Transformational impact through the five system transformation areas and two technology enablers:  

Brochure Series

Background

CTCN Programme of Work (PoW) 2023-2027 aims to enhance transformational impact and scale through two proven technology enablers (national systems of innovation and digitalization) and five system transformations (water-energy-food nexus; buildings and infrastructure; sustainable mobility; energy systems and business and industry).

The brochure series

This document gathers a series of seven stand-alone brochures developed in consultation with the CTCN Resource Mobilization Taskforce to support CTCN and its AB members’ efforts in strengthening relationships and identifying synergies to mobilize resources for climate action.

The brochures also aim to support the understanding of CTCN’s PoW to new NDEs, stakeholders and partners approaching climate technology and innovation for system transformation.

The seven documents follow a similar structure explaining CTCN’s PoW foundations and how CTCN responds to country-driven requests, they briefly present CTCN’s impact at the national and regional level, and conclude with an outlook on next-generation climate technologies.

List of contents

Two proven technology enablers:
   1. National system of innovation
   2. Digitalization

Five system transformations:
   1. Water-energy-food nexus;
   2. Energy systems;
   3. Sustainable mobility;
   4. Buildings and infrastructure;
   5. Business and industry.
Why national systems of innovation matter

Countries' capabilities to drive and enable climate technology innovation are crucial for climate mitigation and adaptation, and for inclusive sustainable development. These capabilities are determined in part by the effectiveness of a nation's national system of innovation (NSI), consisting of:

**Organizations** participating in technology development and transfer, e.g. technology firms, universities and finance institutions;

**Institutional context**, such as norms, laws, incentives (or lack thereof) and cultural practices that stimulate or hinder actors' green innovation efforts, e.g. government policies that affect how the private sector invests in a particular sector; and

**A network of interactions and relations** between the actors and the institutional context, e.g. flows of information and knowledge, and collaboration between firms, universities and research institutions.

CTCN case studies, pilot projects, RD&D, and concept notes can be leveraged/are pivotal to attract investments and funds. CTCN collaborates with The Green Climate Fund, The Global Environmental Facility, The Adaptation Fund Climate Innovation Accelerator, and several regional and national development banks, supporting systems transformation in over 30 countries.

CTCN works with developing countries to accelerate, develop and transfer technologies for low carbon, climate resilient development.
How CTCN is strengthening national systems of innovation

CTCN delivers tangible improvements in the way countries leverage climate technologies within their national climate-resilience strategies and development frameworks: connecting policy-makers to RD&D and industry leaders, and catalysing and amplifying know-how and expertise.

- **32** technical assistance projects involving 36 countries and totaling US$7 million
- **700+** participants attended capacity-building initiatives targeting NSI enhancement
- **12** concept notes or road maps developed

This helps build the capacity of countries to generate national systems of innovation.

Led by a demand-driven process working with NDEs, CTCN also supports national decision-making, sectoral technology roadmaps, market assessments and feasibility studies to create an enabling environment for climate technology development and transfer.

**how CTCN caters to the NSI needs of developing countries**

For over a decade, CTCN has worked with National Designated Entities (NDEs) and over 800 Network members, to provide technical assistance, capacity-building and knowledge-sharing to assist the development of national systems of innovation. This includes:

- strengthening collaborative approaches to climate technology research, development and demonstration (RD&D);
- creating and promoting policy to incentivize and nurture a supportive environment for innovation;
- supporting policy, institutional and regulatory framework development, and planning processes;
- aiding with the advancement of technology transition pathways to stimulate the uptake of climate technologies; and
- strengthening collaboration between the public and private sectors.

NSI must strengthen links with international innovation activities and systems to implement and benefit from technological change. This helps to spur economic growth while improving policy environments, strategies, legal and regulatory frameworks, and institutional arrangements for establishing and/or strengthening their national systems of innovation.

**Three key complementary actions are needed to strengthen NSI:**

1. **Build and develop the core infrastructure:**
   - a strong school curricula that foster innovation
   - investments in RD&D
   - implementing enabling policies (including support-to-market creation)
2. **Focus on specific climate technologies that help meet national climate and development priorities; and**
3. **Build strategic partnerships (or linkages) and coordination capabilities to facilitate interaction and exchange among national actors.**

**“Enhancing technology innovation systems can provide opportunities to lower emissions growth, create social and environmental co-benefits, and achieve other SDGs.”**

IPCC, 6th Assessment Report

**technical assistance projects involving 36 countries and totaling US$7 million**

**700+** participants attended capacity-building initiatives targeting NSI enhancement

**7** technical assistance projects focused on RD&D of technologies

**203** technical assistance projects (of 297) included strengthening of NSI as a systems transformation enabler

**100+** organizations selected as innovative network members, and participated in innovative technology development and transfer

Enhancing technology innovation systems can provide opportunities to lower emissions growth, create social and environmental co-benefits, and achieve other SDGs. 

IPCC, 6th Assessment Report
### Selected examples of CTCN technical assistance, including anticipated country impact

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<th>Examples of the CTCN technical assistance</th>
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<th>Impacts</th>
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<td><strong>Technology outsourcing</strong></td>
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<td>Feasibility study and development of an action plan to manufacture components of small power wind turbines and implementation of a pilot project</td>
<td>Benin</td>
<td>New wind turbine system generating 7.7 GWh/y (supplying 200,000 people) and cutting 5 kilotons of CO$_2$e</td>
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<td>Photovoltaic (PV) solar cell design and manufacturing</td>
<td>Iran</td>
<td>Analysis on current local PV technology status and gap for market creation</td>
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<td>Benchmarking energy and greenhouse gas (GHG) intensity in the metal industry</td>
<td>Thailand</td>
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<td><strong>Technology RD&amp;D</strong></td>
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<td>Establishment of a laboratory for accreditation and quality control of photovoltaic modules</td>
<td>Algeria</td>
<td>Creation of a laboratory to test photovoltaic modules and increased capacity for PV module testing protocols.</td>
</tr>
<tr>
<td>Accreditation of the national Energy Efficiency Lighting Laboratory (JSMO)</td>
<td>Jordan</td>
<td>The international accreditation was granted to JSMO, which will ensure energy efficiency testing as well the enforcement and compliance with existing lighting standards and technical regulations.</td>
</tr>
<tr>
<td>Scaling-up sustainable wood fuel systems</td>
<td>Tanzania (Pwani, Lindi, and Mtwara regions)</td>
<td>Charcoal production for cooking and heating, improved cooking stoves</td>
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<tr>
<td><strong>Technology Diffusion</strong></td>
<td></td>
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<tr>
<td>Incubating climate technologies in small and medium enterprises</td>
<td>Chile</td>
<td>Engagement of 31 micro, small, and medium enterprises and green investment banks for agricultural market creation</td>
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<td>Integrated agroforestry policy</td>
<td>Belize</td>
<td>Identification of mechanisms with the private sector for promotion of agroforestry and mainstream women’s participation in agroforestry</td>
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<td>Development of circular economy road maps</td>
<td>Latin America and the Caribbean</td>
<td>Country roadmaps as a management tool for implementation with the private sector, to create new business models and job creation</td>
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### Developing a framework and roadmap for Zambia’s national system of innovation to foster climate-resilient economic development

Climate variability and change are a major threat to sustainable development in Zambia. The country is experiencing climate-induced hazards, including drought and dry spells, seasonal and flash floods, and extreme temperatures. Some of these hazards, especially droughts and floods, have increased in frequency and intensity over the past few decades and have adversely impacted food and water security, water quality, energy and livelihoods, especially in rural communities, with an aggregated estimated total GDP loss in the range of US$4,330–5,440 million.

