revised NDCs include limited information on specific challenges that Parties face regarding the uptake of technologies. The broader challenges that are referred to in the revised NDCs fall also within the areas of common challenges identified in the previous work of the TEC and the CTCN as summarized below:

(a) The lack of finance and appropriate enabling environments remains a key obstacle for the development, transfer, deployment and diffusion of technology solutions (TEC 2013a, TEC 2018);

(b) There is no one-size-fits-all approach. Each country has different institutional, economic, environmental and social circumstances as well as different national priorities and capacities. In addition, countries are not homogenous. Local circumstances, priorities and capacities within a country can be as diverse as between countries. The challenge is not only to identify or develop locally adjusted technology solutions, but equally to identify or develop locally adjusted approaches that ensure the successful uptake of technologies, specifically with regard to (TEC 2017a, TEC 2017b, TEC 2018, TEC 2021a):

(i) Fostering local ownership of the technology solution and approach for its uptake;

(ii) Ensuring sufficient absorptive capacity of all technology stakeholder;

(iii) Engaging the private sector effectively and sustainably;

(iv) Ensuring sufficient market demand for the technology;

(v) Engaging policy-makers on the scaling-up of successful community-level projects.

36. While this sub-section covers general challenges as observed by the work of the TEC, specific challenges are elaborated in the success stories on the uptake of technologies in support of NDC implementation as presented in section 3 below.

D. Policy and implementation

37. An analysis of linkages between policy and implementation in the context of technology issues and NDCs, including appropriate enabling environments such as regulations, standards and incentives, shows that strong interlinkages are needed for the effective uptake of climate technologies. The analysis is based on the review of revised NDCs and the previous work of the TEC and the CTCN related to NDCs.

38. Interlinkages between policy and implementation are equally required for top-down and bottom-up approaches, meaning that policies need to guide implementation just as much as they need to be guided by implementation realities, including technical, economic, social and institutional viability of technologies. At the same time technology uptake increases, if climate technology projects and programmes are integrated into national policy and strategies such as NDCs (TEC 2019). A growing number of Parties have integrated the outcomes from their TNA or CTCN TAs in their NDCs and through this successfully scaled-up technology solutions, including through leveraging additional support from the Green Climate Fund, the Adaptation Fund and the Global Environment Facility (TEC 2019, CTCN 2021a). The engagement of key line Ministries, for example for finance, economy and agriculture was found to be a decisive factor for TNA outcomes to be considered in national strategy formulation processes, such as the NDC development (TEC 2019).

39. Policies also need to reflect implementation realities in a way that they do not only address technical needs, but also the viability of the uptake of the technologies. Here a technology-specific focus is needed for creating enabling environments through favorable market conditions, innovative financing and business models, and public programmes. The latter is of particular importance for technologies for which a market first needs to be created through raising awareness about the value of a technology, for example by showcasing approaches and results (TEC 2017a).

40. The successful uptake of technologies also requires technology policies and implementation to be inclusive and equitable. An inclusive and equitable process ensures that diverse views, knowledge and expertise is incorporated in all stages of the policy design and of the development, transfer, employment and diffusion of technologies. The uptake of technology solutions resulting from such process is more likely given that local needs, capacities, and practices are reflected and awareness of benefits resulting from the introduction of the technology has already been generated (TEC 2017a).

41. Success stories can play an important role in showcasing how a policy, or certain aspects of it, can be implemented in practice and the concrete benefits for different stakeholders arising from it. Demonstrating the technology solution is therefore crucial for accelerating its uptake (TEC 2019).

E. National adaptation plans

42. An analysis of linkages with national adaptation plans (NAPs) in the context of technology issues and NDCs shows that the NAP process can provide important inputs regarding the consideration of technology issues in NDCs and vice-versa. On the one hand the NAP process can help identify technology options for adaptation components of NDCs and on the other hand the NDC process can make NAPs or sectoral NAPs more concrete and actionable, in particular in those countries where such plans do not yet exist. While most developing country Parties are in the process of developing a NAP, only 22 developing country Parties have a NAP in place.[9]

43. A review of interlinkages between technology issues and NAPs conducted by the TEC in 2013 shows that the methodology and process for developing a NAP is in many aspects similar to the methodology and process for identifying priority technologies, for example through a technology needs assessment (TNAs). Depending on which process is more advanced, the NAP or the NDC process, one process can significantly inform the other. In addition, harmonization of these processes could help accelerate the development and implementation of NAPs and NDCs by pooling resources and avoiding duplication of work (TEC 2013a).

[9] https://unfccc.int/topics/adaptation-and-resilience/workstreams/national-adaptation-plans.

V. Success stories and lesson learned on the uptake of technologies

A. Success stories

44. This section offers eight case studies that showcase the successful uptake of climate change adaptation and mitigation technologies in different geographic regions and technology sectors. The success stories were drawn from the information sources listed in the References section of this publication, which include previous publications, surveys and assessments by the TEC and the CTCN, presentations at Regional Technical Expert Meetings held in Africa, Asia-Pacific and Latin America and the Caribbean, and Eastern Europe and West Asia in 2018, 2019 and 2020, the CTCN database on Technical Assistance (CTCN 2021a) and recommendations from the members of the Joint TEC-CTCN Taskforce on Technology and NDCs.

45. The criteria applied for the initial identification of successful examples from this broad range of information sources were that examples had to focus on a specific technology; have led to an initiation/full uptake of the technology; and be in line with the country's NDC. The initial results were then further consolidated based on availability of information or access to information on different aspects of the success stories, including the level of technology uptake, financing, gender-responsiveness, and challenges and lessons learned. The final selection of the success stories was also guided by the aim of ensuring balance between: geographic regions; groups of countries, with priority given to LDCs and SIDS; technology sector, with efforts made to include a diverse range of technologies; types of approaches, for example women/community-focused, private sector-focused, government-focused, rural/urban-focused; mitigation and adaptation-focused technologies; and diversity of implementation partners. For CTCN Technical Assistance projects, only completed projects were considered and insights from interviews with CTCN Regional Teams were taken into account regarding availability of information, level of technology uptake and use of innovative/replicable approaches.

1. Developing technological tools for adapting to climate change in coastal zones in Uruguay

Participating countries: Uruguay and Spain
Partners: Ministry of Environment of Uruguay, Spanish Agency for International Development (AECID), CTCN, Environmental Hydraulics Foundation (IHCantabria)
Start of technology uptake process: 2015
Climate technology: Climate modelling and vulnerability assessment technology
Contribution to NDC implementation: Formulated, adopted and started the implementation of a National Adaptation Plan for Coastal Areas; and mapped the coastal vulnerability of the Río de la Plata and the Atlantic Ocean to climate change and climate variability.

References:
a) COASTAL-NAP: https://www.gub.uy/ministerio-ambiente/plan-nacional-adaptaci%C3%B3n-zona-costera
b) Climate modelling database: https://www.ambiente.gub.uy/oan/ and https://sit.mvotma.gub.uy/js/sit/

46. **Climate technology:** Climate modelling and vulnerability assessment technology to determine the threat, exposure, and sensitivity to climate variability and climate change in Uruguay's coastal zone by analyzing and evaluating climatic effects on the dynamics of beaches, dune areas, coastal erosion, flood risks and the resulting consequences for the local population, ecosystems, infrastructure and tourism.

47. **Uptake of the climate technology**: Along the Río de la Plata (River Plate) flash floods are caused by a combination of meteorological and hydrological effects. The occurrence of high tides with large atmospherically induced storm waves has raised the mean sea level to three meters above its normal level, causing the removal of beaches and dunes, damage to coastal infrastructure and risks to navigation. On average, extreme events occur once every eleven months, mainly during the summer and autumn periods.

48. Identified technical barriers to face impacts of climate variability and climate change on coastal areas included the lack of quality data or lack of access to existing data, lack of standardized

criteria, methodologies and tools for assessing climate change risks and for implementing adaptation measures or establishing metrics and procedures for evaluating adaptation processes. Other barriers included coordination between the national and local levels and lack of qualified human resources.

