United Nations Climate Change
Technology Executive Committee

CTCN
UN Climate Technology Centre & Network

TECHNOLOGY AND NATIONALLY DETERMINED CONTRIBUTIONS

Stimulating the Uptake of Technologies in Support of Nationally Determined Contribution Implementation

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CO_2 eq	carbon dioxide equivalent
COP	Conference of the Parties
CPA	clean production agreement
CTCN	Climate Technology Centre and Network
GCF	Green Climate Fund
GGGI	Global Green Growth Institute
GHG	greenhouse gas
IATT	United Nations Inter-agency Task Team on Science, Technology and Innovation for the SDGs
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
LDC	least developed country
MRV	measurement, reporting and verification
MSMEs	micro, small and medium-sized enterprises
NAP	national adaptation plan
NDC	nationally determined contribution
NDE	national designated entity
NRLM	National Rural Livelihood Mission of India
OTEC	ocean thermal energy conversion
SANEDI	South African National Energy Development Institute
SDG	Sustainable Development Goal
SIDS	small island developing State(s)
SRI	system of rice intensification
TAP	technology action plan
TEC	Technology Executive Committee
TIPSASA	Thermal Insulation Products and Systems Association of South Africa
TNA	technology needs assessment

FOREWORD

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

Since 2019, the TEC and the CTCN Advisory Board have been exploring areas for collaboration and activities to undertake jointly that align with the technology framework. In 2020, the TEC and the Advisory Board agreed to produce a publication that analyses technology issues related to NDCs.

This publication, the result of the joint effort of the TEC and the CTCN, focuses on technology needs, technology challenges, linkages between policy and implementation, and linkages between NDCs and NAPs. Its intention is to advance insights, share lessons learned and develop recommendations on how to address the issues identified in these key areas.

We are pleased to present our joint findings on the role of technology in NDC implementation and joint recommendations 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 task force on technology and NDCs who provided valuable contributions to this publication.

This is the first time that the TEC and the CTCN have prepared a joint publication. We look forward to continuing our fruitful collaboration in other areas in the future with a view to further accelerating technology-driven climate action under the Paris Agreement to assist the global coronavirus disease 2019 recovery efforts and advance the shift towards a climate-resilient, net zero world.

Stephen Minas
Chair of the Technology Executive Committee

Mareer Mohamed Husny
Vice-chair of the Technology Executive Committee

Moa Forstorp
Chair of the Advisory Board of the CTCN

Omedi Moses Jura
Vice-chair of the Advisory Board of the CTCN

KEY FINDINGS

The majority of Parties mentioned technology in their revised NDCs. However, the structure and level of detail of the 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 information, while some also included quantitative information – in some cases, detailed information on the required scope of technologies and their estimated costs.

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

Technology needs expressed in revised NDCs range from generic needs for support for technology development and transfer to needs for specific technology sectors and types of technologies, in particular those related to agriculture, energy efficiency, renewable energy, climate observation and early warning, infrastructure and urban planning, transportation, water and industry.

Only a few Parties included information in their NDCs 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.

The analysis of linkages between policy and implementation in the context of technology and NDCs found that strong linkages are needed for the effective uptake of climate technologies. In addition, fostering linkages between the technology-related aspects of the NDC and the NAP processes can benefit both processes greatly, avoiding duplication of work and accelerating implementation.

The success stories presented in this publication highlight the great variety of examples from different geographical regions and country contexts where the uptake of technologies is directly supporting the implementation of NDCs. Examples include technology solutions driven by governments, the private sector and communities, and they showcase different approaches to overcoming the technical, financial, institutional and social challenges that arise in taking up technologies. These approaches include innovative policies and business models, gender-responsive approaches and effective stakeholder engagement.

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

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

(a) Catalyse the development and use of action-oriented technology road maps for different sectors at the global, regional and national level, in line with NDC targets and the goals of the Paris Agreement, through, inter alia, facilitating cooperation and knowledge-sharing among Parties and relevant organizations and providing guidance and technical assistance for the development of technology road maps;

(b) Use the technology road maps 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 specific technologies, including through effective stakeholder engagement and financing approaches;

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

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

(a) Foster gender-responsive, inclusive, participatory and equitable processes and approaches to 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 foster stakeholder engagement and buy-in regarding 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 ensure a more socially equitable distribution of benefits and risks;

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

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

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

(e) Make more use of the Technology Mechanism to carry out the above recommendations, including by:

(i) Utilizing technical documents and recommendations on climate technology policies prepared by the TEC;[1]

(ii) 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 its provision of support for the development of technology road maps, tailored to the needs of individual country contexts;

(iii) Sharing more information on technology needs and support to foster a clearer understanding of policy targets by domestic technology stakeholders, facilitate international cooperation, and enable the more targeted provision of support by the TEC and the CTCN, according to their respective functions, and other support providers, as appropriate.

1 https://unfccc.int/ttclear/tec/documents.html.
2 https://www.ctc-n.org/technical-assistance.

I. BACKGROUND

A. Mandate and objectives

In response to a request of the CMA on joint activities,[3] the TEC and the CTCN agreed to jointly produce a publication on technology and NDCs that analyses technology issues related to NDCs, including revised NDCs[4]. The publication, building on previous work of the TEC and the CTCN and insights gathered from technology stakeholders through interviews, identifies success stories and lessons learned regarding the uptake of technologies in support of NDC implementation. It presents observations and concludes with recommendations. The publication is addressed to policymakers with the aim of supporting them in identifying ways of stimulating technology uptake to support NDC implementation.

B. Methodology

The publication is based on a methodology comprising (1) a desk review of information sources, including reports, surveys and assessments of the TEC, the CTCN and the secretariat, and (2) semi-structured interviews conducted with CTCN regional technical assistance teams, NDEs and CTCN technical assistance implementers[5] from April to July 2021 (see TEC (2021a) for a draft outline of the publication and further details on the methodology, including information sources).

The desk review resulted in a synthesis of technology issues related to NDCs with a focus on technology needs, technology challenges, linkages between policy and implementation, and linkages between NDCs and NAPs. It also 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 geographical regions, LDC and SIDS representation, adaptation and mitigation-focused technologies, technology sectors, implementing partners, and cross-cutting issues such as innovation and gender.

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

The publication also reflects the outcomes of the panel discussion on technology and NDCs held at the TEC–CTCN joint session in April 2021.[6]

---

3 Decision 8/CMA.2, para. 3.
4 FCCC/SB/2020/4, annex I.
5 Technical assistance facilitated by the CTCN in response to developing country requests is implemented by members of its Network of technology stakeholders. A list of Network members is available at https://www.ctc-n.org/network/network-members.
6 https://unfccc.int/ttclear/events/2021/2021_event02.

II. TECHNOLOGY AND NATIONALLY DETERMINED CONTRIBUTIONS

A. Overview of technology information in revised nationally determined contributions

This overview[7] presents a synthesis and analysis of the information on technology contained in the 48 revised NDCs, representing 75 Parties[8] received as at 31 December 2020.[9] The synthesis and analysis is in line with the approach taken by the secretariat in preparing its initial NDC synthesis report in response to requests of the COP and the CMA.[10,11]

The 75 Parties that submitted the 48 NDCs represent only 39 per cent of the 189 Parties to the Paris Agreement.[12] Figure 1 below shows these Parties by regional group, and figure 2 below shows the number of developed and developing country Parties that made the submissions. Of the 39 developing country Parties, 7 are LDCs and 10 are SIDS.

The 48 NDCs comprise a relatively small sample size: the 39 developing country Parties constitute only 26 per cent of developing country Parties that are a Party to the Paris Agreement. The small sample size is particularly apparent when looking at specific groups of developing country Parties: 10 per cent of Parties from the African region and 16 per cent of the LDCs had submitted their NDCs as at 31 December 2020.