Innovation is seen as mission-critical to respond to the adverse impacts of climate change, generate economic growth, and achieve Zambia’s vision of becoming a prosperous low-carbon and climate-resilient middle-income country by 2030.

CTCN is helping Zambia:
- Develop a framework and roadmap for the introduction of a national system of innovation,
- Streamline and structure the national approach to innovation,
- Ensure continuous engagement with key stakeholders.

Channelling Zambia’s innovation efforts into a single national innovation framework and roadmap can optimize the return on innovation investments and secure a positive spillover effect across institutions and industries for low-carbon and climate-resilient economic development.
Next-generation NSIs

Public policies can support training and RD&D, complemented by both regulatory and market-based instruments that create incentives and market opportunities in three ways:

1. National systems of innovation are instrumental to keeping the impacts of climate change at bay and building resilience in communities and ecosystems.
2. Policy packages tailored to national contexts and technological characteristics have been effective in supporting low-emission innovation and technology diffusion.
3. The success and sustainability of NSI will depend on the degree of national, international and sectoral collaboration in RD&D, connecting policymakers, stakeholders, research and the innovation community, bridging knowledge and know-how gaps, and ensuring women, youth and vulnerable groups are involved.

CTCN is devising new forms of resource mobilization and partnerships to foster collaboration and learning exchange, consolidating an ecosystem where national systems of innovation can flourish:

a) Strengthening countries' capabilities to drive and enable climate technology innovation.

b) Supporting countries in incentivizing innovation through policy, institutional and regulatory development.

c) Providing opportunities to lower emissions growth, create social and environmental co-benefits, and achieve other SDGs.

d) Facilitate the development and transition to a circular economy, whereby NIS can stimulate economic growth and create new job opportunities, and contribute to a more resilient environment.

About CTCN

The Climate Technology Centre and Network (the implementation arm of UNFCCC’s Climate Change Technology Mechanism, mandated under the Paris Agreement) provides accelerated development and transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries.

CTCN provides a portfolio of 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 is hosted by the UN Environment Programme and is headquartered in Copenhagen, Denmark.
Digitalization and climate change

Digital technologies have the potential to mitigate and help adapt to climate change, playing an increasingly significant role in every sector, from energy generation, distribution and consumption, to transport and agriculture, in which digitalization is becoming essential to transition to smart and climate resilient practices.

The UN Climate Technology Centre and Network (CTCN) recognizes digitalization as a key enabler for climate action, CTCN facilitates the deployment of innovative and sustainable digital technologies across all sectors to support climate action in developing countries. Digitalization is needed from initial design through financing of climate action.

CTCN case studies, pilot projects, RD&D, and concept notes can be leveraged/are pivotal to attract investments and funds. CTCN collaborates with The Green Climate Fund, The Global Environmental Facility, The Adaptation Fund Climate Innovation Accelerator, and several regional and national development banks, supporting systems transformation in over 30 countries.
CTCN strengthens the digitalization capacity and ecosystem of developing countries

For over a decade, CTCN has worked with National Designated Entities (NDEs) and over 800 Network members to provide technical assistance, capacity-building and knowledge-sharing to assist the development of national systems of innovation. This includes:

- **39** technical assistances involving and/or developing digital technologies
- **Over US$6 million** invested into digital technology projects
- **18** digital tools developed or improved, including:
  - Early warning technologies (Thailand, Dominican Republic)
  - Agrometeorological information systems (Mali)
  - Ecosystem monitoring tools, and real-time transportation information systems (Bangladesh)
- **33** countries where CTCN has harnessed digital technologies for climate action
- **24** technical assistances provided training on digital technologies:
  - Drought risk modelling (Saint Kitts and Nevis)
  - Drone-enabled remote sensing of forests (Eswatini)
  - GIS-based monitoring for water loss reduction (Granada)
  - Demand response measures in the energy sector (South Africa)

MaliCrop: the app helping farmers weather the climate crisis in West Africa

Agriculture is the main economic driver in Mali, employing roughly 75 per cent of the population and accounting for 50 per cent of GDP. However, the landlocked country, situated in the Sahara and semi-arid Sahel, is exposed to recurrent extreme events such as severe droughts and catastrophic floods, rendering only 14 per cent of the land suitable for agriculture.

Accurate weather forecasts can make the difference between the success and failure of crops, between securing food on the table, or not.

With the support of CTCN, and partnering with WeatherForce, CTCN supported the development of MaliCrop, an app converging and analysing 10 years’ worth of data, which significantly increases the accuracy of forecasts and offers:

- Data for farmers with no internet access or mobile technologies
- Radio-broadcasts in French and local languages (reaching 110,000+ people)
- Predictions for temperature, humidity and precipitation
- Discussions on historic rainfall patterns
- Warnings on the millet-wasting disease known as mildew

The radio forecast, read from the MaliCrop app, has become a lifeline for farmers in drought-prone Mali, many of whom are women, who can now plan and make informed decisions on how to manage their crops.
CTCN for inclusive digitalization

To close the digitalization gap and ensure developing countries can benefit from digital technologies for climate action, while also ensuring that the deployment of these technologies is sustainable, equitable and effective, CTCN is delivering an extensive portfolio of capacity building activities focusing on digitalization, including:

- A capacity building programme on digital technology innovation in agriculture attended by 26 NDEs from 13 countries.
- A knowledge-sharing programme on blockchain technology for climate action, which included a course for NDEs that was attended by 68 participants, and a 6-part webinar series open to the public that was attended by 388 individuals.

The Youth Climate Innovation Labs and Academies in Africa, Middle East and North Africa, Latin America and the Caribbean, and Asia-Pacific regions of which the Innovation Labs (3-day online hackathon) were attended by 433 young innovators. 35 winning teams were supported Is this supported through two months at Innovation Academy, and about 50 per cent of all winning solutions were digital technologies.

CTCN works with various constituencies under the UNFCCC, including youth, women and indigenous communities, to ensure the socio-economic benefits of digitalization, which contributes to economic growth, job creation, improved livelihoods, support for entrepreneurs, and improvements to gender equality, particularly in the most vulnerable communities.