49. Faced with this challenge, Uruguay has made it a priority in its NDC[10] to develop and implement a national adaptation plan for coastal areas (COASTAL-NAP) based on detailed information on hazards, exposure, sensitivities, and adaptive capacities of human-natural systems. Regional information systems on hazards already existed, but their level of detail was insufficient to build national and local plans on. Uruguay built on, and learned from, existing global and regional systems to increase the level of detail of its national information system to feed directly into decision-making processes in terms of prioritization and adaptation strategies.

50. Through participatory processes of co-management of information and knowledge generation through collaboration between international and national researchers, technical and professional staff from the Ministry of Environment, the Ministry of Tourism, the Ministry of Transport and Public Works, local governments, environmental NGOs, students and citizens, the country managed to develop information and capacities to meet the needs for analyzing climate information and the selection and implementation of adaptation measures in the coastal areas. The improved national database and information systems on variables associated with marine dynamics (wind, pressure, waves, meteorological tide, and sea-level), including high temporal resolution information, now also serves as reference for integrated coastal zone management, operational oceanography, infrastructure construction, coastal zone risk management, ecosystem resilience and tourism management.

51. Knowledge transfer from international researchers (IHCantabria) to local researchers (Universidad de la República) and government entities was ensured through the implementation of training strategies for technical and professional staff and decision-makers from Ministries and local governments. Training was organized in eight modules over seven months, following technical specifications from academic institutions and managing specifications from the inter-institutional working group in charge of preparing the COASTAL-NAP.

52. Historical databases as well as projections of high-resolution dynamics prepared by local researchers were necessary for local-scale impact quantification. A new analysis was hence designed with data on winds and atmospheric pressure, creating a regional atmospheric model. At the same time, models for wave propagation and currents generation were created using topographic data and coastal bathymetric and wind data. The simulations on these models generate databases that were then validated with instrumental observations in the country, making it possible to infer changes in dynamics under climate change scenarios. The variability observed in Uruguay's climate was also analyzed; temperature and rainfall climate trends were identified based on the projection of climate models for potential changes. Due to the high resolution of the analysis, the proposed maps could be generated at different scales without losing information or analytical capacity with scaling levels at the national (the whole Uruguayan coast) and local levels (by municipality and by census district). The combination of high-resolution basic information with impact processes models and a probabilistic approach contributed to significantly reducing uncertainties, when compared with other national-scale studies which are usually applied to indicators for characterizing impact and other risk components. The applied methodology enabled the country to identify zones with the potentially highest coastal flood and erosion risks, the most vulnerable natural and socio-economic sub-systems, and the areas with the highest need for adaptation action.

53. **Financing:** The development of the COASTAL-NAP was supported by the CTCN[11] with IHCantabria as the implementing partner. In parallel training for the development and implementation of the COASTAL-NAP was provided by AECID through its EUROCLIMA+ programme. This in turn has helped the country to secure a USD 30 million GCF project (2022-2025) on increasing resilience in cities, communities and ecosystems of Uruguay’s coastal areas.

[10] NDC of Uruguay (2017). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Uruguay%20First/Uruguay_First%20Nationally%20Determined%20Contribution.pdf.

[11] https://www.ctc-n.org/technical-assistance/projects/development-technology-tools-assessment-impacts-vulnerability-and.

54. **Gender responsiveness:** The technology enabled the assessment of physical vulnerability from which the potentially affected social composition could be determined. In addition to the general impact on housing, the alteration of coastal space also becomes relevant because it serves recreational purposes and as a transit area to essential services, including health, education and access to employment areas. A gender-sensitive approach was crucial to analyze differential uses and precisely determine who will be affected so as to define social vulnerability based on a process that integrates the population's needs according to their specific reality. In addition, the gender approach allows to measure inequalities in access and control of resources as well as in participation in decision-making in the coastal area.

55. **Contribution to NDC implementation:** Coastal areas are listed in Uruguay's NDC as one of the main priorities for implementation and support needs on adaptation measures. Specifically, the NDC includes two targets to have "formulated, adopted and started the implementation of a National Adaptation Plan for Coastal Areas by 2020" and "mapped the coastal vulnerability of the Río de la Plata and the Atlantic Ocean to climate change and variability by 2020". The successful uptake of the climate modelling technology has not only enabled Uruguay to develop its COASTAL-NAP, but also to enhance its capacity and secure funding for the COASTAL-NAP implementation. Therefore, the technology uptake has directly resulted in the achievement of two of the country's key NDC targets on adaptation.

56. **Challenges and lessons learned:** The knowledge incorporation and decision-making were defined on the COASTAL-NAP strategies and actions were focused on iterative mechanisms for consultation and adjustment, which involved four levels of institutional participation. The National Climate Change Response System (NCCRS) guided the process and created a working group called «Adaptation in the Coastal Area» which was composed of national institutions. Its goal was to integrate emerging national, local, and sectoral priorities and to prepare and validate technical drafts for the different components during the creation of the COASTAL-NAP. Sub-national governments were also consulted through different participation ways and training workshops aimed at improving understanding of the vulnerability of the Uruguayan coastal zone. For a period of five years (2015 – 2020), the COASTAL-NAP has maintained various consultation and training strategies for the municipalities along the Río de la Plata and Atlantic Ocean coastal area. The COASTAL-NAP is conceived as a working method that acknowledges all concerns related to variability and climate change along the decision-making processes. In this regard, this mechanism intends to cover all the necessary structures for generating the knowledge that will be applied when it comes to strategic planning.

57. **Long-term sustainability, replicability and a potential for up-scaling:** To ensure the long-term sustainability of the uptake of the climate modelling and vulnerability assessment technology, Uruguay developed shared-ownership platforms for the exchange of information and knowledge among all government levels and with and between academic and civil society networks. These platforms ensure the continuous engagement of the different stakeholder groups in the use and further development of the technology.

2. Adapting to floods and droughts in India through the water storage technology Bhungroo

Participating country: India
Partner: Naireeta Services Private Limited (Naireeta Services)
Start of technology uptake process: 2007
Climate technology: Storm water management technology
Contribution to NDC implementation: Better adapting to climate change through enhanced investments in sectors vulnerable to climate change, including agriculture, water and disaster management; creating additional carbon sinks; and addressing the challenges of poverty eradication, food security and nutrition, gender equality and women empowerment, and water and sanitation.

References:
a) Naireeta Services: www.naireetaservices.com
b) Videos explaining the Bhungroo technology:
https://www.youtube.com/watch?v=E9ynVXjf-i8 and
https://www.youtube.com/watch?v=QAMarW5IBG8&t=52s

58. **Climate technology:** Bhungroo is a storm water management technology that filters, injects and stores excess storm water through pipes[12] within subsoil layers based on detailed geophysical and geological analysis and data simulation. The technology works on the principles of aquifer storage and recovery, managed aquifer recharge and recovery and vertical drainage. Using a surface space of only one to two square meters, each Bhungroo can conserve nearly one to four million litres of water each year within its subsurface zone. 17 different technical designs of the technology have been created and made operational for women smallholders in different agroclimatic zones across India, Bangladesh, Vietnam and Ghana.

59. **Uptake of the climate technology**: In India the occurrence of flash floods, extreme weather events and droughts has increased in frequency and in unpredictability. In 2000, the National Bureau of Soil Survey and Land Use Planning estimated that 11.6 million ha of land (7,5% of India's total arable land), mainly in western and northern India as well as some eastern coastal areas, was prone to waterlogging, and that on 6 million ha of this land the waterlogging led to heavy crop damage.[13] In 2020, the International Federation of Red Cross and Red Crescent Societies estimated that heavy floods in some of these areas have threatened the survival of 12 million people.[14] The successful uptake of the technology at the rural community level was ensured by building on locally available resources and skills and locally manageable maintenance processes. The technology is introduced through a capacity-building programme targeted at three different groups: 1. land-owning farmers who can afford to invest in the technology; 2. poor, vulnerable, illiterate women farmers working collectively in self-help groups and benefitting from a grant-making program developed by Naireeta Services; and 3. smallholders farmers supported by a government program. Geological, geohydrological, geophysical, mechanical engineering, civil engineering and agriscience principles are explained through gender-responsive, locally acceptable methods for the installation of the technology units. The uptake of the technology starts with a water needs assessment that is then followed by drilling, casing and then procurement of filtration materials, erecting the filtration chamber, testing and geotagging. Each activity includes various sub-activities, which are all carried out in line with traditional knowledge and cultural acceptances. For example, the water needs assessment takes into account local seasonal variations, crop patterns and irrigation types, based on traditional knowledge. This is followed by an assessment of the total storm water availability, including storm water sources, minimum/peak volumes and durations of inflow per source. All data collection tools are designed for unschooled users and result in the creation of open-source knowledge.