Figure 1. Nationally determined contributions received as at 31 December 2020, by regional group

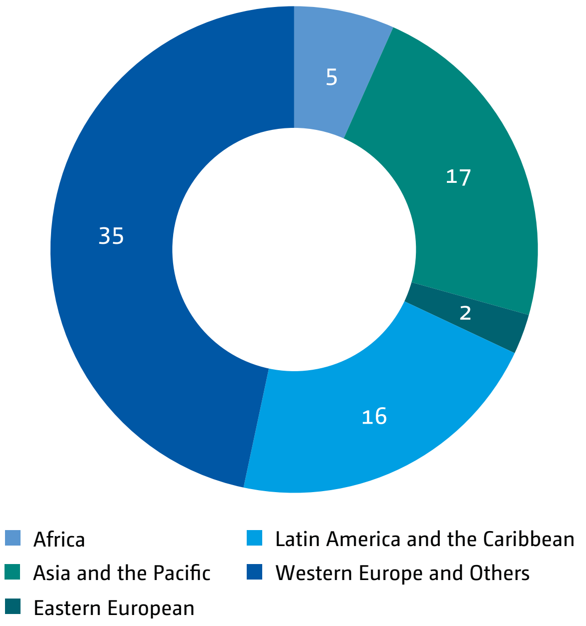
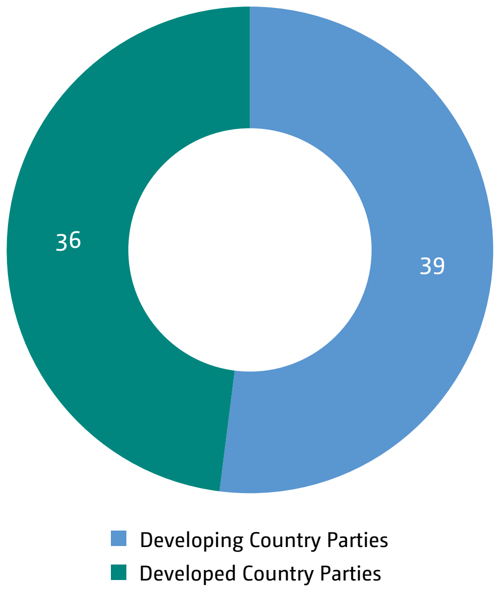


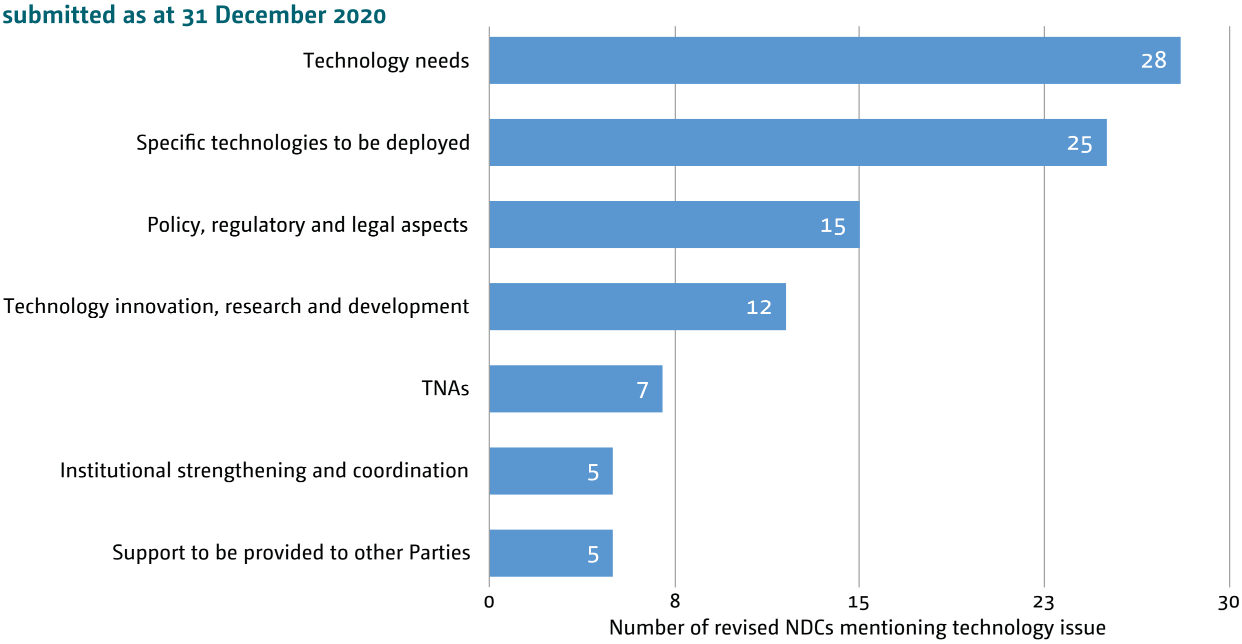
Figure 2. Nationally determined contributions submitted by developing and developed country Parties, as at 31 December 2020



7 The overview is based on a working paper prepared by the secretariat in March 2021 on the analysis and synthesis of technology components in NDCs. Available at https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tn_meetings/2908f3b0dfb24bf38e21e76b6bc8c9b5/47e31c6820c34af7bf4fcc12b4a0eb64.pdf.
8 The NDC submitted by the European Union is the only NDC considered for this report that represents a group of Parties. Since the European Union represents 27 Parties, 48 NDCs represent 75 Parties.
9 All NDCs are available in the NDC registry at https://www4.unfccc.int/sites/NDCStaging/Pages/Home.aspx.
10 Decisions 1/CP.21, para. 25, and 1/CMA.2, para. 10.
11 FCCC/PA/CMA/2021/2.
12 Status of ratification of the Paris Agreement as at 31 December 2020. See https://unfccc.int/process/the-paris-agreement/status-of-ratification.

Most NDCs (90 per cent) include information on technology even though there is no provision in the Paris Agreement or related decisions of the COP or the CMA that requests Parties to provide such information. However, the structure and level of detail of the information varies significantly. Of the 43 NDCs[13] that refer to technology, 11 (26 per cent) have a dedicated section on technology, while 32 (74 per cent) only refer to technology in one or some sections. Regarding qualitative and quantitative information, 40 NDCs (93 per cent) include only qualitative information on technology aspects, while 16 (37 per cent) include both types of information. Five NDCs (12 per cent) include information on specific projects for technology development and transfer, some with detailed information on technical and financial requirements, implementing entities and time frames.

Figure 3. Aspects of technology referred to in the nationally determined contributions submitted as at 31 December 2020



Most of the 43 Parties that provided information on technology in their NDCs did so in the context of actions that inherently address both adaptation and mitigation (32 Parties) or focus on mitigation (31 Parties). Twenty Parties referred to climate technology for adaptation.

Information on technology in NDCs is focused on the following aspects, as shown in figure 3 above: overall technology needs (28 Parties); specific technologies to be deployed (25); policy, regulatory and legal aspects (15); technology innovation and research and development (12); TNAs (7); institutional strengthening and coordination (5); and support to be provided to other Parties for technology development and transfer (5).

13 Given that the NDC of the European Union 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.

The table on the next page presents examples of information provided in each of these categories. Some technology references in NDCs focused on cross-cutting and other issues, such as strengthening market preparation, business planning and investment to promote the deployment of prioritized technologies; promoting the social acceptance of new technologies; and ensuring the gender-responsiveness of technology development and transfer.

Overall technology needs mentioned by Parties in their NDCs mainly related to 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-emission or zero emission vehicles, and hydrogen technologies.

Actions on policy, regulatory and legal aspects commonly included in NDCs are developing or updating policies that promote technology innovation, energy efficiency, and the accelerated adoption and transfer of climate technologies through private investments.