<table>
<thead>
<tr>
<th>Service area</th>
<th>Outcome</th>
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<tbody>
<tr>
<td>Piloting digital tools: CTCN supports countries in developing and piloting locally adapted digital solutions to drive climate adaptation and increase resilience in communities.</td>
<td>This leads to significant reductions in greenhouse gas (GHG) emissions.</td>
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<tr>
<td>Exploring emerging digital technologies: With the support of CTCN, countries explore the climate potential of emerging technologies such as artificial intelligence, blockchain, Internet of Things, cloud computing and open data.</td>
<td>This facilitates the deployment of digital technologies for climate action across the five system transformation areas.</td>
</tr>
<tr>
<td>Building capacities and knowledge: To strengthen capacity for research and development (R&amp;D) and endogenous innovation around digital technologies for climate action, CTCN delivers twinning arrangements (South-South, North-South) of institutions researching and developing digital technologies across the five transformation areas.</td>
<td>This secures abilities to evaluate digital readiness for climate action at a national level.</td>
</tr>
<tr>
<td>Supporting digital readiness: CTCN develops National Digitalization Readiness Index (NDRI) to evaluate the potential of each developing country transforming their system in five identified areas by applying digital tools.</td>
<td>This provides a baseline to support the enabling environment for digital technologies by harnessing opportunities and identifying and removing barriers.</td>
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</table>

Next-generation digitalization

The next generation of digitalization for climate action in developing countries will require a sustainable and ethical approach that considers the potential of digital technologies to contribute to climate mitigation and adaptation as well as their environmental and social risks, challenges and opportunities for the most vulnerable communities. It will also require partnerships between technology providers, financing institutions, governments, and civil society to ensure that digital solutions are deployed effectively and equitably.
Moving forward the CTCN will prioritize:

- **Artificial intelligence (AI) and machine learning technology** to optimize energy use and reduce greenhouse gas emissions in various sectors, such as transportation and agriculture.
- **Blockchain technology**, to create transparent and secure systems for tracking climate-related transactions such as for climate insurances and decentralized energy trading.
- **Internet of Things devices** to manage irrigation patterns in the agricultural sector, as well as to collect data on climate and environmental conditions.
- **Cloud computing** to run complex climate models, which can provide insights into the potential impacts of climate change and inform mitigation and adaptation strategies.
- **Open data and digital platforms** to facilitate knowledge sharing and collaboration on climate action, as well as support the development of innovative digital solutions.

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### #AI4ClimateAction – Artificial Intelligence for Climate Action Initiative

The UNFCCC Technology Mechanism Technology Executive Committee (TEC) and CTCN have recently launched #AI4ClimateAction – Artificial Intelligence for Climate Action Initiative.

Artificial Intelligence as an integral part of the digitalization effort, is an enabler across all systems of transformations and has already proven crucial across different applications ranging from transforming energy systems through enhanced smart grids, to enabling more effective disaster risk reduction and multi-hazard early warning systems, and bolstering the resilience of agricultural communities by improving accuracy and access to weather forecast for crop management.

TEC and CTCN are inviting organizations to join #AI4ClimateAction and work together through partnerships with the UNFCCC and as members of CTCN.

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### About CTCN

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1 NDEs are technology representatives selected by each country’s government representing 164 parties to the UNFCCC [https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country](https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country)

2 CTCN’s Network includes members from: National technology and regional climate technology centres, intergovernmental, international, regional or sector organization, research, financial, non-governmental, industry, SMEs, and private sector organizations.

3 To unlock a more equitable world, a global effort is needed to encourage and invest in the creation of digital public goods: open-source software, open data, open artificial intelligence models, open standards and open content. This is key to achieving the Sustainable Development Goals. Digital public goods should adhere to privacy and other applicable laws, standards and best practices, do no harm. The **UN Road map for digital cooperation** particularly highlights the role played by the Digital Public Goods Alliance, which was established in response to the High-Level Panel’s recommendation on Digital Public Goods, and with which the Office works closely.
With a global population expected to reach 9 billion people by 2050, approaching water, energy and food (WEF) as a nexus with complex relationships is crucial for sustainable climate strategies and solutions.

Climate change is threatening livelihoods by accelerating water scarcity and energy and food insecurity, and contributing to a set of other issues affecting health, people displacement, and peace and security, with women, children and vulnerable communities paying the highest toll.

The WEF nexus approach integrates aspects of the hydrological, biological, social and technological spheres to understand the complex interactions between water, energy, and food production, distribution and consumption.

The approach also helps determine how these interactions are affected by policies and various other factors, and how technology and innovation can enhance efficiency and efficacy.

CTCN case studies, pilot projects, R&D, and concept notes can be leveraged/are pivotal to attract investments and funds. CTCN collaborates with The Green Climate Fund, The Global Environmental Facility, The Adaptation Fund Climate Innovation Accelerator, and several regional and national development banks, supporting systems transformation in over 30 countries.
CTCN responds to the water, energy and food needs of developing countries

For over a decade, CTCN has worked with National Designated Entities (NDEs) and over 800 Network members to provide a range of technical assistance, capacity-building and knowledge-sharing, including:

- Supporting countries in developing innovative solutions and leveraging energy as a key enabler for sustainable agriculture, increasing crop yields by up to four times, improving water efficiency and expanding post-harvest storage.
- Developing aggregated agro-processing technologies and trade-related capacities that support agriculture value chains.
- Boosting the use of renewable energy on smallholder farms to tap into groundwater available in shallow aquifers.
- Supporting action for national and regional innovation in cooling systems and energy-efficient transportation.
- Increasing availability, accessibility and affordability of food by developing sustainable and reliable water management strategies for agriculture.
- Promoting energy efficiency and renewable energy sources to enhance the resilience of food systems and reduce the vulnerability of food production to energy price fluctuations.
- Mitigating soil degradation by promoting sustainable agricultural practices within the WEF nexus framework, such as conservation agriculture, agroforestry, and integrated soil and water management.
- Increasing productivity and efficiency in agriculture value chains to minimize agriculture-related deforestation.

In parallel, technical assistance and each intervention work to strengthen National Systems of Innovation and digitalization as proven technology enablers.

The WEF nexus approach emphasizes the need for integrated and sustainable management of these systems to build long-term resilience. It also encourages cross-sectoral collaboration, stakeholder engagement and the empowerment of women to find effective solutions to water scarcity, energy inefficiency and food insecurity.

SLAMDAM: A portable and refillable dam is helping Africa counter rising waters

CTCN is helping countries adapt to the impacts of climate change, including floods, rising seas, extreme temperatures, and storms, by introducing responsive climate technologies.

Weather extremes are expected to become more common as Burundi’s climate changes. Because of this, CTCN implemented SLAMDAM: a portable and refillable dam designed to protect Mpanda and its 25,000 residents from flooding while also acting as storage area for water during times of drought. Two people can fill a 100-metre-section of the barrier in an hour by pumping water into it from a nearby lake or river, whereas building a traditional 100-metre flood barrier with sandbags would take 14 people at least 20 hours.

With SLAMDAM the community was able to harness the flood water to plant and irrigate during the dry season, thus enhancing food security for the community. There are plans to scale up the project to cover a larger area and support more communities.
How CTCN is enabling transformative solutions

A two-pronged approach of facilitating partnerships and knowledge exchange, while supporting the design of policies and solutions for building a resilient WEF ecosystem, has helped CTCN deliver tangible changes in achieving national-level energy goals, while supporting the development of relevant national WEF policies, strategies and plans.

By implementing innovative climate adaptation financing mechanisms, and a conducive policy framework for technology regulation and trainings, the approach has enhanced local governments’ and communities’ use of selected technologies, and has allowed small- and medium-sized farms and enterprises to access sustainable climate technologies. Led by a demand-driven process working with National Designated Entities, CTCN also supports national decision-making, sectoral technology roadmaps, market assessments and feasibility studies to create an enabling environment for climate technology development and transfer.