60. **Gender responsiveness:** Given the predominant patriarchal rural system in India, the technology was, in its early days, targeted at male smallholder farmers. However, male farmers did not have the required trust in, and experience of, collective ownership and management. They were also lacking time to invest in refining and adapting the technology to their local soil and water situations. At the same time female participation in the further development of the technology was increasing and achieving better results with increasing cost effectiveness of units through collective leadership. Women therefore became Naireeta Service's target group for localizing and disseminating the Bhungroo technology. Since then, thanks to a specific Women Climate Leadership Programme developed by Naireeta Services, women in many communities in India have embraced the technology and managed the technology uptake process from initiation to scale up and maintenance. The programme consists of technical training sessions and support enabling poor women farmers to become ambassadors of the Bhungroo technology and to sell their technical consultancy services and thus turning them into micro entrepreneurs.

61. The joint ownership, operation and maintenance of the technology by women groups within a community also leads to the joint ownership of the irrigation water it produces, transforming the social status of the beneficiaries from agricultural laborers to financially self-reliant farmers comparable to land owners. The Bhungroo technology provider, Naireeta Services, makes it a condition to hand over the technology ownership rights to the women in charge of the technology in order for the community to use the irrigation water. The ownership rights have to be documented in writing within the local governance system and in line with local social norms. This is another key component of how the technology contributes to gender mainstreaming in climate action. The Bhungroo technology has received various awards for its innovative and women-empowering

[12] "Bhungroo" is a Gujarati colloquial world and means straw or hollow pipe.

[13] http://www.iiwm.res.in/pdf/Bulletin_30.pdf.

[14] https://media.ifrc.org/ifrc/press-release/17-5-million-affected-floods-threatened-disease-south-asia.

approach, including the UNFCCC Momentum for Change Award, the Gender Just Climate Solutions Award of the UNFCCC Women and Gender Constituency, the Cartier Women Initiative Award and the Buckminster Fuller Challenge Grand Prize.

62. **Financing:** Naireeta Services developed a financing model for the technology uptake, which is based on a two-tier marketing strategy: On the one hand Bhungroo units are sold for profit to rich farmers, who have a proven return on investment within two and half years. On the other hand, Naireeta Services uses its profits to mobilize grants that enable poor, illiterate women farmers to access the technology. The collective ownership of the Bhungroo units by underprivileged women farmers is a prerequisite set-up by Naireeta Services to access the grant-supported technology. It is key to ensure the gender equality and women's empowerment in the programme. Women farmers benefit via improved revenues secured through increased crop production, and fees earned through the provision of maintenance services to other communities using the same technology. Food security, doubling of agriculture-based income, emancipation from debt and interest payments are usually achieved within two to three years after the installation of the technology.

63. **Contribution to NDC implementation:** As part of its NDC, India aims to "better adapt to climate change by enhancing investments in … sectors vulnerable to climate change, particularly agriculture, water… and disaster management"; to "create an additional carbon sink of 2.5 to 3 billion tons of CO2 equivalent through additional forest and tree cover by 2030"; and to address "the challenges of poverty eradication, food security and nutrition,… gender equality and women empowerment, water and sanitation, energy…" [15]

64. To date more than 5,000 Bhungroo technology units are in place, which are benefiting more than 15,000 women smallholder farmers and 150,000 rural poor. The technology offers a sustainable solution for enhancing investment in climate change adaptation in the agriculture and water sectors as well as in disaster management. In addition, based on the 5000 units installed, the technology can lead to carbon absorption of 112,000 to 129,000 t. CO2 eq. per year[16] through increased growth of vegetation, according to a pilot study conducted in 2018 by Leigh University.

65. The Indian government has therefore incorporated the Bhungroo technology within its National Rural Livelihood Mission (NRLM) policy as a means for increasing action on climate change adaptation, while advancing poverty eradication, livelihood generation and food security. A total budget of USD 5.1 billion has been allocated for the implementation of NRLM with the aim of directly benefitting 70 million poor rural households.

66. Bhungroo, one of the supported technologies of the NRLM, benefits from a dedicated loan plan. But the formal bank credit system and the policy measures generally reserve loans or financial support to land owners. Only around 14% of agricultural land is owned by women according to India's Agricultural Census of 2015-16.[17] So, practically, the system excludes women farmers from the beneficiary group to access the loan for the Bhungroo technology, as women generally have no land-tenure rights in India. Approximately 14 million of the 23 million rural households headed by women are considered "deprived" (landlessness, no proper housing, no education).[18] If only 10% of the 14 million women-headed deprived rural households would be able to access the Bhungroo technology thanks to a targeted gender-responsive policy incentive, up to 1.68 million acres of land (deprived women farmers cultivate 1.2 acres of land in average)[19] could also be turned into productive land in winter and during the monsoon season. This could increase income and food security for about 7.5 million rural poor (5.4 persons per households) and create a carbon sink of about 38 to 43 million tons of CO2 equivalent per year.[20]

[15] NDC of India (2016), p. 4 and p. 29. Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/India%20First/INDIA%20INDC%20TO%20UNFCCC.pdf.

[16] The estimations are based on a study by Leigh University of 2018, which found that one Bhungroo unit can support crop cultivation on about five acres (2 ha) of land and that depending on the crop an average of 22.5 to 25.8 tons CO2eq can be sequestered per acre per year.

[17] India's Agricultural Census of 2015-16. Available at: https://agcensus.nic.in/document/agcen1516/T1_ac_2015_16.pdf.

[18] Socio Economic & Caste Census of the Government of India. Available at: https://secc.gov.in/welcome.

[19] Field-level data from Naireeta Services based on 10 years of work with women farmers in different states of India.

[20] See footnote 14.

67. **Challenges and lessons learned:** Every Bhungroo technology site is unique and has a plethora of different geological, geo-hydrological, agricultural, mechanical and civil engineering challenges. To address those challenges in a cost-efficient manner, the technology developer and provider entered into various local, national and international partnerships and continuous research work to adjust processes and refine the technology to date.

68. The technology uptake in rural communities facing extreme poverty has also been a challenge as it requires pooling the financial and human resources of several smallholders and turning to collective ownership, operation and maintenance. Women organized in self-help groups have proven to be much more experienced and prone to collective management of Bhungroo technology units than men. Women's ability to work together has also led to constant improvement of the technology. However, women's lack of access to land ownership rights still remains a serious barrier to the uptake of the technology, in particular as it limits women's access to microcredit instruments and to government support programs designed to promote the Bhungroo technology. This makes the gender approach particularly relevant for the successful uptake of the technology. Key lessons could be shared at national level with the NRLM and at global level via the UNFCCC Gender Action Plan.

69. **Long-term sustainability, replicability and a potential for up-scaling:** In the next five years an additional 10,000 units of the Bhungroo technology will be installed across the globe, enabling 50,000 farmers to triple their agricultural income on average, impacting a total of about 250,000 rural poor indirectly. This will lead to improved soil fertility of 50,000 acres of land and the first-time productive use of 220,000 acres of land in the winter season.

3. Making buildings more energy efficient in South Africa

Participating country: South Africa
Partners: South African National Energy Development Institute (SANEDI), Thermal Insulation Products and Systems Association of South Africa (TIPSASA)
Start of technology uptake process: 2015
Climate technology: Energy efficient building technology

Contribution to NDC implementation: Using innovative energy efficient solutions to achieve sectoral GHG emission reduction targets.