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

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

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

Examples of information on technology in nationally determined contributions submitted as at 31 December 2020, by category

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 the 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 private vehicles, commercial vehicles and public vehicles (taxis and buses) (Chile) • Ensure a smooth transition to the nationwide adoption and use of renewable energy technologies mainly solar photovoltaic technology, which is critical to the country (Brunei Darussalam) • Increase energy efficiency in the industrial sectors (Japan)
Policy, regulatory and legal aspects	• Develop and update energy efficiency standards and regulations for end-use technologies, including 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 for gender-responsive climate-smart technologies and practices (Nepal) • Promote clean fuel technology regulations to set standards for GHG emissions and economic incentives for fuel-efficient vehicles and e-mobility (Papua New Guinea) • Adjust the country's regulatory framework to create stronger incentives for private investment in technologies that increase climate resilience (Republic of Moldova)
Technology innovation and research and development	• 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 variability, seasonal changes and extreme weather events (Maldives) • Significantly scale up research and development investments for core emission reduction technologies, for example renewable energy, zero emission vehicles and hydrogen technologies (Republic of Korea)
Institutional strengthening and coordination	• Generate, focus and link the supporting tools for technology development and transfer, both for 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 the national and regional level, and strengthen cooperation and information exchange on technology transfer among local actors and with global actors (Chile) • Build institutional capacity to support the transfer of climate technologies and environmentally sound technologies (Republic of Moldova) • Support research, technology development and innovation through alliances with academic institutions, think tanks and research centres that contribute to generating knowledge, developing new technologies, transferring processes and appropriating technologies (Colombia)
Support to be provided to other Parties for technology development and transfer	• Commit to fostering 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

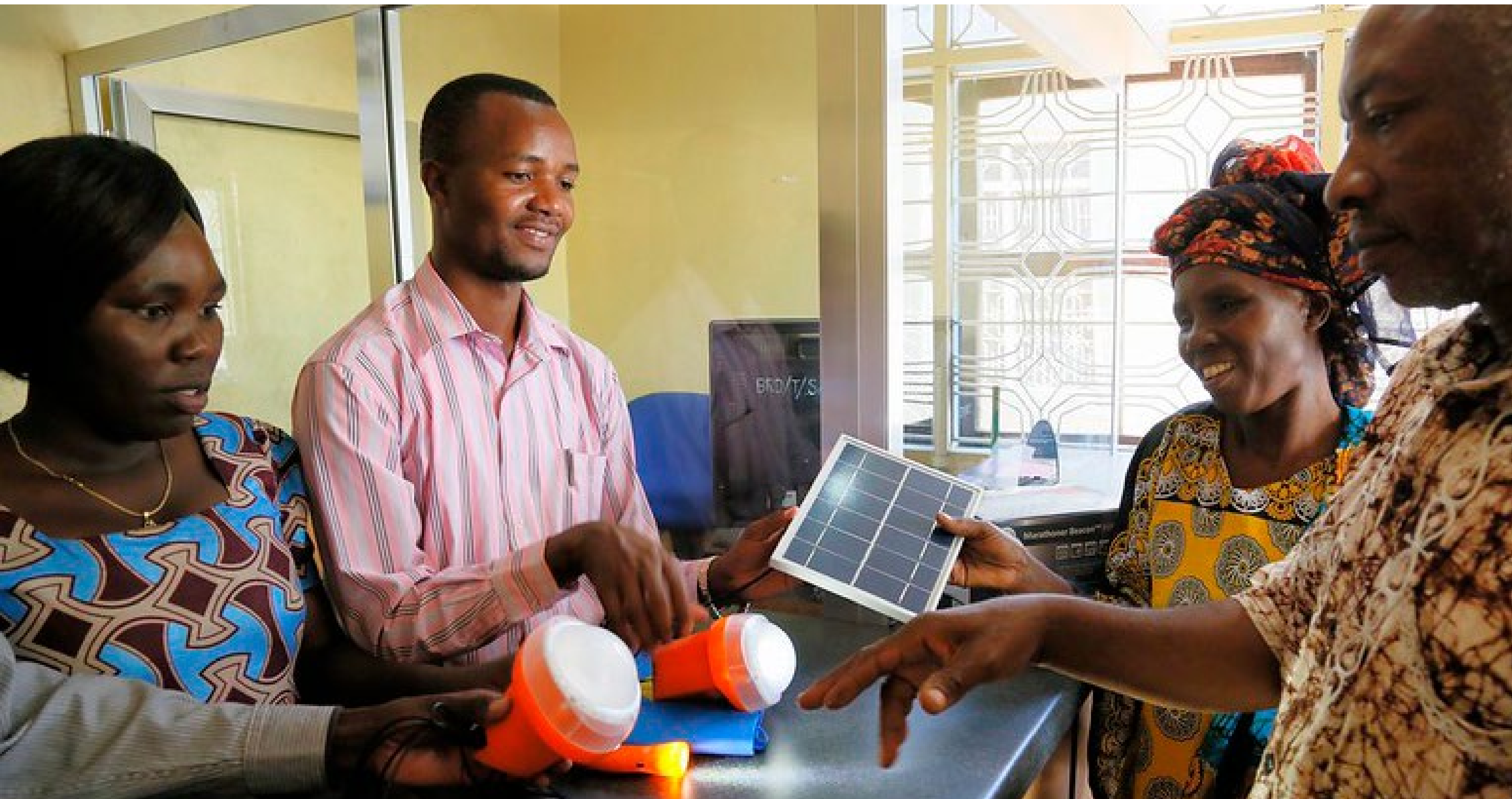
The level of detail of the information on technology needs provided by developing country Parties in their revised NDCs varies significantly. While some developing country Parties made only a generic reference to their technology needs, most included information on specific technology sectors and types of technology, in particular noting needs in agriculture, energy efficiency, renewable energy, climate observation and early warning, infrastructure and urban planning, transportation, water and industry. In some cases, needs were further qualified and quantified, with detailed technology interventions, information on the type and scope of required technologies, and estimated implementation costs being provided. For example, Cuba in its NDC described advancing low-emission transportation through the introduction of more than 55,000 electric vehicles and the installation of around 25,000 charging stations by 2030 at an estimated cost of USD 1,479 million. Rwanda described 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. Overall, solar and wind energy technologies, low-emission or zero emission vehicles, and energy-efficient appliance and processes were among the most frequently cited technologies for achieving adaptation and mitigation targets.

Seven Parties referred in their revised NDCs to TNAs, with Cambodia and Mongolia stating that they require support for conducting updated TNAs that address certain components of their NDCs. The Dominican Republic and Papua New Guinea highlighted their needs for support to conduct a TNA for their NDCs as a whole. Panama, the Republic of Moldova and Suriname reported that previously conducted or ongoing TNAs informed the development of their revised NDCs. This confirms the finding of the latest synthesis report on TNAs that most Parties do not consider the TNA process in isolation, but rather as complementary to national policies and plans such as NDCs and NAPs.[14]

A review of CTCN technical assistance projects[15] undertaken since the adoption of the Paris Agreement in 2015 shows an increasing number of projects that focus on directly contributing to the implementation of the NDC of the respective country. These technical assistance projects predominantly reflect technology needs in agriculture, energy efficiency, water, climate observation and early warning, infrastructure and urban planning, and renewable energy, which is in line with the common areas of technology needs identified in the revised NDCs.

14 FCCC/SBI/2020/INF.1.

15 Documents on CTCN technical assistance are available at https://www.ctc-n.org/technical-assistance/data.



C. Technology challenges

The analysis of technology challenges related to NDCs was based on the review of revised NDCs and the previous work of the TEC and the CTCN related to NDCs. Revised NDCs include limited information on specific challenges that Parties face regarding the uptake of technologies in support of NDC implementation, but some of these challenges are elaborated in the success stories presented in the later section of this document. The broader challenges referred to in the NDCs fall within the areas of common challenges identified in the previous work of the TEC and the CTCN, as summarized as follows:

(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, 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 those among 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, 2017b, 2018, 2021a):

   (i) Fostering stakeholder engagement and buy-in regarding the technology solution and approach for its uptake;

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

   (iii) Engaging the private sector effectively and sustainably;

   (iv) Ensuring sufficient market demand for the technology;

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

D. Policy and implementation

An analysis of linkages between policy and implementation in the context of technology and NDCs, including appropriate enabling environments incorporating regulations, standards and incentives, shows that strong linkages are needed for the effective uptake of climate technologies.

Linkages between policy and implementation are required for both 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 the technical, economic, social and institutional viability of technologies. At the same time the technology uptake increases when 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 of their TNAs or CTCN technical assistance into their NDCs and through doing so have successfully scaled up technology solutions. Some have leveraged support from the GCF, the Adaptation Fund and the Global Environment Facility to scale up technologies (TEC, 2019). 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 NDC development (TEC, 2019).

Policies need to reflect implementation realities so as to address not only technical needs, but also the viability of the uptake of a technology. A technology-specific focus is needed for creating enabling environments through promoting favourable market conditions, innovative financing and business models, and public programmes. Public programmes are of particular importance for technologies for which a market first needs to be created through raising awareness of their value, for example by showcasing approaches and results (TEC, 2017a).