Selected examples of CTCN WEF nexus technical assistance, including anticipated country impact

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<th>Examples of CTCN technical assistance</th>
<th>Countries</th>
<th>Impacts</th>
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<tr>
<td>Strengthen the National Disaster Management Agency (NDMA) capacity’s application of unmanned aerial</td>
<td>Eswatini</td>
<td>• Enhanced capacity of the use of modern technologies such as remote sensing and UAVs for better analysis of agricultural vulnerabilities.</td>
</tr>
<tr>
<td>vehicles (UAVs) and remote sensing technology for vulnerability assessments and response planning</td>
<td></td>
<td>• Provision of a foundation course as the basis for more capacity building.</td>
</tr>
<tr>
<td>Cost-benefit Assessment of Mitigation Options in Rice Production: Data compilation, tools and training</td>
<td>Viet Nam</td>
<td>• Better integration and upscaling of climate-smart agricultural practices.</td>
</tr>
<tr>
<td>Application of environmental flows and river basin management framework for the Tebicuary River basin</td>
<td>Paraguay</td>
<td>• Enhanced management of control of flow, water intake and discharge, resulting in a conserved and resilient environment.</td>
</tr>
<tr>
<td>Improvement of water supply management through a server-based Geographical Information System (GIS)</td>
<td>Grenada</td>
<td>• Improvement and cost-benefit analysis in line with Nationally Determined Contributions (NDC) implementation.</td>
</tr>
<tr>
<td>for monitoring and control of water loss reduction in Grenada</td>
<td></td>
<td>• Enhanced capacity of the government to programme similar investments at scale and mainstream them into agricultural commodity programmes.</td>
</tr>
<tr>
<td>Saline water purification technology at the household level and low-cost durable housing technology for</td>
<td>Bangladesh</td>
<td>• Enhanced knowledge of the local government and communities on the use of selected technologies.</td>
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<tr>
<td>coastal areas</td>
<td></td>
<td>• Improved livelihood for approximately 38 million people living in the rural area of the coastal zone.</td>
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<tr>
<td></td>
<td></td>
<td>• Increased access to safe water for coastal communities.</td>
</tr>
</tbody>
</table>

“The deployment of climate-smart technologies, such as solar pumping irrigation systems, not only addresses food insecurity but also helps to provide opportunities for farmers to farm throughout the year.”

Christopher B. Kabah, NDE, Environmental Protection Agency of Liberia

Inclusive and just WEF production, access and consumption

Working with various constituencies under UNFCCC, including businesses and industry, NGOs, youth, women and indigenous communities, CTCN is closing the technology gap, and ensuring developing countries have access to and reap the benefits of reliable, affordable and sustainable innovation and technology.

Investing in the WEF nexus sets a solid foundation for securing access to sustainable food, water and energy sources, which can trigger a virtuous circle generating an array of socio-economic benefits in the longer term, including improved livelihoods, job creation, better economic growth and national and regional security. This investment also supports entrepreneurship and improvements in gender equality.
Next-generation WEF

The WEF nexus is critical for all countries to conserve precious and often dwindling resources, such as water and viable soil, in the face of climate impacts, and to transform entire food supply chains to reduce emissions, build resilience, and meet climate and sustainable development goals.

CTCN supports countries in the collection and sharing of data and information, strengthens institutions, and delivers programmatic and multi-country technical assistance. It also harnesses emerging technologies and solutions to maximize synergies across water, energy and food systems, including:

- Enhanced platforms and tools for collaboration and learning on agri-food technology development and transfer, such as CTCN’s new technical assistance in Malawi focusing on using simple mobile technologies for collecting climate data.¹
- Supporting the development of relevant national strategies, policies and develop implementation plans.
- Using digital technologies for the WEF nexus. For example, in Nigeria, CTCN is implementing the Radio-Internet (RANET) climate disruptive technology initiative: harnessing the combined potential of radio and the internet to enhance agricultural resilience.
- Providing opportunities for integrated planning and management. Examples include the development of flood early warning systems that help farmers to plan accordingly and avoid losses caused by flooding incidents.
- Designing knowledge transfer and capacity building programmes, such as integrated water resource management, sustainable agriculture and renewable energy technologies. For example, in the Democratic Republic of Congo, CTCN is developing an incubation programme for innovative companies based on climate technologies.
- Sensor deployment to aid food and crop resilience.
- Improved water management, accounting, and productivity.

About CTCN

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¹ NDEs are technology representatives selected by each country’s government representing 164 parties to the UNFCCC https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country
² CTCN’s Network includes members from national technology and regional climate technology centres; intergovernmental, international, regional or sector organizations; and research, financial, non-governmental, industry, SME and private sector organizations.
⁴ IPCC defines national systems of innovation (NSI) as: “the set of institutions to create, store and transfer the knowledge, skills and artifacts which define technological opportunities” (Metcalfe, 1995). National systems of innovation reflect a complex mixture of institutions (e.g., financial, legal, scientific and technological and educational), public policies (regarding, e.g., taxation, export/import promotion, science, technology and innovation), and business and social relationships.
⁵ Digitalization: Digital technologies impact positively and negatively on greenhouse gas (GHG) emissions through their own carbon footprint, technology application for mitigation, and induced larger social change. Whether the digital revolution will be an enabler or a barrier for decarbonization will ultimately depend on the governance of both digital decarbonization pathways and digitalization in general (medium evidence, high agreement). CTCN will use the approach that positive impacts of digitalization are realized for emission reductions and creation of resilience.
Energy Systems

DECARBONIZING ENERGY SYSTEMS FOR NET ZERO

CTCN works with developing countries to accelerate, develop and transfer technologies for low carbon, climate resilient development.

Why energy systems matter

Energy systems are the largest source of CO₂ emissions globally and achieving net zero will require a paradigm shift in energy production, conversion and use. But these systems are complex, entailing both physical infrastructure and equipment (supply), and societal elements (demand). Also, they are linked across all economic sectors, and are controlled by laws, regulations, exemptions and subsidies.

Therefore, any ongoing technology innovation must develop and integrate rapidly, and create transformation through system-wide transitions across entire value chains.

This is where The Climate Technology Centre and Network (CTCN), the implementation arm of the UN Framework Convention on Climate Change Technology Mechanism, can add its expertise. Recognizing the complexity and urgency of energy system transformation, CTCN offers support to developing countries to build resilient and clean energy as a core priority of its 2023–2027 Programme of Work.¹

CTCN case studies, pilot projects, RD&D, and concept notes can be leveraged/are pivotal to attract investments and funds. CTCN collaborates with The Green Climate Fund, The Global Environmental Facility, The Adaptation Fund Climate Innovation Accelerator, and several regional and national development banks, supporting systems transformation in over 30 countries.
CTCN responds to the energy systems innovation needs of developing countries

Since 2014, CTCN has been working with governments through their National Designated Entities (NDEs) and over 800 Network members, providing a range of technical assistance, capacity-building and knowledge-sharing, such as:

**Energy efficiency**
- Supporting countries in developing energy efficiency and conservation regulations and planning. For example, an institutional framework for the energy efficiency act and regulations targeting energy intensive sectors, such as household and industries (Nigeria).
- Supporting the development of energy efficiency standards for domestic appliances and industrial processes and equipment (Botswana).
- Incentivizing energy-efficient solutions and creating a favourable ecosystem for solutions to thrive, such as the development of green building guidelines and standards (Ghana).