References: SANEDI's work on cool surfaces:
https://www.sanedi.org.za/Cool_Surfaces/index.html

70. **Climate technology:** The passive thermal control technology project is a combination of heat and light-reflective roof coating and traditional thermal insulation that significantly increases energy efficiency of buildings. The thermal insulation largely acts as a barrier to heat flow or heat transfer from the building (heat loss during the colder months), whereas the cool-coated roofs prevent absorption of the heat by the building by means of solar reflectance, reducing heat transfer to the interior. These technologies are energy passive, relatively low cost and low maintenance.

71. **Uptake of the climate technology:** Historically, insulation has been the only trusted and effective passive thermal control technology used for both heating and cooling of a building. However, in the South African context, insulation is far more effective at retaining building heat than cooling it. The reflective cool roof technology has an inexpensive one-off cost of application and can last for between 10 years up to the life of the roof. To achieve similar cooling as a cool roof, the thickness of the bulk insulation has to be increased. Respectively, the return on investment, if insulation thickness is doubled/tripled/quadrupled takes 13/17/19 years to recover. However, both technologies are needed as they solve different needs.

72. Inspired by international research, SANEDI initiated a local programme with TIPSASA, South Africa's leading industry body on passive heating and cooling, to develop and deploy the passive cooling technology in line with local context. As a member of TIPSASA, the South African Cool Surfaces Association was legally allowed to participate and contribute to the regulation of cool coating product quality, preventing technology failure and reputational damage. More importantly though, SANEDI wanted to avoid reducing the minimum standards already set for insulation, if cool roofs were included in the energy efficiency design. This reduction of minimum standards falsely equates insulation to cool surfacing, an off-set that would deteriorate the efficacy of much-needed heat retention in the winter months. While heat reduction in summer is a far more prevalent need, there is a higher mortality rate due to extreme cold than extreme heat events in South Africa.

However, if used together, cool coatings and insulation regulate thermal comfort in buildings more effectively, have a quicker cost recovery and lead to a significantly improved climate change mitigation effect.

73. For the deployment of the technology, local unemployed people are trained, provided with an industry recognized training certificate, and hired under supervision, which allows them to generate income from the installation and maintenance of the technology as well as to enter the broader job market. This effective local community engagement fosters a sense of ownership and responsibility to the project, thereby reducing the risk of theft and vandalism.

74. **Gender responsiveness:** For the selection of the trainees, SANEDI gave a preference to women, who are most affected by unemployment and economic inequalities, resulting in 52% female participants. Initially, there was resistance from the traditionally patriarchal communities that protested the inclusion of women in construction labour. After awareness-raising and training, the women challenged this and inclusion of women is now the norm.

75. **Financing:** Initially, the cool surface technology was introduced with technological and financial support from the Cool Roof Rating Council in 2013. Since then, SANEDI has attracted public funding and further international donor funding to scale up the technology. Due to the technology's huge success, the government of South Africa decided to deploy the technology over large areas of close to 700, 000 square meter.

76. **Contribution to NDC implementation:** South Africa aims in its NDC[21] to reduce its GHG emission, including through the use of innovative energy-efficient solutions. This innovative passive cooling technology results in emission reductions of 5 to 13 tCO_2e per $100m^2$ of roof per year and therefore has the potential to significantly contribute to South African GHG emission reduction targets.

77. The uptake of the technology has also resulted in reduced peak electricity demand, which has contributed to the improved stability of fragile grids and resulted in cost reductions from lower electricity bills with 5% to 20% of costs saved. The technology has also improved living standards of poorer communities and contributed to the better health of infants, the elderly and sick people, who are vulnerable to high temperatures.

78. **Challenges and lessons learned:** Due to competing priorities within government, the cool roofs technology did at first not get the required public funding and support. However, SANEDI's energy efficiency public awareness campaign created a ground swell of interest in the technology that then led to its further promotion across media platforms, which ultimately resulted in increased government support.

79. In the beginning, the private sector was equally hesitant to take up this new technology. Through the bilateral engagement with individual paint producing companies, SANEDI finally got the necessary support. This has even resulted in advanced discussion on the joint establishment of a product performance testing facility, which would lead to significant cost reduction for the testing of new products, which currently still needs to be done abroad.

80. **Long-term sustainability, replicability and a potential for up-scaling:** The long-term sustainability, replicability and up-scaling of the technology was ensured through: 1) the localization of the technology through the development and adoption of national quality standards; 2) its inclusion in the national building codes; 3) facilitating the local production of cool coatings; 4) introducing tax incentives for building owners, and 5) working closely with national government institutions, local governments and municipalities and local communities on the roll-out of the technology in different parts of the country.

[21] NDC of South Africa (2015). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/South%20Africa%20First/South%20Africa.pdf.

4. Increasing energy efficiency in the Solomon Islands

Participating country: Solomon Islands
Partners: CTCN, PricewaterhouseCoopers (PwC) India
Start of technology uptake process: 2017
Climate technology: Energy efficient water pump technologies
Contribution to NDC implementation: improving energy and water security, reducing GHG emissions from the energy sector.

References: CTCN technical assistance: https://www.ctc-n.org/technical-assistance/projects/solomon-water-energy-efficiency-and-self-generation-plan

81. **Climate technology:** Energy efficient water pumping technology solutions, including retrofitting of existing technology, operational improvements, and new energy efficient motors and pumps reducing GHG emission from the energy sector, while helping to better meet current and future water demands at lower energy costs.

82. **Uptake of the climate technology:** In the Solomon Islands the energy consumption for water management accounts for about 10% of the country's energy demand, which depends almost entirely on diesel-based electricity generators. Water demand is already exceeding water delivery capacity and expected to increase further due to population growth and expansion of the water supply network.

83. The government sought assistance from the CTCN to identify more energy efficient solutions to run its water and wastewater pumping facilities to address the country's increasing water demand. The government conducted a detailed energy audit with support from the CTCN Network member PricewaterhouseCoopers India to identify the most suitable energy efficiency and renewable energy options. Insights from the detailed energy audit formed the basis for a variety of energy efficiency measures, including retrofitting of existing pumps, improvements in operational practices and the identification, procurement and implementation of more energy-efficient motors and pumps. The energy efficiency of some of the country's water pump stations increased significantly simply by reducing artificially high pressure on the pumping system or by reducing oversized pumps.

84. **Gender responsiveness:** Improving energy efficiency in the water sector will enable the Solomon Islands to expand its water supply network, which will be predominantly benefit women. Currently, in some parts of the country, water is still carried by women over long distance for household consumption as tap water supply is not yet universally available. A report on gender co-benefits was prepared as part of the CTCN technical assistance.[22]

85. **Financing:** Energy efficiency could be significantly increased without any investment costs, simply by developing and implementing operational improvements and carrying retrofits of existing technology in-house. These energy efficiency gains resulted in energy costs savings, which were then used for piloting new technology solutions. In addition, the Solomon Islands worked with PwC India in the context of the CTCN technical assistance to develop documents to leverage financing for the procurement of further energy-efficient water pumps.

86. **Contribution to NDC implementation:** The uptake of energy-efficient water pumping technology solutions is supporting the implementation of Solomon Island's NDC by improving energy security and reducing GHG emissions from the energy sector. The estimated GHG emission reduction over the life time of the energy efficiency improvements is 3260t of CO_2 equivalent. It has also helped to improve water security and thus contribute to one of the priority adaptation interventions outline in the NDC.[23]

87. Other benefits of the uptake of the energy efficient technology solutions are significant energy cost savings that can be used for expanding the water supply system to currently un-serviced area. In addition, energy efficiency measures have improved occupational health and safety due to improved housekeeping of pump stations.

[22] https://www.ctc-n.org/system/files/dossier/3b/CTCN%20TA_Gender%20Co-Benefits_Solomon%20Water_20200508.pdf.