The successful uptake of technologies also requires technology policies and implementation strategies to be inclusive and equitable. Diverse views, knowledge and expertise should be incorporated at all stages of policy design and of technology development, transfer, deployment and diffusion. Technology solutions resulting from an inclusive and equitable process are more likely to be taken up given that local needs, capacities and practices have been reflected and awareness of the benefits of introducing the technology has already been generated (TEC, 2017a).

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

E. National adaptation plans

An analysis of linkages between NAPs and NDCs in the context of technology shows that the process to formulate and implement NAPs can provide important inputs regarding the consideration of technology issues in NDCs, and vice versa. The NAP process can help identify technology options for adaptation components of NDCs, while the development of NDCs can make NAPs or sectoral NAPs concrete and actionable, or could be helpful tool to inform the development of NAPs in particular for those countries that do not yet have a NAP. While most developing country Parties are in the process of developing a NAP, only 22 have one in place.[16]

A review of linkages between TNA 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 through a TNA. 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 can help accelerate the development and implementation of both NAPs and NDCs by pooling resources and avoiding duplication of work (TEC, 2013a).

16 https://unfccc.int/topics/adaptation-and-resilience/workstreams/national-adaptation-plans.

III. SUCCESS STORIES AND LESSONS LEARNED ON THE UPTAKE OF TECHNOLOGIES

A. Success stories

The eight success stories presented in this publication showcase the successful uptake of climate change adaptation and mitigation technologies in different geographical regions and technology sectors. The success stories were drawn from publications, surveys and assessments of 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; and recommendations from the members of the joint TEC–CTCN task force on technology and NDCs.

The criteria applied for the initial identification of success stories from the broad range of information sources were that examples had to have focused on a specific technology, led to either initiation or full uptake of the technology, and been in line with the country's NDC. The initial results were consolidated on the basis of availability and accessibility of information on aspects of the success stories, including the level of technology uptake, financing, gender-responsiveness, and challenges and lessons learned. The final selection was guided by the aim of ensuring balance in geographical region; groups of countries, with priority given to the LDCs and SIDS; technology sector, with efforts made to include a diverse range of technologies; types of approaches, for example approaches with a focus on women, the community, the private sector, the government, or rural or urban areas; mitigation versus adaptation 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 the availability of information, level of technology uptake and use of innovative and replicable approaches.

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

Participating countries	Uruguay and Spain
Partners	Ministry of Environment of Uruguay, Spanish Agency for International Development Cooperation, CTCN, Environmental Hydraulics Foundation (IHCantabria), Universidad de la República
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 NAP for coastal areas, and mapped the coastal vulnerability of the Río de la Plata and the Atlantic Ocean to climate change and climate variability

Further information:
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

Climate technology: Climate modelling and vulnerability assessment technology was developed to determine the threat of climate variability and climate change to Uruguay's coastal zones and their exposure and sensitivity to it by analysing and evaluating climatic effects on the dynamics of beaches, dunes, coastal erosion and flood risks, and the consequences for the local population, ecosystems, infrastructure and tourism.

Uptake of the climate technology: Along the Río de la Plata (River Plate), flash floods are caused by a combination of meteorological and hydrological factors. The occurrence of high tides with large atmospherically induced storm waves has raised the mean sea level to three metres 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 11 months, mainly during summer or autumn.

The identified technical barriers to addressing the impacts of climate variability and climate change on coastal areas include lack of quality data, lack of access to data, and 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 include poor coordination between the national and local level and insufficient human resources with appropriate expertise.

Faced with this challenge, Uruguay made developing and implementing a NAP for coastal areas (hereinafter referred to as COASTAL-NAP) a priority in its NDC (submitted in 2017). The NAP was to be based on detailed information on hazards, exposure, sensitivities and adaptive capacities of coupled human and natural systems. Regional information systems for 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 systems, which feed directly into decision-making processes for prioritizing adaptation strategies.

Through the participatory processes of co-management of information and knowledge generation via 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 non-governmental organizations, students and citizens, the country managed to collect information and the capacity to meet the needs of analysing climate information and selecting and implementing adaptation measures in coastal areas. The improved national database and information systems for variables associated with marine dynamics (wind, pressure, waves, meteorological tide and sea level), including high temporal resolution information, now also serve as a reference for integrated coastal zone management, operational oceanography, infrastructure construction, coastal zone risk management, ecosystem resilience-building and tourism management.

Knowledge transfer from international researchers (at IHCantabria) to local researchers (Universidad de la República) and government entities was ensured by implementing 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.

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 wind and atmospheric pressure, creating a regional atmospheric model. At the same time, models for wave propagation and current generation were created using topographic data and coastal bathymetric and wind data. The simulations on these models generated databases that were 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 analysed; temperature and rainfall climate trends were identified on the basis of the projections of climate models for potential changes. Owing 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 level (by municipality and by census district). The combination of high-resolution basic information with impact process 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 highest coastal flood and erosion risks, the most vulnerable natural and socioeconomic subsystems, and the areas with the highest need for adaptation action.

Financing: The development of the COASTAL-NAP was supported by the CTCN[17] with IHCantabria as the implementing partner. Training for developing and implementing the COASTAL-NAP was provided by the Spanish Agency for International Development Cooperation through the EUROCLIMA+ programme of the European Commission. This support in turn 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.

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

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

Contribution to NDC implementation: Coastal areas are listed in Uruguay's NDC as one of the main priorities for implementation and support needs for adaptation measures. The NDC includes two targets, namely, to have (1) formulated, adopted and started the implementation of a NAP for coastal areas by 2020 and (2) 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 enabled Uruguay to not only develop its COASTAL-NAP, but also enhance its capacity and secure funding for COASTAL-NAP implementation. Therefore, the technology uptake has directly resulted in the achievement of two of the country's key NDC targets on adaptation.

Challenges and lessons learned: Knowledge inclusion and decision-making were defined as 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 guided the process and created a working group on adaptation in coastal areas, which was composed of national institutions. Its goal was to integrate emerging national, local and sectoral priorities, and to prepare and validate drafts of the components of the COASTAL-NAP. Subnational governments were consulted and training workshops were held aimed at improving understanding of the vulnerability of Uruguayan coastal zones. For 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 in relevant decision-making processes. In this regard, it intends to cover all the necessary structures for generating the knowledge that will be applied when it comes to strategic planning.

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

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

Participating countries	India
Partners	Naireeta Services Private Ltd.
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 the empowerment of women, and water and sanitation

Further Information:
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

Climate technology: Bhungroo is a storm water management technology that filters, injects and stores excess storm water through pipes[18] 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 metres, each Bhungroo can conserve one to four million litres of water each year within its subsurface zone. Seventeen different technical designs of the technology have been created and operationalized for women smallholders in different agroclimatic zones across India, as well as in Bangladesh, Ghana and Viet Nam.

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 hectares of land (7,5 per cent of India's total arable land), mainly in western and northern India as well as in some eastern coastal areas, was prone to waterlogging, and that on 6 million hectares of this land, waterlogging led to heavy crop damage.[19] The successful uptake of the Bhungroo 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 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 programme developed by Naireeta Services; and (3) smallholders supported by a government programme. Geological, geohydrological, geophysical, mechanical engineering, civil engineering and agriscience principles for installing the Bhungroo technology units are explained to women smallholder farmers in their own language and in simple terms . The uptake of the technology starts with a water needs assessment, and is followed by drilling, casing, procurement of filtration materials, erection of the filtration chamber, testing and geotagging. Each of these activities includes various subactivities, all of which are carried out in line with traditional knowledge and in a culturally acceptable manner. For example, the water needs assessment takes into account traditional knowledge of local seasonal variations, crop patterns and irrigation types. An assessment of total storm water availability, including storm water sources, minimum and peak volumes, and duration of inflow per source, is then made. All data collection tools are designed for unschooled users and result in the creation of open-source knowledge.

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

The joint ownership, operation and maintenance of the technology by groups of women within a community leads to the joint ownership of the irrigation water the technology produces, transforming the social status of the beneficiaries from agricultural labourers to financially self-reliant farmers comparable with landowners. 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 are documented 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 approach that empowers women, including the UNFCCC Momentum for Change Award, now called United Nations Global Climate Action Award, the Gender Just Climate Solutions Award of the women and gender constituency, the Cartier Women's Initiative Award and the Buckminster Fuller Challenge Grand Prize.

18 *Bhungroo* is a colloquial Gujarati word meaning 'straw' or 'hollow pipe'.
19 http://www.iiwm.res.in/pdf/Bulletin_30.pdf.