**Renewable energy**
- Developing grid codes and policies for renewable energy and grid integration, such as formulating a national electricity grid code and the definition of a net metering policy (Timor-Leste).
- Creating enabling environments to accelerate renewable energy uptake through policies and capacity building. For example, a pre-feasibility study of the use of photovoltaic systems on the roofs of public buildings, with a connection to the network, and the definition of a net metering policy (The Comoros).
- Providing solutions to lower existing barriers to deploying renewables and preventing technology lock-ins, such as the feasibility study of a combined heat and power supply using green hydrogen (Thailand).

In parallel, technical assistance and interventions work to strengthen national systems of innovation (NSI) and digitalization as proven technology enablers.

### Pakistan develops an energy auditor workforce

Prior to 2017, Pakistan had no professional certification system for energy auditors. With the passage of the National Energy Efficiency and Conservation Act in 2016, **CTCN and the Energy and Resources Institute developed a national certification scheme for energy auditors and managers**, including rules and regulations required for making the certification scheme effective, together with training programmes and guidebooks. The National Energy Conservation Centre is responsible for audits and is supported to conduct certification examinations and select qualified energy auditors for the textile, cement, conventional power plant and pulp and paper sectors.

The energy certification scheme in Pakistan has to potential to:
- **Reduce 42,000 tonnes** of CO₂ emissions per annum
- **Defer the need to install extra electricity generation capacity**
- **Offer a potential 20–25 per cent of energy saving in the industrial sector.**
- **Promote green job growth via the certification programme and generate a pool of energy auditors/managers**

“CTCN support in the design and implementation of climate technology solutions has created a virtuous circle; it helped Pakistan decarbonize energy systems and at the same time created a wealth of other economic opportunities from green jobs growth to new markets creation.”

*Dr Saima Shafique, NDE, Ministry of Climate Change, Pakistan*
How CTCN is enabling transformative solutions

Led by a demand-driven process working with NDEs, CTCN also supports national decision-making, sectoral technology roadmaps, market assessments and feasibility studies to create an enabling environment for climate technology development and transfer.

Selected examples of CTCN energy system technical assistance

<table>
<thead>
<tr>
<th>Examples of CTCN technical assistance</th>
<th>Countries</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development and implementation of energy efficiency and conservation regulations through certification courses for energy managers and energy auditors</td>
<td>Bangladesh, Nigeria, Pakistan</td>
<td>National policies addressing climate change mitigation officially proposed, adopted, or implemented</td>
</tr>
<tr>
<td>Direct use applications and technologies in low to medium-temperature geothermal systems</td>
<td>Djibouti, Ethiopia, Kenya, Rwanda, Tanzania, Uganda, Uruguay</td>
<td>National roadmap proposed, adopted, or implemented</td>
</tr>
<tr>
<td>Development of an energy efficiency master plan</td>
<td>Tonga</td>
<td>National roadmap adopted</td>
</tr>
<tr>
<td>Capacity development for the deployment of demand response to mitigate against carbon emissions and electricity supply shortages</td>
<td>South Africa</td>
<td>Increased national and local implementation capacities</td>
</tr>
<tr>
<td>Accreditation for a laboratory for energy efficient testing and quality control</td>
<td>Algeria, Jordan</td>
<td>Standards and regulations supported by the assistance</td>
</tr>
<tr>
<td>Formulating a national electricity grid code and the definition of a net metering policy</td>
<td>Bahamas, Cambodia, Comoros, Seychelles, Timor-Leste</td>
<td>Standards and regulations supported by the assistance</td>
</tr>
<tr>
<td>Industrial energy efficiency in large industries and SMEs</td>
<td>Chile, Congo, Kenya, Paraguay, South Africa, Thailand, Viet Nam, Zimbabwe</td>
<td>Industrial energy efficiency standards and process optimization developed, and efficient technologies identified</td>
</tr>
<tr>
<td>Development of a national power-to-gas master plan</td>
<td>Lao PDR</td>
<td>National roadmaps and policy measures developed.</td>
</tr>
</tbody>
</table>
Inclusive and just energy system transition

The transition to clean and resilient energy systems is a shared responsibility between developed and developing countries, including the private sector and governments protecting vulnerable groups as well as those whose livelihoods rely on fossil fuel-based sectors. Working with various constituencies under the UNFCCC, including youth, women and indigenous communities, CTCN is closing the technology gap, and ensuring developing countries have access to and reap the benefits of reliable, affordable, and sustainable energy. These include, for example, support in the Gender Just Climate Solutions Awards and the Youth Climate Innovation Labs.

Investing in the clean energy transition generates an array of socioeconomic benefits in the longer term, including economic growth, job creation, improved livelihoods, support for entrepreneurs, and improvements to gender equality.

Next-generation net-zero energy systems

CTCN is exploring emerging technologies and solutions to continue to support countries in developing decarbonization pathways (long-term emissions reduction plans), including:

- Use of digitalization and AI for energy system management
- Demand-side management and demand response, and energy storage applications
- Grid optimization and smart grid operation including decentralized power systems (IPPs)
- Decarbonizing or greening the grid and hard-to-abate sectors
- Strengthening National Systems of Innovation to create market mechanisms for energy supply
- Use of non-conventional renewable energy systems, such as ocean thermal energy, offshore wind, geothermal energy, energy islands, etc.
- Fuel substitution through alternative energy carriers, such as green hydrogen, bioenergy and ammonia as substitutes

About CTCN

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CTCN provides a portfolio of 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 is hosted by the UN Environment Programme and is headquartered in Copenhagen, Denmark.

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1 UNEP CTCN (2022), Changing the Systems That Change the Climate https://pow.ctc-n.org/
2 NDEs are technology representatives selected by each country’s government representing 164 parties to the UNFCCC https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country
3 National Systems of Innovation (NSI): IPCC defines NSI as: “the set of institutions to create, store and transfer the knowledge, skills and artifacts which define technological opportunities” (Metcalfe, 1995). National systems of innovation reflect a complex mixture of institutions (e.g., financial; legal; scientific and technological; educational), public policies (regarding, e.g., taxation; export/import promotion; science, technology, and innovation), and business and social relationships.
4 Digitalization: Digital technologies impact positively and negatively on GHG emissions through: their carbon footprint; technology application for mitigation; and induced social change. Whether digital tech will be an enabler or a barrier for decarbonisation depends on governance of both digital decarbonisation pathways and digitalization in general. CTCN takes the approach that positive impacts of digitalization are realized for emission reductions and resilience.
In 2021, CO₂ emissions from the transport sector accounted for 36 per cent, with an annual increase of 8 per cent, to nearly 7.7 Gt CO₂. Reducing greenhouse gas (GHG) emissions and transitioning towards net-zero mobility is essential to combat climate change, representing not only a significant challenge but also a great opportunity for a comprehensive innovation-driven transformation throughout the entire value chain and in policy and research and development (R&D).

In recent years, electric car markets have seen exponential growth boosted by strong regulations, fiscal incentives, and investment in zero and low-carbon vehicle operations. But countries need stronger innovation capacities to deploy cutting-edge technologies, including battery, electric and fuel cell electric vehicles, and alternative fuels. Digital technologies can bring additional services to transform the sector by making car-sharing, battery charging and smart monitoring services available to users.