[23] NDC of Solomon Islands (2016). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Solomon%20Islands%20First/SOLOMON%20ISLANDS%20INDC.pdf.

88. **Challenges and lessons learned:** Key challenges that the Solomon Islands faced regarding making their water pumping system more energy efficient was a lack of technical knowledge and skills as well as access to funding. The technical assistance provided by CTCN through its network member PwC India addressed these challenges in part by identifying low-cost solutions through retrofitting and changes in operations combined with on the ground training and a technical manual on the implementation of the identified solutions. An important lesson learned is that considerable energy efficiency improvement can be achieved through operating practices and retrofits with little or no investments. However, major technological changes require high investments.

89. **Long-term sustainability, replicability and a potential for up-scaling:** The uptake of the technology is sustainable in the long-term as knowledge on energy-efficiency achieved through operational improvements has been transferred through training modules with train-the-trainer components and captured in operational manuals for future reference. Investment in identified new energy efficient technologies is sustainable, replicable and can be scaled-up due its strong profitability through reduced energy costs and applicability for all water pumping stations throughout the country.

5. Accelerating the uptake of climate technologies in micro-, small- and medium-sized enterprises in Chile

Participating country: Chile
Partners: Agency for Climate Change and Sustainability (ASCC), Chilean Economic Development Agency National Council for Clean Production, CTCN, iQonsulting, Carbon Trust
Start of technology uptake process: 2016
Climate technology: Various technologies for low-emission climate-resilient agri-food processing and new funding mechanisms
Contribution to NDC implementation: GHG emissions reductions; strengthening of public-private cooperation mechanisms for the execution of adaptation actions at national and local scales, increased robustness of sustainable development indicators.

Reference:
CTCN technical assistance: https://www.ctc-n.org/technical-assistance/projects/incubating-climate-technologies-small-and-medium-enterprises-chile

90. **Uptake of the climate technology:** In Chile, the agriculture sector is an important contributor to the economy that is highly vulnerable to the adverse effects of climate change. Within the sector, micro, small- and medium-sized enterprises (MSMEs) make up the majority of producers. Chile sought technical assistance from the CTCN to better understand barriers that prevent MSMEs from adopting climate technologies in the agri-food sector; solve the low adoption of climate technologies; analyze agri-food chains with the purpose of identifying critical points for the introduction of climate technologies; analyze and make recommendations on existing certification, demand aggregation and financial instruments and their effectiveness in the promotion of climate technologies on MSMEs and propose improved instruments in this regard. Building on the results of the technical assistance, Chile adjusted its support mechanism for MSMEs, which resulted in an increased focus and uptake of climate technologies, in particular with regard to solar energy and water and energy efficiency.

91. Through the CTCN technical assistance, the domestic agri-food chains were mapped and analyzed, resulting in the identification of investment priorities for technologies with the highest potential for GHG emission reductions and climate change adaptation benefits for MSMEs in different local contexts. The identified technologies include energy efficient lighting and ventilation systems, drip irrigation, pre-coolers and refrigeration energy heat recovery systems, and solar energy for power generation, heating of water, biodigesters and air drying. This was accompanied by an analysis of barriers that MSMEs are facing regarding the uptake of climate technologies and by the development of solutions to overcome these barriers. Since the CTCN technical assistance, nine agri-food economic industrial associations and their companies are or have been implementing enhanced actions, including the largest food export association.

92. Stakeholder engagement, knowledge transfer and capacity-building were facilitated through the partnership between the two CTCN technical assistance implementers, Carbon Trust, an international expert on clean technologies, and iQonsulting, a local expert on agriculture and climate

change, that allowed to adapt international good practices to the local context. The consortium also leveraged the strong local network of iQonsulting to engage with local communities, policy-makers, financial institutions, academia and NGOs.

93. Chile integrated some of the recommendations of the CTCN technical assistance in its Clean Production Agreements (CPAs) with the agri-food sector by including financing for identified priority technologies, and adopting changes in the CPAs. CPAs, recognized as a nationally appropriate mitigation action by the UNFCCC,[24] are certifiable agreements with sectoral associations, in which the MSMEs through their associations commit to specific goals and actions on making production processes more sustainable within a specified period. As such, CPAs leverage the social capital of a business association with its associates, building trust, sharing knowledge and aggregating technology demands from the specific sector or sub-sector. The CPA preparation and coordination costs are funded up to 70% by the government of Chile. The combination of all these changes has resulted in an increased work with the prioritized agri-food industries; increased uptake of photovoltaic solar energy solutions and increases in energy and water efficiency, in particular through variable speed drivers for conveyor belts, heat recovery systems and energy efficient lighting technologies. The changes made to the CPA also resulted in the most complete SDG reporting for a mitigation action in the country[25] as well as in the introduction of a licensed platform for supporting the measurement, reporting and verification (MRV) of CPAs.[26] At the policy level this data helps to generate traction and interest of possible partners and has led to the provision of financing for technology transfer from sub-national governments.

94. **Financing:** Public finance for the uptake of climate technologies by MSMEs has increased not only through CPAs, but also through other public budget lines, for example for water efficiency projects. Commercial banks are now also increasingly financing projects in this area.

95. **Gender responsiveness:** ASCC requires projects applying for public funding to provide information on whether there are barriers to technology transfer, which are due to the gender of technology users or business owners. In addition, for the approval of funding requests, the gender responsiveness of the project and gender balance within the project team are considered.[27]

96. **Contribution to NDC implementation:** The uptake of climate technologies in the agri-food chains is contributing to Chile's mitigation and adaptation targets, in particular the development of public-private cooperation mechanisms for the execution of adaptation actions at the national and local levels. In addition, the MRV of CPAs is contributing to Chile's target on establishing a MRV mechanism that considers the following criteria applied to the design, application and monitoring of each commitment: synergy with the SDGs, just transition, water security, gender equality and equity, cost-efficiency, nature-based solutions, types of knowledge, and active engagement.[28]

97. **Challenges and lessons learned:** Main challenges for the uptake of climate technologies in the agri-food sector include local technology providers' limited reach into remote areas and possibilities for serving micro and small enterprises due to high transaction costs. In addition, the combination of a lack of trust and a lack of capacity of MSMEs to evaluate new technologies, technology providers, and financial possibilities hinders the adoption of climate technologies.

98. The CPAs provide a government-backed framework that aggregates demand with the support of the business association and therefore offers a solution to reduce the transaction costs of selling, importing and financing low-emission technologies by creating economies of scale and trust between the participants. The main insight on how the transfer actually happened is by getting one of the businesses to successfully implement the technology, and then showcase and share their results with the other businesses in the context of the CPA. Trust and imitation of peers plays a

[24] https://www4.unfccc.int/sites/PublicNAMA/_layouts/un/fccc/nama/NamaForRecognition.aspx?ID=11&viewOnly=1.

[25] https://datastudio.google.com/reporting/508a6d6e-72cc-4cbc-b573-8401ab9eeccf/page/1ZguB?s=g3gxLHnD0sk.

[26] https://github.com/AgenciaSustentabilidadyCambioClimatico/accion.

[27] https://www.ascc.cl/resources/uploads/documentos/bases_tecnicas_de_la_linea_6_del_fondo_para_la_promocion_de_acuerdo_de_produccion_limpia_y_de_iniciativas_publicas_y_privadas.pdf.

[28] NDC of Chile (2020). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Chile%20First/Chile%27s_NDC_2020_english.pdf.

significant role in the decisions made by the MSMEs. In addition, the provision of technical support has played a significant role in the adoption of climate technologies.

99. **Long-term sustainability, replicability and a potential for up-scaling:** The sustainability of the technology uptake is ensured through efficiencies created in the production process of MSMEs that lead to cost reductions, increased energy and water autonomy and production outputs. The approach taken by Chile is replicable in other countries as it can be easily adjusted to target the locally most suitable climate technologies. Chile has been working with Colombia on a possible replication of the CPA approach. The approach also has a potential for up-scaling as not all MSMEs have been reached in the country to date, , but for this to happen effectively further redesign might be needed to decrease the reliance on public funds.