Financing: Naireeta Services has developed a financing model for the technology uptake, which is based on a two-tier marketing strategy: Bhungroo units are sold for profit to rich farmers, who have a proven return on investment within two and half years, and Naireeta Services then 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 for accessing the grant-supported technology. Collective ownership is key to ensuring gender equality and women's empowerment. Women farmers benefit via improved revenues secured through increased crop production, as well as fees earned through the provision of maintenance services to other communities using the same technology. Food security, the doubling of agriculture-based income, and emancipation from debt and interest payments are usually achieved within two to three years after the installation of the technology.

Contribution to NDC implementation: As part of its NDC (submitted in 2016), India aims to (1) "better adapt to climate change by enhancing investments in…sectors vulnerable to climate change, particularly agriculture, water…and disaster management"; (2) create an additional carbon sink of 2.5 to 3 billion t CO_2 eq through additional forest and tree cover by 2030; and (3) address "the challenges of poverty eradication, food security and nutrition…gender equality and women empowerment, water and sanitation, energy…".

By June 2021, more than 5,000 Bhungroo technology units have been put in place, benefiting more than 15,000 women smallholders and 150,000 poor rural people. 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, the 5,000 units installed can lead to carbon absorption of 112,000–129,000 t CO_2 eq per year[20] through increased growth of vegetation, according to a pilot study conducted in 2018 by Leigh University.

The Indian Government has incorporated the Bhungroo technology within its NRLM policy as a means of 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.

Bhungroo, one of the technologies supported under the NRLM, benefits from a dedicated loan plan. But the formal bank credit system and policy measures generally reserve loans or financial support for landowners. Only around 14 per cent of agricultural land is owned by women, according to India's agricultural census of 2015-2016.[21] So, practically, the system excludes women farmers from the group accessing loan for the Bhungroo technology, as Indian women generally have no land tenure rights. Approximately 14 million of the 23 million rural households headed by women are considered deprived (without land, proper housing or education).[22] If only 10 per cent of these 14 million households were able to access the technology through a targeted gender-responsive policy incentive, up to 0.68 million hectares of land (deprived women farmers cultivate 0.5 hectares of land on average)[23] could be turned into productive land in winter and during the monsoon season. This could increase income and food security for about 7.5 million poor rural people (5.4 persons per household) and create a carbon sink of 38–43 million t CO_2 eq per year.

20 The estimates are based on a study by Leigh University (2018), which found that one Bhungroo unit can support crop cultivation on about 5 acres (2 ha) of land and that, depending on the crop, an average of 22.5–25.8 t CO_2 eq can be sequestered per acre per year.

21 Available at https://agcensus.nic.in/document/agcen1516/T1_ac_2015_16.pdf.

22 Socio Economic and Caste Census 2011 of the Government of India. Available at https://secc.gov.in/welcome.

23 Field data from Naireeta Services based on 10 years of work with women farmers in different states of India.

Challenges and lessons learned: Every Bhungroo technology site is unique and has a plethora of different geological, geohydrological, agricultural, mechanical and civil engineering challenges. To address these challenges in a cost-efficient manner, Naireeta Services has entered into local, national and international partnerships and conducts continuous research into adjusting processes and refining the technology.

Uptake of the technology in rural communities facing extreme poverty has 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 in and accepting of 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 land ownership rights still remains a serious barrier to uptake, in particular as it limits women's access to microcredit instruments and to government support programmes designed to promote the technology. This makes the gender approach particularly relevant for the successful uptake of the technology. Key lessons could be shared at the national level via NRLM and at the global level via the UNFCCC gender action plan.

Long-term sustainability, replicability and potential for scaling up: 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 about 250,000 poor rural people indirectly. Scaling up of the technology will also lead to improved soil fertility of 20,000 hectares of land and the first-time productive use of 89,000 hectares of land in the winter season.

© South African National Energy Development Institute

3. Making buildings more energy efficient in South Africa

Participating countries	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

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

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 the 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 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.

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 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. The return on investment if insulation thickness is doubled, tripled or quadrupled takes 13, 17 or 19 years, respectively, to recover. However, both technologies are needed as they solve different needs.

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 the 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 important, SANEDI wanted to avoid reducing the minimum standards already set for insulation, if cool roofs were included in the energy efficiency design. This reduction in minimum standards falsely equates insulation to cool surfacing, an offset 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.

To deploy 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 job market. This effective local community engagement fosters a sense of ownership and responsibility in the project, thereby reducing the risk of theft and vandalism.

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

Financing: 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. As a result of the technology's huge success, the Government of South Africa decided to deploy the technology over large areas – close to 700,000 m2.

Contribution to NDC implementation: South Africa aims in its NDC (submitted in 2015) to reduce its GHG emissions, including through using innovative energy-efficient solutions. This innovative passive cooling technology results in emission reductions of 5–13 t CO_2 eq per 100 m2 roof per year and therefore has the potential to significantly contribute to national GHG emission reduction targets.

The uptake of the technology has 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 5–20 per cent of costs saved. The technology has also improved the living standards of poorer communities and contributed to the better health of infants, the elderly and sick people, who are vulnerable to high temperatures.

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

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

Long-term sustainability, replicability and potential for scaling up: The long-term sustainability, replicability and suitability for scaling up of the technology was ensured through: (1) localizing the technology through the development and adoption of national quality standards; (2) including the technology in 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.

4. Increasing energy efficiency in the Solomon Islands

Participating countries	Solomon Islands
Partners	CTCN, PricewaterhouseCoopers India
Start of technology uptake process	2017
Climate technology	Energy-efficient water pump technologies
Contribution to NDC implementation	Improving energy and water security, and reducing the GHG emissions of the energy sector

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

Climate technology: Energy-efficient water pumping technology solutions, including retrofitting existing technology; making operational improvements; and implementing new energy-efficient motors and pumps all reduced GHG emissions from the energy sector while helping to better meet current and future water demands at lower energy costs.

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

The Government sought assistance from the CTCN to identify energy-efficient solutions to run its water and wastewater pumping facilities to address the country's increasing water demand. The Government, with support from CTCN Network member PricewaterhouseCoopers India, conducted a detailed energy audit to identify the most suitable energy efficiency and renewable energy options. Insights from the audit formed the basis for a variety of energy efficiency measures, including retrofitting existing pumps, making operational improvements, and identifying, procuring and implementing 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.

Gender-responsiveness: Improving energy efficiency in the water sector will enable the Solomon Islands to expand its water supply network, which will predominantly benefit women. Currently, in some parts of the country, water for household consumption is still carried by women over long distances as tap water supply is not yet universally available. A report on gender co-benefits was prepared as part of the CTCN technical assistance.[24]

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

Contribution to NDC implementation: The uptake of energy-efficient water pumping technology solutions is supporting the implementation of Solomon Island's NDC (submitted in 2016) by improving energy security and reducing GHG emissions from the energy sector. The estimated GHG emission reduction over the lifetime of the energy efficiency improvements is 3,260 t CO_2 eq. Uptake of the technology has also helped to improve water security and thus contribute to one of the priority adaptation interventions outlined in the NDC.

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

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 areas currently without service. In addition, energy efficiency measures have improved occupational health and safety as a result of improved housekeeping of pump stations.

Challenges and lessons learned: Key challenges that the Solomon Islands faced regarding making its 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 PricewaterhouseCoopers India addressed these challenges in part by identifying low-cost solutions through retrofitting and operational changes combined with conducting on-the-ground training and producing a technical manual on the implementation of the identified solutions. An important lesson learned is that considerable energy efficiency improvements can be achieved with little or no investments. However, major technological changes require large investments.

Long-term sustainability, replicability and potential for scaling up: 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. The investment in identified new energy-efficient technologies is sustainable, replicable and can be scaled up owing to 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 countries	Chile
Partners	Agency for Climate Change and Sustainability, 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 agrifood processing and new funding mechanisms
Contribution to NDC implementation	GHG emission reductions, strengthening of public–private cooperation mechanisms for executing adaptation actions at the national and local scale, and increased robustness of sustainable development indicators

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

Uptake of the climate technology: In Chile, the agriculture sector is an important contributor to the economy, and is highly vulnerable to the adverse effects of climate change. Within the sector, MSMEs make up the majority of producers. Chile sought technical assistance from the CTCN to better understand the barriers that prevent MSMEs from adopting climate technologies in the agrifood sector; solve the low adoption of climate technologies; analyse agrifood chains with the purpose of identifying critical points for the introduction of climate technologies; analyse and make recommendations on existing certification, demand aggregation and financial instruments and their effectiveness in promoting climate technologies to 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 on and uptake of climate technologies, in particular with regard to solar energy and water and energy efficiency.