CTCN enables transformational change in systems by supporting sustainable mobility including:
- Mobility regulations development
- Deployment of low-emissions vehicles
- Improvement in vehicle fuel economy
- Use of digital technologies to enhance intelligent urban transport systems

Investing in innovative solutions unlocks economic opportunities. As countries transition to low-carbon transport systems, new markets for electric vehicles, renewable fuels, and smart mobility services emerge.
CTCN enables regulatory frameworks and policies to support innovation in transport

For over a decade, CTCN has been working with National Designated Entities (NDEs) and over 800 Network members, providing a range of technical assistance, capacity-building, and knowledge-sharing, such as:

- Developing policies and sectoral policy roadmaps for deploying and scaling up e-mobility and supporting sustainable infrastructure;
- Providing feasibility studies for low-carbon modes of transport including EVs and urban transport;
- Development of low-emission mobility policies and financing proposal; and
- Creating opportunities for the internationalization of the hydrogen energy research and development network.

- Enabling intelligent transport systems (ITS) leveraging digitalization and the integration of advanced technologies into transport systems. ITS solutions, such as real-time traffic management, smart parking and connected vehicles, enhance efficiency, reduce congestion and minimize emissions.
- Devising solutions for mobility as a service (MaaS), introducing digital platforms that integrate multiple transport options (e.g., buses, bikes, car-sharing) into seamless, user-friendly services.

In parallel, technical assistance and interventions work to strengthen national systems of innovation (NSI) and digitalization as proven technology enablers.

Jakarta drives sustainable mobility in Indonesia

Since the economic boom several decades ago, traffic and air pollution in Jakarta has significantly worsened. It is estimated that the greenhouse gas (GHG) emission in Jakarta will rise to 117 million tons of CO₂, in which the contribution from transportation will be about 25 per cent.

CTCN, working with the Institute for Transportation Development Policy and Cadmus Group LLC, supported the development of Transjakarta: the longest bus rapid transit system in South-East Asia.

CTCN worked closely with relevant e-mobility stakeholders and provided:

- an investment and business model
- policy recommendations and an operational plan
- a charging strategy and implementation road map
- an assessment of grid and renewable energy adoption

As a result, Transjakarta is using the electrification road map and investment plan developed by CTCN to deploy 1,635 e-buses (50 per cent of Jakarta’s bus fleet) by 2030. Around US$1.4 million in investment opportunities has been identified to support Jakarta’s charging facilities and grid infrastructure with the potential to integrate solar roofing for buses and the Mass Rapid Transit (MRT) stations.

In 2022, Jakarta adopted the policy recommendations and successfully procured its first 30 e-buses.

“CTCN technical assistance provided the technical and feasibility robustness to prepare the transition of the existing fleet to electric buses as part of the next steps that the country must take towards sustainable mobility.”

Ligia Castro de Doens, Climate Change Director, main focal point for UNFCCC, International Technical Cooperation Office of the Ministry of Environment, Panama
How CTCN is enabling transformative solutions

CTCN supports systems transformations in countries by facilitating the flow of know-how, experience and solutions for sustainable mobility. Developing countries can leverage national systems of innovation to foster collaboration among government, industry, academia and civil society. By creating conducive environments for knowledge sharing, research and development, these frameworks enable the co-creation of sustainable transport solutions.

Building upon its expertise in developing and strengthening enabling environments, CTCN has developed national electric vehicle roadmaps and regulatory frameworks, converging innovative solutions and policy development in several countries, including Ghana and Papua New Guinea.

- **15** technical assistance projects totaling US$3 million
- **18** developing countries supported, 1 multi-country project
- **Thousands** of stakeholders participated in capacity-building
- **2** on Digitalization and **13** on national systems of innovations

Led by a demand-driven process working with National Designated Entities, CTCN also supports national decision-making, market assessment and feasibility studies of various innovative technologies for mobility.

Selected examples of CTCN sustainable mobility technical assistance, including anticipated country impacts

<table>
<thead>
<tr>
<th>Examples of CTCN technical assistance</th>
<th>Countries</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing a national framework for deploying and scaling up e-mobility</td>
<td>Cambodia, Ghana, Papua New Guinea, Solomon Islands, Tanzania, Vanuatu, Zimbabwe</td>
<td>National Electric Vehicle framework and roadmap officially proposed, adopted, or implemented</td>
</tr>
<tr>
<td>Development of framework for real-time transport information systems for public transport in Greater Dhaka</td>
<td>Bangladesh</td>
<td>Feasibility study ongoing on the development of a real-time information system on vehicle location, waiting time and route information for public transport</td>
</tr>
<tr>
<td>Technical capacity enhancement for planning an urban public transport system in Vientiane, Lao PDR</td>
<td>Lao PDR</td>
<td>Pre-feasibility study ongoing to improve the urban public transport system in Vientiane</td>
</tr>
<tr>
<td>Accelerating the transition to sustainable mobility and low-carbon emissions in Panama City</td>
<td>Panama</td>
<td>Economic assessment and technical evaluation conducted to support decision on the electrification of buses in Panama City</td>
</tr>
</tbody>
</table>

Transition to sustainable mobility

Sustainable mobility refers to equitable access to secure, safe and efficient modes of transport supported by climate-responsive infrastructure for the movement of goods and people. Electrification of road, marine and aviation transport all matters to achieve the net-zero goals.

Transport is fundamental to economic growth, connecting people to essential services such as health care, education, social services and business. As such, it is one of the critical sectors that require more financing and investment to create both the innovation and digital infrastructure, and the policy-ecosystem that can enable and incentivize a fast and just transition.

Mainstreaming gender in public e-mobility services

Engagement processes in formulating roadmaps for transitioning towards sustainable mobility can be powerful tools to promote gender equality. In Papua New Guinea, CTCN supported the development of a national policy for deploying and scaling up e-mobility, aiming to advance gender equality by accelerating the provision of accessible, affordable, reliable and safe public transport – issues that are central to women, as the initial gender analysis pointed out. A gender training was conducted to help raise awareness and provide options for enhanced gender mainstreaming in transport policy and enhance equity and inclusion among users of public e-mobility services. Mainstreaming gender in public e-mobility services also means enhancing autonomy as well as professional and economic opportunities for women.
Next-generation sustainable mobility systems

Next-generation sustainable mobility systems integrating AI, digitalization and new energy sources offer transformative solutions to reduce carbon emissions, enhance efficiency and create smart transportation networks.

CTCN is exploring emerging and cutting-edge technologies and solutions, including:

- Use of digitalization and AI for smart monitoring systems for traffic management (e.g., Bus Rapid Transit system)
- Bi-directional charging, and optimization of EV charging infrastructure in countries, specifically in small island developing states (SIDS)
- Innovative and efficient battery chemicals, energy storage systems (ESS) and its end-of-life management
- Electrification of medium to heavy-duty vehicles using low-emission fuels, (e.g., power to-x)
- Modernize fleets by adopting low-carbon or zero-carbon and alternative fuels
- Create stronger linkages with innovative energy systems transformations
- Intelligent logistics and supply chain management
- Electric vehicle charging infrastructure-smart grid integration. The integration of AI and digital technologies with renewable energy sources creates a symbiotic relationship between sustainable energy generation and transportation. AI algorithms can analyse energy generation patterns, predict supply-demand fluctuations, and optimize the allocation of energy resources. This enables smart grid integration with EV charging infrastructure, enhancing grid stability and maximizing the use of renewable energy.
- Strengthening National Systems of Innovation to create incentives for emerging technologies and switch to fuel substitution through alternative energy carriers such as green hydrogen, bioenergy and ammonia as substitutes.