6. Advancing low-emission mobility solutions in Cambodia

Participating country: Cambodia
Partners: CTCN, Global Green Growth Institute, Envelops Co. Ltd.
Start of technology uptake process: 2019
Climate technology: Electric motorcycles
Contribution to NDC implementation: Reduce transport sector emissions through the promotion of low-emission transport modes.

Reference:
a) CTCN technical assistance: https://www.ctc-n.org/technical-assistance/projects/development-low-emission-mobility-policies-and-financing-proposal
b) GGGI awareness raising campaign: https://gggi.org/gggi-promote-sustainable-e-mobility-in-cambodia-through-an-exciting-one-month-campaign/

100. **Climate technology:** Electric motorcycles and a network of charging and maintenance stations.

101. **Uptake of the climate technology:** Cambodia's road transport mainly relies on fossil fuel vehicles. Increasing transportation needs coupled with the country's economic growth has been the main driver of rising GHG emissions from the transport sector and worsening air quality in urban areas.

102. Cambodia identified the limitation of information, policy and planning, institutional capacity and commercial market as key barriers for the uptake of low-emission mobility in the country. The limitation of information pertained to the economic, social and environmental benefits of low-emission mobility. The limitation of policy and planning was mainly regarding incentivizing the uptake of electric vehicles and removing incentives for fossil fuel vehicles. The limitation of institutional capacity pertained to technical expertise for the development of national low-emission projects and coordination and engagement of stakeholders in planning and realizing such projects.

103. Cambodia sought technical assistance from the CTCN and the Global Green Growth Institute (GGGI) to accelerate the transition to low-emission mobility by addressing the identified key barriers. In cooperation with Envelops Co. Ltd, who carried out the CTCN technical assistance, a policy action plan was developed that focused on the introduction of electric motorcycles given that two and three wheelers are a common mode of transportation in Cambodia. An in-depth assessment of Cambodia's electric vehicle market revealed a lack of awareness and trust in electric vehicle technology as a reason for the low uptake of electric mobility in the country. Cambodia, in partnership with GGGI, delivered a broad awareness raising campaign which resulted in a larger social acceptance of electric motorcycles and recognition of their economic benefits.

104. **Gender responsiveness**: Fostering the uptake of electric vehicles, will contribute to lower costs of transportation in the longer term. Women, particularly suburban areas of Cambodia, who suffer from significantly lower income than men with poor access to labour market, will in particular benefit from lower mobility cost in terms of increased access to employment, markets, education and health services, but also to the caretaking and household responsibilities that the majority of women hold.

105. **Financing**: An incentive programme for purchasing electric motorcycles was developed, including grants, subsidized loans and tax incentives. As part of the CTCN technical assistance a Green Climate Fund project proposal was prepared to support the incentive programme and the roll

out of 1,000 electric motorcycles in 2022. In addition, the government, with support from GGGI, developed a national investment plan, which also aims to introduce an electric bus system in Siem Reap at the value of USD 16 million from 2022 to 2024.

106. **Contribution to NDC implementation:** The uptake of electric motorcycles is contributing to the Cambodia's NDC mitigation target of reducing transport sector emissions through the promotion of low-emission transport modes.[29]

107. Other benefits of the technology uptake include the reduction of air pollution, especially in urban areas, as well as economic benefits for the technology users. A comparison of operating costs for driving 100 km with an electric motorcycle and a fuel motorcycles at power of 100cc and 125cc shows that the cost of driving an electric motorcycle is about eight to ten times lower.

108. **Challenges and lessons learned:** Reliable access to electricity is not available throughout the country. Therefore, electric motorcycles need to be introduced together with stand-alone re-charging stations that have a battery swapping system in place for efficient servicing. Here, the size of the re-charging stations is of key importance to strike a balance between local demand and potential grid instability. The availability of maintenance stations is of equal importance, which will require capacity-building of local mechanics.

109. Another challenge is the overall low public awareness about electric vehicles in general, which is compounded by limited exposure to the technology. In 2019, a survey by the Ministry of Environment found that only 34% of respondents could sufficiently explain what an electric motorcycle is. Common public concerns that prevent the uptake of electric motorcycles also include:

(a) Range anxiety due to a lack of charging stations and low battery range;

(b) Maintenance issues due to the very limited availability of maintenance stations;

(c) Design options given the limited range of electric motorcycle models;

(d) Investment costs as there is no second-hand market for electric motorcycles and a lack of financial institutions willing to provide loans for the purchase;

(e) Quality concerns given that national standards for electric motorcycles are still under development, which allows low quality vehicles to enter the market that contribute to negative consumer perceptions.

110. Furthermore, a solution for the management of battery waste needs to be developed to ensure that batteries are properly discharged or recycled, for example through take-back schemes with producers.

111. **Long-term sustainability, replicability and a potential for up-scaling:** Cambodia's approach towards advancing low-emission mobility solutions through the uptake of electric motorcycles is sustainable in the long-term as it creates an enabling environment for a striving electric motorcycle market. In economic terms, electric motorcycles in Cambodia are on average ten time cheaper than combustion engine motorcycles over a ten-year period. The approach is replicable in other countries as it can be easily adjusted to local circumstances. It also has a potential for up-scaling as is currently limited to urban areas.

[29] NDC of Cambodia (2020). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Cambodia%20First/20201231_NDC_Update_Cambodia.pdf.

7. Strengthening climate-resilient agriculture in the Dominican Republic

Participating countries: Colombia, Dominican Republic
Partners: Inter-American Institute for Cooperation on Agriculture (IICA)
Start of technology uptake process: 2016
Climate technology: System of Rice Intensification (SRI)
Contribution to NDC implementation: Improved capabilities to adapt appropriately to climate change and variability in the rice production subsector (Colombia); Reduced emission from rice cultivation through the change of production technology (Dominican Republic).

Reference:
a) SRI International Network and Resources Center: http://sri.ciifad.cornell.edu
b) Project website: https://www.fontagro.org/proyecto/cultivar-mas-con-menos-adaptacion-validacion-y-promocion-del-sistema-intensivo-del-cultivo-arrocero-sica-en-las-americas-como-una-respuesta-al-cambio-climatico

112. **Climate technology:** SRI is an agroecological and climate-smart production strategy based on four key principles: 1. Early and healthy plant establishment; 2. Minimize competition between plants; 3. Build fertile soils rich in organic matter and soil biota; 4. Manage water carefully, avoiding flooding and water stress and increasing the aeration of the soil. Through this, SRI modifies the management of plants, soil, water and nutrients, thus enhances resource use efficiency and productivity of the system while reducing vulnerability to climate change. It is a flexible, knowledge-intensive system implemented through practices that are contextualized in response to the needs, priorities and skills of each producer.

113. **Uptake of the climate technology:** In Colombia and the Dominican Republic small-scale farmers play an important role for agriculture and food security. Climate change is causing greater water stress, greater storm damages and increased crop diseases that impact heavily on small scale farmers.

114. SRI was developed by rice producers in Madagascar in the second half of the twentieth century. It is employed by over 10 million producers in Africa and Asia and now also starting to become more known in Latin America and the Caribbean. SRI does not require the use of new seed varieties, synthetic fertilizers or agrochemical crop protection to get higher outputs. On the contrary, SRI reduces farmers' needs for seeds and water, and often even for labour, and therefore gives them greater returns from their available land, labour and capital. This raises their incomes while also being beneficial for the environment and increasing climate-resilience.

115. Technical experts and farmers from Colombia visited their counterparts in the Dominican Republic to exchange experiences on the local contextualization and application of the SRI methodology. The exchange included both theoretical aspects and practical insights through a demonstration parcel. The two sides exchanged data, discussed challenges, jointly identified suitable practices, developed draft protocols for the implementation and monitoring of demonstration parcels and established a process and communication channels for the regular exchange of information. The technical experts together with the farmers then innovated and tested different options to identify the most suitable practices for the respective local contexts, recognizing that the change process had to be gradual. Farmers then continued and further improved their tailored SRI approaches as initial production cycles had resulted in increased yields of up to 25 per cent, decreased water use of up to 45 per cent, increased seed use efficiency of up to 96 per cent and decreased production costs of up to 10 per cent. Additional benefits included reduced agrochemical use and reduced lodging due to extreme winds. In Tolima, Colombia and the Dominican Republic, producers experienced up to a 43 per cent and 68 per cent increase in net utility with SRI, respectively, compared to conventional production.