Through the CTCN technical assistance, the domestic agrifood chains were mapped and analysed, 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 local contexts. The technologies identified 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. The mapping was accompanied by an analysis of barriers that MSMEs face in the uptake of climate technologies and by the development of solutions to overcome these barriers. Since the CTCN technical assistance, nine agrifood economic industrial associations, including the largest food export association, and their companies have been implementing enhanced action.

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, which allowed international good practices to be adapted to the local context. The partnership also leveraged the strong local network of iQonsulting to engage with local communities, policymakers, financial institutions, academic institutions and non-governmental organizations.

Chile integrated some of the recommendations of the CTCN technical assistance in its CPAs with the agrifood sector by including financing for the priority technologies identified and adopting changes in the CPAs. CPAs, recognized as a nationally appropriate mitigation action by the UNFCCC,[25] are certifiable agreements with sectoral associations in which 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 subsector. CPA preparation and coordination costs are funded up to 70 per cent by the Government of Chile. The combination of all these changes has resulted in increased work with the prioritized agrifood industries, increased uptake of photovoltaic solar energy solutions, and increased energy and water efficiency, in particular through variable speed drivers for conveyor belts, heat recovery systems and energy-efficient lighting technologies.

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

The changes made to the CPAs also resulted in the most complete SDG reporting for a mitigation action in the country[26] as well as in the introduction of a licensed platform for supporting the MRV of CPAs.[27] At the policy level, these data help to generate traction and interest of possible partners and has helped with the provision of financing for technology transfer from subnational governments.

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.

Gender-responsiveness: The Agency for Climate Change and Sustainability requires that projects applying for public funding provide information on whether there are barriers to technology transfer related to the gender of technology users or business owners. In addition, in the approval process of funding requests, the gender-responsiveness of the project and the gender balance within the project team are considered.

Contribution to NDC implementation: The uptake of climate technologies in agrifood chains is contributing to Chile's mitigation and adaptation targets in its NDC (submitted in 2020), in particular the development of public–private cooperation mechanisms for executing adaptation actions at the national and local level. In addition, the MRV of CPAs is contributing to Chile's target of 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.

26 https://datastudio.google.com/reporting/508a6d6e-72cc-4cbc-b573-8401ab9eeccf/page/1ZguB?s=g3gxLHnD0sk.
27 https://github.com/AgenciaSustentabilidadyCambioClimatico/accion.

Challenges and lessons learned: The main challenges for the uptake of climate technologies in the agrifood sector include local technology providers' limited reach into remote areas and their limited 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.

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 among participants. Insights into the transfer can be gained by one of the businesses successfully implementing the technology and then showcasing and sharing its results with other businesses in the context of the CPA. Trust and imitation of peers plays a significant role in the decisions made by MSMEs. In addition, the provision of technical support has played a significant role in the adoption of climate technologies.

Long-term sustainability, replicability and potential for scaling up: 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 more production outputs. The approach taken by Chile is replicable in other countries as it can be easily adjusted to target the most suitable climate technologies for the location. Chile has been working with Colombia on a possible replication of the CPA approach. The approach also has the potential for being scaled up as not all MSMEs have been reached in the country, but for this to happen effectively, a redesign might be needed to decrease the reliance on public funds.

6. Advancing low-emission mobility solutions in Cambodia

Participating countries	Cambodia
Partners	CTCN, GGGI, Envelops Co. Ltd.
Start of technology uptake process	2019
Climate technology	Electric motorcycles
Contribution to NDC implementation	Reduction in transport sector emissions through the promotion of low-emission transport modes

Further Information:
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/

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

Uptake of the climate technology: Cambodia's road transportation system 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.

Cambodia identified the following limitations as key barriers to the uptake of low-emission mobility in the country: information, pertaining to the economic, social and environmental benefits of low-emission mobility; policymaking and planning, pertaining to incentivizing the uptake of electric vehicles and removing incentives for fossil fuel vehicles; institutional capacity, pertaining to technical expertise for developing national low-emission projects and coordinating and engaging stakeholders in the planning and realization of such projects; and commercial markets.

Cambodia sought technical assistance from the CTCN and GGGI to accelerate the transition to low-emission mobility by addressing the key barriers identified. In cooperation with Envelops Co. Ltd., who carried out the CTCN technical assistance, a policy action plan was developed that focused on introducing 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 the 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 that resulted in greater social acceptance of electric motorcycles and recognition of their economic benefits.

Gender-responsiveness: Fostering the uptake of electric vehicles will contribute to lower costs of transportation in the long term. Women in particular, and particularly those in suburban areas, who have significantly lower incomes than men and poor access to the labour market, will benefit from lower mobility costs in terms of increased access to employment, markets, education and health services, but also in terms of their caregiving and household responsibilities, which the majority of women hold.

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 GCF 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 has the aim of introducing an electric bus system in Siem Reap at a cost of USD 16 million from 2022 to 2024.

Contribution to NDC implementation: The uptake of electric motorcycles is contributing to Cambodia's NDC (submitted in 2020) mitigation target of reducing transport sector emissions through the promotion of low-emission transport modes.

Other benefits of the technology uptake include a reduction in air pollution, especially in urban areas, and economic benefits for the technology users. A comparison of operating costs showed that driving 100 km with an electric motorcycle is 8 to 10 times lower than with a fuel 100 or 125 cubic capacity motorcycle.

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 charging stations that have a battery swapping system in place for efficient servicing. The size of the charging stations is of key importance to striking a balance between local demand and potential grid instability. The availability of maintenance stations is of equal importance, and will require capacity-building for local mechanics.

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

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

(b) The very limited availability of maintenance stations;

(c) The limited range of electric motorcycle models available;

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

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

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.

Long-term sustainability, replicability and potential for scaling up: Cambodia's approach to 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 thriving electric motorcycle market. In economic terms, electric motorcycles in Cambodia are on average 10 times cheaper than combustion engine motorcycles over a 10-year period. The approach is replicable in other countries as it can be easily adjusted to local circumstances. It also has the potential for being scaled up domestically as it is currently limited to urban areas.

7. Strengthening climate-resilient agriculture in the Dominican Republic

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

Further Information:
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

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

Uptake of the climate technology: In Colombia and the Dominican Republic, small-scale farmers play an important role in agriculture and food security. Climate change is causing greater water stress, greater storm damage and increased incidence of crop diseases, all of which impact heavily on small-scale farmers.

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 is now 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 achieve 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.

Technical experts and farmers from Colombia visited their counterparts in the Dominican Republic to exchange experience on the local contextualization and application of the SRI methodology. The exchange included both theoretical aspects and practical insights through a demonstration parcel of land. 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 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. Initial production cycles 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 department in Colombia, and in the Dominican Republic, producers experienced up to a 43 per cent and 68 per cent increase, respectively, in net utility with SRI compared with conventional production.

The endogenous capacities of both the technical experts and the smallholder producers were developed through SRI and the application of its principles, including their capacities to establish validation parcels of land, make empirical observations and make appropriate adjustments, measure results over time, and communicate the technology to other technical experts and smallholder producers.Gender-responsiveness: The project encourages the participation of women in the training and field trips and collects gender-disaggregated participation data on all activities.

Contribution to NDC implementation: The uptake of the SRI technology has been supporting the objective of Colombia's NDC (submitted in 2020) to improve its capability to adapt appropriately to climate change and variability in the rice production subsector. In the Dominican Republic, the SRI methodology has great potential to contribute to the country's NDC (submitted in 2020) target of reducing emissions from rice cultivation through changes in production technology.

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 the hundreds of peer-reviewed articles published 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) the need to work with farmers to foster innovation, adapt SRI and facilitate its adoption as it requires multiple changes to conventional production techniques. The latter need is perhaps the greatest challenge.