About CTCN

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1. NDEs are technology representatives selected by each country’s government representing 164 parties to the UNFCCC. [https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country](https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country)
2. National Systems of Innovation (NSI): IPCC defines NSI as: “the set of institutions to create, store and transfer the knowledge, skills and artifacts which define technological opportunities” (Metcalfe, 1995). National systems of innovation reflect a complex mixture of institutions (e.g., financial; legal; scientific and technological; educational), public policies (regarding, e.g., taxation; export/import promotion; science, technology, and innovation), and business and social relationships.
3. Digitalization: Digital technologies impact positively and negatively on GHG emissions through: their own carbon footprint; technology application for mitigation; and induced larger social change. Whether the digital revolution will be an enabler or a barrier for decarbonisation will ultimately depend on the governance of both digital decarbonisation pathways and digitalization in general (medium evidence, high agreement). The CTCN will use this approach that positive impacts of digitalization is realized for emission reductions and creation of resilience.
5. World Bank, 2017
The building and construction sector accounts for almost one-third of total final energy. The end-use sector direct CO₂ emissions is 15 per cent, and its share of emissions rises to around 30 per cent if indirect emissions from the electricity and heat used within the buildings are included.

The sector has been moving at two speeds. On the one hand, energy needs have steadily been on the rise, driven by the growing energy access in developing countries and by the increasing demand for air conditioning and energy-consuming appliances.¹ On the other hand, energy efficiency and emissions reduction have progressed at a much slower pace, with two-thirds of countries still lacking mandatory building energy standards. This is important, as most new construction is slated to occur in those countries without or with low energy standards.²

Climate technology and innovation, including newly-built design, retrofittting and the redesign of existing infrastructure combined with nature-based solutions and grey infrastructure,³ has a key role in strenghtening communities' resilience while helping boost energy efficiency and emissions reduction within the building and construction sector. Smart solutions can ensure buildings and infrastructure are adapted for climate change and greater resilience and safety of the people using them.

CTCN case studies, pilot projects, RD&D, and concept notes can be leveraged/are pivotal to attract investments and funds. CTCN collaborates with The Green Climate Fund, The Global Environmental Facility, The Adaptation Fund Climate Innovation Accelerator, and several regional and national development banks, supporting systems transformation in over 30 countries.
But such adaptations are expensive. In low- and middle-income countries, designs for more resilient assets in the power, water and sanitation, and transport sectors would cost between US$11 billion and US$65 billion a year by 2030 – an incremental cost of around 3 per cent compared with overall investment needs. To minimize these costs in resilient buildings as well as save lives and protect development investments, early and targeted investment is crucial. Estimates show that the net benefit of investing in resilient infrastructure in low- and middle-income countries would amount to US$4.2 trillion, which is a US$4 benefit for each US$1 invested.

CTCN solutions for communities and energy-efficient buildings and infrastructure

Working with National Designated Entities (NDEs), CTCN provides customized technical support, capacity-building and knowledge-sharing activities in response to countries’ requests for assistance in addressing resilience challenges linked to the ongoing and transitional risks to infrastructure caused by the impact of climate change, including:

- Developing green buildings’ standards and new energy-efficiency business models;
- Developing early warning systems for flood and droughts;
- Implementing nature-based solutions and ecosystem-based approaches;
- Innovative application of adaptation technologies such as sensor based automated irrigation, use of drones for crop monitoring and planning; and
- Forest fire preventive monitoring and abatement.

Led by a demand-driven process working with NDEs, CTCN also supports national decision-making, sectoral technology roadmaps, market assessments and feasibility studies to create an enabling environment for climate technology development and transfer.

Thailand needs to reduce emissions to meet national targets for the building sector. The National Energy Efficiency Plan (2015–2036) and Nationally Determined Contribution (NDC) Roadmap mandate the reduction of 113 million tonnes of GHG emissions by 2030 through renewable energy and energy efficiency. While the national building energy code from 2009 set minimum energy standards for new buildings, the lack of knowledge and guidance on cost-efficient technologies made it hard to enforce such standards.

To address these issues, CTCN and its Consortium Partners, the National Renewable Energy Laboratory and The Energy and Resources Institute, prepared a Green Climate Fund Readiness proposal. The International Institute for Energy Conservation led the development of energy consumption benchmarks for selected building types and a techno-financial assessment of energy-efficient building technologies upon approval of the concept note.

Through the technical assistance provided by CTCN, Thailand was able to:

- Determine potential of commercial buildings included under the Building Energy Code (BEC) in meeting the NDC target.
- Develop a more rigorous mechanism for enforcing BEC in selected buildings.
- Determine upfront financial investment required for both energy efficiency and integrating renewable energy with buildings.

As a result, Thailand can avoid 20 million tons CO₂e of GHG emissions by the 2030 timeframe, as defined in the Thailand NDC.
How CTCN is enabling the building sector clean transition

By facilitating and strengthening the flow of know-how experience, and solutions for the building and construction sector clean transition, CTCN has delivered tangible progress towards achieving net-zero goals, while supporting the identification and the development of relevant national business and industry policies, strategies and plans.

This two-pronged approach – converging innovative solutions and policy development – has proven successful in several countries, including Burundi (helping with flood and drought damage prevention) and Kyrgyzstan (formalizing Building codes), and led to the delivery of:

- **77** technical assistance projects delivered totalling US$15 million
- **62** developing countries received CTCN’s technical assistance, and **3** multi-country technical assistance projects
- **50** projects on National Systems of Innovation and **27** projects included Digitalization

Thousands of stakeholders took part in a range of capacity-building activities, including:

- GHG inventory preparation training (Sri Lanka)
- Six-day training courses on GIS and photogrammetry and unmanned aerial vehicle (UAV) standard operation procedures
- UAV pre-mission planning for disaster management (Eswatini)
- A workshop on drought forecasting tools for water supply system resilience (Saint Kitts and Nevis).

In parallel, each technical assistance and intervention works to strengthen national systems of innovation (NSI) and digitalization as proven technology enablers.

**Selected examples of CTCN buildings and infrastructure technical assistance including anticipated impact**

<table>
<thead>
<tr>
<th>Examples of the CTCN technical assistance</th>
<th>Countries</th>
<th>Impacts</th>
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<tbody>
<tr>
<td>Easily deployable water-filled flood barriers used to prevent damage from flooding and to store water vapor to ensure water availability in times of drought</td>
<td>Burundi</td>
<td>Pilot demo completed and adopted. The country is now scaling up the adoption of the technology at the national level by leveraging climate adaptation funds.</td>
</tr>
<tr>
<td>Development of policy guidelines on building codes for enhancing energy efficiency and identification of viable technologies for public buildings</td>
<td>Kyrgyzstan</td>
<td>Building codes (heating, ventilation and air conditioning) for old buildings were revised and delivered, and are in the process of being adopted.</td>
</tr>
</tbody>
</table>
| Strengthen the National Disaster Management Agency (NDMA) capacity’s application of unmanned aerial vehicles (UAVs) and remote sensing technology for vulnerability assessments and response planning | Eswatini | • Enhanced capacity of the use of modern technologies such as remote sensing and UAVs for better analysis of agricultural vulnerabilities.  
• Provision of a foundation course as the basis for more capacity building. |
| Improving resilience of the education system to climate change impacts in the Eastern Caribbean region | Antigua and Barbuda, Saint Lucia | A new hurricane-proof building design for public schools was submitted and approved by the Ministry, which will also serve as shelters during emergency response. |
| Rehabilitation and modernization of the district heating system in the City of Banja Luka | Bosnia and Herzegovina | A strategy to improve the district heating system was delivered and adopted by the local authorities, who in turn managed to secure a European Bank for Reconstruction and Development investment of EU€15 million in biomass boilers, network upgrades and other efficiency measures. |

We are now moving towards a comprehensive plan for water management, integrating all available hydrological and meteorological data, monitoring consumption, and raising awareness on water storage.