116. Endogenous capacities of both the technical experts and smallholder producers were developed on SRI and the application of its principles and how to establish validation parcels, including on making empirical observations and adjusting appropriately, how to measure results over time as well as on how to communicate this technology to other technical experts and smallholder producers.

117. **Gender responsiveness:** The project encourages the participation of women in the training and field trips and collects gender-disaggregated participation data for all activities.

118. **Contribution to NDC implementation:** The uptake of the SRI technology has been supporting the objective of Colombia's NDC[30] to improve capabilities to adapt appropriately to climate change and variability in the rice production subsector. In the Dominican Republic, the SRI methods have great potential to contribute to the country's NDC,[31] target of reducing emission from rice cultivation through the change of production technology.

119. **Challenges and lessons learned:** The many thousands of farmers who have been adapting and implementing SRI in diverse agroecological contexts across the world combined with hundreds of peer reviewed articles on SRI have demonstrated that SRI is an effective technology that provides multiple agronomic, environmental and economic benefits. The key challenges to uptake include 1) the need to mechanize production to ensure cost-effectiveness at larger scales, 2) the need to strengthen the enabling environment, for instance, to incentivize a reduction in water use and 3) perhaps the greatest challenge is working with farmers to foster innovation, adapt SRI and facilitate its adoption as it requires multiple changes to conventional production techniques.

120. **Long-term sustainability, replicability and a potential for up-scaling**: To ensure the long-term sustainability of the introduction of the SRI approach, the Colombian National Federation of Rice Producers is committed to integrating SRI efforts into its Broader Massive Adoption of Technology (AMTEC) programme, which seeks to increase the agricultural sector's environmental and socioeconomic sustainability to increase competitiveness and productivity while reducing production costs. A key challenge to overcome is the need to mechanize production to ensure SRI is cost effective – this requires mechanized planting and weed control. The SRI technology has been already replicated and scaled-up across Africa and Asia. Countries from Latin America that have engaged with Colombia and the Dominican Republic on their experiences regarding the uptake of the SRI technology, for example Argentina, Chile, Costa Rica, Panama and Venezuela have also started to replicate experiences from their counterparts.

8. Utilizing ocean energy in Nauru

Participating country: Nauru
Partners: CTCN, Institute of Ocean Energy of Saga University, Overseas Environmental Cooperation Center of Japan
Start of technology uptake process: 2020
Climate technology: Ocean thermal energy conversion
Contribution to NDC implementation: Achieving water and energy security; transitioning to renewable energy in the electricity generation sector.

121. **Climate technology:** Ocean thermal energy conversion (OTEC) is a technology that produces both energy and desalinated water. Energy is produced by harnessing the temperature differences between ocean surface waters and deep ocean waters. And the condensed water resulting from the process is an abundant fresh water source.

122. **Uptake of the climate technology:** Nauru is committed to generating 100% of its electricity needs from renewable energy sources by 2050. The country has been increasing its use of solar energy, but requires complementary energy sources for achieving its target. At the same time the country needs to address the increasing climate change-induced scarcity of fresh water sources.

123. The enormous potential of ocean energy in Nauru is long known as the country had set up the world's first OTEC pilot plant in cooperation with Japan in 1981. However, extreme weather events caused major damages, which ceased its operation. Nauru's TNA[32] identified OTEC as the priority mitigation technology taking into account significant OTEC technology improvements over the past decades, such as climate-proof constructions methods and the possibility to produce large amounts of fresh water through the energy generation process.

[30] NDC of Colombia (2020). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Colombia%20First/Colombia%20iNDC%20Unofficial%20translation%20Eng.pdf.

[31] NDC of the Dominican Republic (2020). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Dominican%20Republic%20First/Dominican%20Republic%20First%20NDC%20(Updated%20Submission).pdf.

[32] https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2020/04/nauru-final-tna-report-2020.pdf.

124. The government of Nauru engaged local communities from the outset in the process of identifying and pursuing OTEC as a technology solution for the country. In particular, landowners of the project site and surrounding communities were consulted.

125. **Gender responsiveness:** Stakeholder consultations were designed in a way that women and men were involved equally. The TNA and CTCN technical assistance processes led to the development of safeguards for a gender-responsive planning and implementation of the technology and found that women will be the primary beneficiaries of fresh water production due to their strong involvement in the agricultural sector.

126. **Financing:** Through the technical assistance provided by the CTCN, Nauru was able to verify that the introduction of the latest OTEC technology, is not only technically feasible, but also socially, environmentally and economically viable. While the plant is economically viable in terms of operation, Nauru requires support for the installation of the OTEC plant. It therefore utilized the CTCN's technical assistance also for the development of funding proposals that help secure the high initial investment costs required for the OTEC plant.

127. **Contribution to NDC implementation:** Nauru's NDC[33] priorities include achieving energy and water security as well as transitioning to renewable energy in the electricity generation sector. The OTEC technology contributes significantly to these objectives by providing energy from renewable sources and large amounts of fresh water.

128. The generation of fresh water does not only contribute to water security, but also to food security and economic benefits for local communities as it enables fresh water fish aquaculture.

129. **Challenges and lessons learned:** Among the key challenges was the lacked of technical and financial resources to assess the potential of the OTEC technology and its technical, social, environmental and economic viability. This challenge was overcome by carrying out the TNA and through technical assistance provided by the CTCN. Another key challenge is the high initial investment cost for the construction of an OTEC plant. To overcome this challenge, Nauru utilized the CTCN technical assistance to develop a financing proposal.

130. **Long-term sustainability, replicability and a potential for up-scaling:** Once installed, the OTEC technology is sustainable in the long-term as it runs fairly autonomous and permanently with little maintenance costs, while bringing large economic, social and environmental benefits to the country. The technology also has a huge potential for replication in other SIDS, in particular those island countries located in the Pacific, where the required large differences between surface water temperature and deep-water temperature is widely in place.

B. Lessons learned

131. The success stories presented in section 3.1. above as well as the review of revised NDCs and previous work of the TEC and the CTCN on technology and NDCs resulted in the identification of the following lessons learned. While revised NDCs do not refer specifically to lessons learned regarding the uptake of technologies, various concrete insights can be drawn from the success stories and previous work by the TEC and CTCN as synthesized below:

(a) **Stakeholder engagement for effective and efficient technology solutions:** Stakeholders play a crucial role in climate technology planning and implementation, not only for identifying effective technical solutions in different local contexts (Success stories 3.1.1 and 3.1.6), but also for creating awareness and fostering co-ownership of solutions (Success stories 3.1.2 and 3.1.7). The success stories also demonstrated how the successful uptake of technologies requires approaches that are gender-responsive (Success story 3.1.2), take into account the enhancement of indigenous capacities and endogenous technologies (Success story 3.1.7), and are tailored to local circumstances, including special circumstances of LDCs and SIDS (Success stories 3.1.4, 3.1.6 and 3.1.8).

(b) **Proving economic and social viability through local champions, creating enabling environments for long-term sustainability**: The uptake of environmentally-sound technologies is only sustainable in the long-term, if technologies are economically, institutionally

[33] NDC of Nauru (2016). Available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Nauru%20First/Nauru_NDC.pdf.

and socially viable (TEC 2020). Creating local champions that showcase the success of technology solutions can play a crucial role in securing further financial, but also institutional and social support needed for the uptake of a technology in a country (TEC 2020). The financial feasibility of envisaged business models is as important as the technical feasibility and the social acceptance of the technology itself (Success story 3.1.7). Governments have a major role to play in creating enabling environments to address the challenges to the uptake of technologies by establishing and enforcing appropriate regulatory and institutional frameworks (TEC 2021c, success stories 3.1.2 and 3.1.3). Enabling environments need to be targeted at engaging the private sector, which plays an important role in accelerating the uptake of technologies (TEC 2020, success stories 3.1.5 and 3.1.6). High initial investment costs can be partially overcome through pooling of funds (Success story 3.1.2), developing innovative business models (Success story 3.1.5) or engaging multilateral donors or funds (Success stories 3.1.1, 3.1.6 and 3.1.8). Sometimes low-cost solutions for technology-driven climate action can be found in retrofitting of existing technologies or changes in operation (Success story 3.1.4).