Long-term sustainability, replicability and potential for scaling up: To ensure the long-term sustainability of the SRI approach, the Colombian National Federation of Rice Producers is committed to integrating SRI efforts into its Broader Massive Adoption of Technology programme, which seeks to increase the agriculture 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 already been replicated and scaled up across Africa and Asia. Countries in Latin America that have engaged with Colombia and the Dominican Republic on their experience regarding the uptake of the SRI technology, for example Argentina, Chile, Costa Rica, Panama and Venezuela, have also started to replicate the experience of their counterparts.


© Overseas Environmental Cooperation Center

8. Utilizing ocean energy in Nauru

Participating countries	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 (OTEC)
Contribution to NDC implementation	Achieving water and energy security, and transitioning to renewable energy in the electricity generation sector

Climate technology: OTEC is a technology that produces both energy and desalinated water. Energy is produced by harnessing the temperature differences between surface ocean waters and deep ocean waters. The condensed water resulting from the process is an abundant freshwater source.

Uptake of the climate technology: Nauru is committed to generating 100 per cent 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 freshwater sources.

The enormous potential of ocean energy in Nauru has long been known; the country set up the world's first OTEC pilot plant in cooperation with Japan in 1981. However, extreme weather events caused major damage, which resulted in the cessation of its operations. Nauru's TNA[28] identified OTEC as the priority mitigation technology, taking into account significant OTEC technology improvements over the past few decades, such as climate-proof construction methods, and the possibility of producing large amounts of fresh water through the energy generation process.

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.

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 would be the primary beneficiaries of freshwater production owing to their strong involvement in the agriculture sector.

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

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 its installation. It therefore utilized the CTCN's technical assistance for developing funding proposals for securing the high initial investments required.

Contribution to NDC implementation: Nauru's NDC (submitted in 2016) priorities include achieving energy and water security and 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.

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

Challenges and lessons learned: Among the key challenges was the lack 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 construction of the OTEC plant. To overcome this challenge, Nauru utilized CTCN technical assistance to develop financing proposals.

Long-term sustainability, replicability and potential for scaling up: Once installed, the OTEC technology is sustainable in the long term as it runs mostly autonomously and can be considered as permanent, with little maintenance costs, while bringing large economic, social and environmental benefits to the country. The technology also has great potential for replication in other SIDS, in particular those located in the Pacific, where the required large differences between surface water temperature and deep-water temperature exists.

B. Lessons learned

While the revised NDCs do not refer specifically to lessons learned regarding the uptake of technologies, insights can be drawn from the success stories presented in this publication and the previous work of the TEC and the CTCN on technology and NDCs. Several lessons learned were thus identified, as follow. Technology-specific lessons learned can also be drawn from the closing reports of the technical assistance requests completed by the CTCN.

1. Stakeholder engagement ensures effective and efficient technology solutions

Stakeholders play a crucial role in climate technology planning and implementation – not only in identifying effective technology solutions in different local contexts (success stories Cambodia and Uruguay), but also in creating awareness and fostering co-ownership of these solutions (Dominican Republic and India). The success stories demonstrated how the successful uptake of technologies requires approaches that are gender-responsive (India), take into account the enhancement of indigenous capacities and endogenous technologies (Dominican Republic) and are tailored to local circumstances, including the special circumstances of the LDCs and SIDS (Cambodia, Nauru and Solomon Islands).

2. Economic and social viability of technologies, including the use of local champions contribute to creating enabling environments for long-term, sustainable technology uptake

The uptake of environmentally sound technologies is only sustainable in the long term if the technologies are economically, institutionally and socially viable (TEC, 2020). Creating local champions to showcase the success of technology solutions can play a crucial role in securing the further financial, as well as 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 (success story Dominican Republic). Governments have a major role to play in addressing the challenges to the uptake of technologies through the creation of enabling environments by establishing and enforcing appropriate regulatory and institutional frameworks (TEC, 2021c; success stories India and South Africa). Enabling environments need to be targeted at engaging the private sector, which plays an important role in accelerating the uptake of technologies (TEC, 2020; Cambodia and Chile). High initial investment costs can be partially overcome through pooling funds (India), developing innovative business models (Chile) or engaging multilateral donors or funds (Cambodia, Nauru and Uruguay). Sometimes, low-cost solutions for technology-driven climate action can be found in retrofitting existing technologies or making operational changes (Solomon Islands).

3. Experience-sharing and capacity-building accelerate technology uptake

Documenting and sharing challenges, good practices 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 Dominican Republic and India). All aspects of the uptake of a technology need to be documented, including approaches taken at the stages of its development, transfer, deployment and diffusion, in particular with regard to overcoming institutional, social and economic barriers. This applies to adaptation technologies, which are often more orgware- and software-focused, as much as to mitigation technologies, which have stronger hardware components. The exchange of experience during the design of approaches and processes can result in immediate efficiency gains and therefore accelerated action (TEC, 2017b, 2020). Targeted capacity-building support for policymakers, technology providers and end users that builds on shared experience and lessons learned can lead to significantly accelerated uptake of technologies (India and South Africa).

IV. OBSERVATIONS

Parties agree on the importance of technology to implementing adaptation and mitigation actions in pursuing the purpose and goals of the Paris Agreement. While most Parties mentioned technology in their revised NDCs, the structure and level of detail of the information varies significantly. Providing more detailed information on the use of technology and technology needs and challenges in their NDCs could facilitate:

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

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

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

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

To stimulate the uptake of technologies in support of NDC implementation, it may be beneficial to develop and include sectoral technology road maps[29] with specific, time-bound technology targets. Some Parties are already pursuing the development of sectoral technology road maps and some global technology road maps have been developed by intergovernmental organizations, for example for the energy sector (IEA, 2021; IRENA, 2019) or more broadly in the form of science, technology and innovation road maps for the SDGs (IATT, 2020). However, for many technology sectors, in particular with regard to adaptation technologies, global technology road maps are unavailable (TEC, 2013b, 2014). As per its functions, the TEC could catalyse the development and use of technology road maps at the global, regional and national level by promoting cooperation among relevant stakeholders, particularly governments and relevant organizations.[30] The CTCN, at the request of countries, could provide advice and support related to the development of such road maps.

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 the facilitation of 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.[31] 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 social impacts on local communities.

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 success stories presented in this publication show 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.

29 Technology road maps help identify policies and measures that are instrumental in supporting project implementation, and they 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 road maps could therefore be useful in other planning processes, including providing a ready-to-use structure for individual parts of TAPs and translating the outcomes of TNAs into concrete, time-bound actions related to a selected group of technologies. Techniques for preparing road maps could be used for TAPs or accompany already prepared TAPs, specifying steps towards their desired implementation (TEC, 2014).

30 Decision 1/CP.16, para. 121(g).

31 Decision 15/CMA.1, annex, para. 3(b).

V. RECOMMENDATIONS

This section offers two sets of recommendations on how to stimulate the uptake of climate technologies in support of NDC implementation, some of which are addressed to the TEC and the CTCN and some to Parties. The successful uptake of a technology depends 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 diffusion.

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

(a) Catalyse the development and use of action-oriented technology road maps for different sectors at the global, regional and national level, in line with NDC targets and the goals of the Paris Agreement, through, inter alia, facilitating cooperation and knowledge-sharing among Parties and relevant organizations and providing guidance and technical assistance for the development of technology road maps;

(b) Use the technology road maps 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 specific technologies, including through effective stakeholder engagement and financing approaches;

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

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

(a) Foster gender-responsive, inclusive, participatory and equitable processes and approaches to 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 foster stakeholder engagement and buy-in regarding 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 ensure a more socially equitable distribution of benefits and risks;

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

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

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

(e) Make more use of the Technology Mechanism to carry out the above recommendations, including by:

(i) Utilizing technical documents and recommendations on climate technology policies prepared by the TEC;[32]

(ii) Actively engaging with the CTCN[33] to benefit from its provision of technology solutions, capacity-building and advice on policy, legal and regulatory frameworks, and its provision of support for the development of technology road maps, tailored to the needs of individual country contexts;

(iii) Sharing more information on technology needs and support to foster a clearer understanding of policy targets by domestic technology stakeholders, facilitate international cooperation, and enable the more targeted provision of support by the TEC and the CTCN, according to their respective functions, and other support providers, as appropriate.

VI. ACKNOWLEDGEMENTS

The TEC and the CTCN extend their appreciation to the interviewees, including NDEs and technology implementers, and representatives of observer organizations participating in the joint TEC-CTCN task force on technology and NDCs for the inputs they provided and to Moritz Weigel of The China Africa Advisory for preparing this publication.

32 https://unfccc.int/ttclear/tec/documents.html.
33 https://www.ctc-n.org/technical-assistance.

VII. BIBLIOGRAPHY

CTCN (2020a): NDE Survey Results 2020.

CTCN (2020b): Transformational Impact Assessment Report.

CTCN (2021): Technology Briefs on Success Stories (Forthcoming).

IATT (2020): Guidebook for the Preparation of Science, Technology and Innovation for SDG Roadmaps. Available at: https://sustainabledevelopment.un.org/content/documents/26937Guidebook_STI_for_SDG_Roadmaps_final_Edition.pdf.

IEA (2021): Net Zero by 2050. A Roadmap for the Global Energy Sector. Available at: https://www.iea.org/reports/net-zero-by-2050.

IRENA (2019): Global energy transformation: A roadmap to 2050. Available at: https://www.irena.org/publications/2019/Apr/Global-energy-transformation-A-roadmap-to-2050-2019Edition.

TEC (2013a): Possible integration of the TNA process with NAMA and NAP processes. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TEC_column_L/4f85c880f1b54a6bb1ed32a3b7e1bc94/7262a425eab84ac8a0ab4a5980d7e58d.pdf.

TEC (2013b): Background paper on Technology Roadmaps. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TEC_tab_1/c4305238ff8d4dee90493855bf224fd1/0ee6a8165b634fb0861a4ea6cf2ce411.pdf.

TEC 2014: Using roadmapping to facilitate the planning and implementation of technologies for mitigation and adaptation. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TEC_column_L/3aaf07d4cf1d4d51998b57771759880a/f427db90b3c54f2d979f984db5af18ce.pdf.

TEC (2017a): Technological Innovation for the Paris Agreement. Implementing nationally determined contributions, national adaptation plans and mid-century strategies. TEC Brief #10. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/brief10/8c3ce94c20144fd5a8b0c06fefff6633/57440a5fa1244fd8b8cd13eb4413b4f6.pdf.

TEC (2017b): Compilation of Good Practices in effective knowledge-sharing and practical learning on climate adaptation technologies through South-South and triangular cooperation. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/brief9/a5fbac8997e84fef84a47d81dba46279/3762bead33cd42e989361241cfbb6fc7.PDF.

TEC (2018): Potential of South-South and triangular cooperation on climate technologies for advancing implementation of nationally determined contributions and national adaptation plans. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/brief9/7a74a2f17f204b6ba17f1ec965da70d7/f4e361cd56d4463a8daa4ab29a1254db.pdf.

TEC (2019): Draft paper on experiences, lessons learned and good practices in conducting TNAs and implementing their results. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tn_meetings/9c6eeaa690534874bbcbb85bada9882c/b566fb9540cd4932b5503a0518d2af94.pdf.

TEC (2020): Innovative Approaches to Accelerating and Scaling Up Climate Technology Implementation for Mitigation and Adaptation. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/innovative_approaches/07a2f73969c945928ffa1ec74285f356/235654758e1343f788b1f1132bb109b8.pdf.

TEC (2021a): Draft outline of joint TEC-CTCN publication on technology and NDCs. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tn_meetings/8e97861f938243a09b533fa979f99274/21bd713814d446c0bb47b74fbfa745f4.pdf.

TEC (2021b): Compilation of Good Practices and lessons learned on international collaborative research, development and demonstration initiatives of climate technology. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tec_rdandr/5d9775214b7d425a81a5cba3ad471389/adf73bd6ac524d2792efb8499970d2f2.pdf.

TEC (2021c): Draft paper on enabling environments and challenges to technology development and transfer identified in TNAs, NDCs and CTCN technical assistance. Available at: https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tn_meetings/0ec5dc7fc4a045468f11e360347f7da7/8a6bc538ce414d21a2a5efa460ebfe39.pdf.

UNFCCC (2018a): Case studies presented during Regional Technical Expert Meeting on Mitigation 2018 for Latin America and the Caribbean. Available at: https://unfccc.int/sites/default/files/resource/20181001_LAC%20regional%20TEMs-M%20Summary%20Report.pdf.

UNFCCC (2018b): Case studies presented during Regional Technical Expert Meeting on Mitigation 2018 for Asia and the Pacific. Available at: https://unfccc.int/sites/default/files/resource/20180926_AP_regional%20TEMs-M%20Summary%20Report.pdf.

UNFCCC (2018c): Case studies presented during Regional Technical Expert Meeting on Mitigation 2018 for Africa. Available at: https://unfccc.int/sites/default/files/resource/Regional%20TEM%20Nairobi_%20Report_Final_0.pdf.

UNFCCC (2018d): Joint annual report of the Technology Executive Committee and the Climate Technology Centre and Network for 2018. Annex I: Recommendations of the Technology Executive Committee on ways forward and actions to be taken based on the outcomes of the technical expert meetings on mitigation. FCCC/SB/2018/2. Available at: https://unfccc.int/sites/default/files/resource/SB_2018_2.pdf.

UNFCCC (2019a): Case studies presented during Regional Technical Expert Meeting on Mitigation 2019 for Latin America and the Caribbean. Available at: https://unfccc.int/sites/default/files/resource/Brief%20report_Regional%20TEMs_LAC_CW_Final.pdf.

UNFCCC (2019b): Case studies presented during Regional Technical Expert Meeting on Mitigation 2019 for Asia and the Pacific. Available at: https://unfccc.int/sites/default/files/resource/Brief%20Report%20TEM%202019_AP%20CW_Final.pdf.

UNFCCC (2019c): Joint annual report of the Technology Executive Committee and the Climate Technology Centre and Network for 2019. Annex: Recommendations of the Technology Executive Committee on ways forward and actions to be taken based on the outcomes of the technical expert meetings on mitigation. FCCC/SB/2019/4. Available at: https://unfccc.int/sites/default/files/resource/sb2019_04E.pdf.

UNFCCC (2020a): Case studies presented during Regional Technical Expert Meeting on Mitigation 2020 for Africa. Available at: https://unfccc.int/ttclear/events/2020/2020_event03.

UNFCCC (2020b): Case studies presented during Regional Technical Expert Meeting on Mitigation 2020 for Latin America and the Caribbean. Available at https://unfccc.int/ttclear/events/2020/2020_event04.

UNFCCC (2020c): Case studies presented during Regional Technical Expert Meeting on Mitigation 2020 for Asia and the Pacific. Available at: https://unfccc.int/ttclear/events/2020/2020_event05.

UNFCCC (2020d): Case studies presented during Regional Technical Expert Meeting on Mitigation 2020 for Eastern Europe and West Asia. Available at: https://unfccc.int/ttclear/events/2020/2020_event06.

UNFCCC (2020e): Joint annual report of the Technology Executive Committee and the Climate Technology Centre and Network for 2020. Annex III: Recommendations of the Technology Executive Committee on ways forward and actions to be taken based on the outcomes of the technical expert meetings on mitigation. FCCC/SB/2020/4. Available at: https://unfccc.int/sites/default/files/resource/sb2020_04_adv.pdf.

About the Technology Executive Committee

The Technology Executive Committee is the policy component of the Technology Mechanism, which was established by the Conference of the Parties in 2010 to facilitate the implementation of enhanced action on climate technology development and transfer. The TEC analyses climate technology issues and develop policies that can accelerate the development and transfer of low-emission and climate resilient technologies.

The Technology Executive Committee may be contacted through the United Nations Climate Change Secretariat.

Platz der Vereinten Nationen 1, 53113 Bonn, Germany
Email: tec@unfccc.int

Website: www.unfccc.int/ttclear/tec

About the Climate Technology Centre and Network (CTCN)

The Climate Technology Centre and Network (CTCN) is the implementation arm of the UNFCCC Technology Mechanism. The Centre promotes the accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries. The CTCN provides technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries by harnessing the expertise of a global network of technology companies and institutions.

CTCN, UN City, Marmorvej 51, 2100 Copenhagen, Denmark
Email: ctcn@unep.org

Website: www.ctc-n.org/

A digital copy of this report can be downloaded from:
https://unfccc.int/ttclear/tec/techandndc.html

#climatetech