(c) **Experience sharing and capacity-building for accelerated technology uptake:** Documenting and sharing good practices, challenges and lessons learned regarding the uptake of technologies can stimulate the uptake of the same or similar technologies domestically or in another country (Success stories 3.1.2 and 3.1.7). The uptake of technologies needs to be documented in its entirety, including approaches taken in the different stages of technology development, transfer, deployment and diffusion, in particular with regard to overcoming institutional, social and economic barriers. This applies equally for adaptation technologies that are often more orgware and software focussed as well as for mitigation technologies that have stronger hardware components. The exchange of experiences during the design of approaches and processes can lead to immediate efficiency gains and therefore accelerated action (TEC 2017b, TEC 2020). Targeted capacity-building support for policy-makers and technology providers and end-users that builds on shared experiences and lessons learned can significantly support the accelerated uptake of technologies (Success stories 3.1.2 and 3.1.3). A variety of technology-specific lessons learned can also be drawn from the closing reports of the TA requests completed by the CTCN to date (CTCN 2021a).

VI. Observations

132. Parties agree on the importance of technology for the implementation of adaptation and mitigation actions under the Paris Agreement. While most Parties include references to technology in their NDCs, the structure and depth of such information varies significantly. Providing more detailed information on the use of technology and technology needs and challenges in NDCs could facilitate:

(a) Learning between Parties through creating more understanding of technology approaches taken or envisaged for specific adaptation and mitigation actions;

(b) A better understanding of policy targets among domestic technology stakeholders;

(c) Increased support for developing country Parties from international sources that are increasingly focussed on NDC targets;

(d) The work of the TEC on identifying policies that can accelerate the development and transfer of low-emission and climate resilient technologies.

133. More concretely, to stimulate the uptake of technologies in support of NDC implementation it may be beneficial to develop and include sectoral technology roadmaps[34] with specific timebound technology targets in NDCs. Some Parties are already pursuing the development of national sectoral technology roadmaps and some global technology roadmaps have been developed by

[34] Technology roadmaps help identify policies and measures that are instrumental in supporting project implementation, and also identify and address specific challenges. Their contents can be regarded as the basis for good planning practices in various areas, including technology implementation to enhance mitigation and adaptation to climate change. Technology roadmaps could therefore be useful in other planning processes, including for the provision of a ready-to-use structure for individual parts of technology action plans (TAPs), translating the outcomes of TNAs into concrete, time-related actions related to a selected group of technologies. Roadmapping techniques could be used in TAPs or accompany already prepared TAPs, specifying steps towards their desired implementation (TEC 2014).

intergovernmental organizations, for example for the energy sector (IEA 2021, IRENA 2019) or more broadly in the form of science, technology and innovation roadmaps for the SDGs (IATT 2020). However, for many technology sectors, in particular with regard to adaptation technologies, global technology roadmaps continue to remain unavailable (TEC 2013b, TEC 2014). As per its functions, the TEC could catalyse the development and use of technology roadmaps at the global, regional and national levels through cooperation between relevant stakeholders, particularly governments and relevant organizations.[35] The CTCN, at the request of countries, could also provide advice and support related to the development of such roadmaps.

134. The uptake of technologies in support of NDC implementation should be guided by the principles of the technology framework established under the Paris Agreement, including to facilitate the active participation of all relevant stakeholders, taking into account sustainable development, gender, the special circumstances of the LDCs and SIDS, and the enhancement of indigenous capacities and endogenous technologies.[36] The broad and effective participation of stakeholders is key for ensuring that the uptake of technologies safeguards human rights and does not have any negative impacts on the social environments of local communities.

135. As regards linkages between policy and implementation, it is important to ensure that policies build on local capacities, endogenous technologies and natural resources that are specific to the national or local context. The case studies in section 3 have shown that while policies are often a key enabler for the deployment and uptake of technologies, in some cases technology uptake is bottom-up process. There is a need to further explore the linkages between policy and implementation regarding technology as well as specific adaptation and mitigation outcomes resulting from these linkages. In this context, there is also a need to develop indicators to measure the effectiveness and efficiency of the deployment of technology solutions and their impact on NDC implementation.

VII. Recommendations

136. This section offers two sets of recommendations on how to stimulate the uptake of climate technologies in support of NDC implementation based on the findings presented in the previous sections. The successful uptake of a technology does not only depend on its ability to meet specific technical needs, but even more so on an economically and socially viable approach that can ensure the technology's effective deployment and diffusions. The first set of recommendations looks at possible further work to be undertaken by the TEC and the CTCN in this regard. The second set of recommendations is offered to Parties.

137. To stimulate the uptake of technologies in support of NDC implementation, the TEC and the CTCN could:

(a) Catalyze the development and use of action-oriented technology roadmaps for different sectors at the global, regional and national levels, in line with NDC targets and the goals of the Paris Agreement, through facilitating cooperation between Parties and relevant organization;

(b) Use the technology roadmaps as guidance for its further work, including on supporting the transition to specific environmentally sound technologies identified for different sectors, focusing efforts on supporting the creation of enabling environments for the uptake of these specific technologies, including through effective stakeholder engagement and financing approaches;

(c) Consider the update of this joint publication on a regular basis to reflect more precisely latest developments and trends regarding the role of technology for NDC implementation.

138. To stimulate the uptake of technologies in support of NDC implementation, Parties could:

(a) Foster gender-responsive, inclusive, participatory and equitable processes and approaches for the uptake of climate technologies that take into account the needs, priorities, knowledge and capacities of all technology stakeholders, generate awareness of technology benefits and result in the co-ownership of these processes and technologies. In particular, technology uptake

[35] Decision 1/CP.16. Paragraph 122 (g).
[36] Decision 15/CMA.1. Annex. Paragraph 3 (b).

needs to lead to a just transition that protects workers and communities, including indigenous peoples and women, and ensures a more socially-equitable distribution of benefits and risks;

(b) Create success stories that demonstrate local economic and social benefits achieved through the uptake of environmentally sound technologies and their contribution to NDC implementation with a view to leveraging broader financial, institutional and social support for replication and upscaling of those technologies;

(c) Support market creation and expansion for prioritized technologies by putting in place enabling legal and regulatory environments and by enhancing capacities of technology stakeholders to benefit from those environments, taking into account that in many cases adaptation technologies require more public support as market-based approaches are more difficult to develop than for mitigation technologies;

(d) Systematically document and disseminate information on pursued policies, schemes and programmes to foster the uptake of a technology, including information on challenges and lessons learned regarding meeting NDC targets, to inform future policies and prioritization of technologies, including for revised NDCs and NAPs;

(e) Including more detailed information on technology in NDC, for example on technology needs and support, to foster a clearer understanding of policy targets by domestic technology stakeholders, facilitate international cooperation, and enable a more targeted provision of support by the TEC and the CTCN, according to their respective functions, and other support providers, as appropriate;

(f) Make more use of the Technology Mechanism to carry out the above recommendations, including by utilizing technical documents and recommendations on climate technology policies prepared by the TEC,[37] and in addition for developing country Parties, by actively engaging with the CTCN[38] to benefit from its provision of technology solutions, capacity-building and advice on policy, legal and regulatory frameworks, and support for the development of technology roadmaps, tailored to the needs of individual country contexts.

VIII. Acknowledgements

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[37] https://unfccc.int/ttclear/policies.
[38] https://www.ctc-n.org/technical-assistance.

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