Cheryl Jeffers, Ministry of Environment, Climate Action and Constituency Empowerment, Saint Kitts and Nevis
Next-generation buildings and infrastructure

An increasing number of countries are seeking system-wide transformations and requesting support to enhance buildings and infrastructure to strengthen the resilience of communities affected by climate change impacts, including:

- Net-zero emission buildings, green infrastructure and green building materials
- Application of Internet of Things (IoT) for building management
- Use of remote sensing and UAVs for urban planning through nature-based solutions
- Longer lead times based on early warning systems for drought, floods etc.
- Integrated coastal zone management through nature-based solutions
- Real-time systems for monitoring and management of floods
- Climate resilient smart cities
- Integrated water management systems, smart water and waste-water networks
- Digital public goods, and community-based solutions and resource pricing

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3. The IPCC’s 6th assessment report identifies retrofitting and the redesign of existing infrastructure combined with the new design as a way to capitalise on existing knowledge with regard to nature-based solutions and grey infrastructure. This can lead to inclusive adaptation processes. IPCC AR6 Chapter 6 Cities, settlements and key infrastructure.
5. NDEs are technology representatives selected by each country’s government representing 164 parties to the UNFCCC. https://www.ctc-n.org/about-ctcn/national-designated-entities/national-designated-entities-by-country
6. National Systems of Innovation (NSI): IPCC defines NSI as: “the set of institutions to create, store and transfer the knowledge, skills and artifacts which define technological opportunities” (Metcalfe, 1995). National systems of innovation reflect a complex mixture of institutions (e.g., financial; legal; scientific and technological; educational), public policies (regarding, e.g., taxation; export/import promotion; science, technology, and innovation), and business and social relationships.
7. Digitalization: Digital technologies impact positively and negatively on GHG emissions through: their own carbon footprint; technology application for mitigation; and induced larger social change. Whether the digital revolution will be an enabler or a barrier for decarbonisation will ultimately depend on the governance of both digital decarbonisation pathways and digitalization in general (medium evidence, high agreement). CTCN will use this approach that positive impacts of digitalization is realized for emission reductions and creation of resilience.
In 2019, industry accounted for 24 per cent of global GHG emissions, as manufacturing processes, e.g. in the cement and steel industries, are extremely energy and emissions intensive. Business and industry are threatened by climate change with increasingly extreme weather events damaging critical infrastructure for manufacturing and logistics. Climate action in the industrial sector is required to reduce its carbon footprint and in parallel increase climate resilience of businesses and industries.

With an increasing portfolio of low-carbon and cost-competitive technology alternatives, there is a valid business case for climate action. Climate action can:

- Stimulate economic growth by boosting human capital (healthier lifestyles and better education)
- Enhance natural capital (valuation through ecosystem services)
- Boost technological change
- Increase productivity and efficiency (getting more with less)

Businesses and industries, small and medium enterprises (SMEs), and large cooperations have the capacities to:

- innovate
- Co-create low-carbon pathways
- Strengthen their economic competitiveness
- Improve climate resilience
Decarbonization and clean transition are great opportunities for business and industry

The UN Climate Technology Centre and Network (CTCN) provides ground-up support in the transition to low-carbon industries and businesses in developing countries. It works with SMEs and businesses across industries, including building and construction, to identify technology needs and opportunities to reduce greenhouse gas (GHG) emissions and enhance resilience to the impacts of climate change.

CTCN facilitates business and industry clean transition

For over a decade, working with National Designated Entities (NDEs) and over 800 Network members, CTCN has provided developing countries with a range of technical assistance, capacity-building and knowledge-sharing services pertaining to the role of business and industry. By supporting governments to set the right policies and incentives, tangible changes have been made in progressing towards net-zero goals, whether by strengthening reporting requirements of GHG emissions in specific industries, identifying low-carbon pathways, or introducing climate policies. Overall, CTCN has provided the following support:

- 41 technical assistance projects totalling almost US$6 million
- 17 roadmaps, action plans, policies and frameworks developed
- 12 pilot projects prepared/conducted
- 42 developing countries supported, including 3 multi-country projects
- 28 projects on mitigation, 12 on cross-cutting themes, and 1 on adaptation

In parallel, technical assistance and interventions work to strengthen national systems of innovation (NSI) and digitalization as proven technology enablers.

Enabling sustainable pathways in Thailand’s iron and steel industry

The iron and steel industry is a vital part of Thailand’s economy, yet the sector is highly energy intensive, contributing significantly to the national GHG emissions.

The Iron and Steel Institute of Thailand (ISIT) has identified energy efficiency measures as having a dual benefit for the industry: reducing GHG emissions and reducing energy costs to remain economically competitive. With CTCN technical assistance, the industry has gained transparency on energy and emissions levels and received guidance on adopting energy efficiency measures.

A benchmark study of steel plants identified current energy and emissions levels, and energy reporting guidelines were introduced to maintain transparency. An energy efficiency manual with operational practices and technological upgrades, and financial models demonstrating economic viability and financing approaches of the energy efficiency options were developed.

Through energy efficiency measures, the Thai iron and steel industry has the potential to reduce 381,000 metric tons of CO₂ within a five-year time period, the equivalent of taking more than 82,800 cars off the road.
### Selected examples of CTCN business and industry activities, including anticipated country impact

<table>
<thead>
<tr>
<th>Examples of CTCN technical assistance</th>
<th>Countries</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of circular economy roadmaps</td>
<td>Brazil, Chile, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Mexico, Paraguay, Uruguay Côte d’Ivoire, Kenya, Malawi, South Africa, Zambia, Zimbabwe</td>
<td>• Development of circular economy roadmaps including recommendations for policy, technology, infrastructure, and capacity building; • Preparation of pilot projects such as digital platforms for waste trading, decentralized integrated waste-transfer stations of their productive activities.</td>
</tr>
<tr>
<td>Feasibility study for the setup of a biogas plant</td>
<td>Mauritius</td>
<td>• Preparation of a public-private partnership agreement for the setting-up and operation of a biogas plant • GHG emissions reduction potential of 600 metric tons of CO₂e per year</td>
</tr>
<tr>
<td>Technologies and industrial processes in cement producing industries</td>
<td>Congo, South Africa</td>
<td>• Reduction potential of 122,000 to 166,000 metric tons of CO₂e per year in Congo • Feasibility of waste heat recovery, carbon capture and mineralization in South Africa</td>
</tr>
<tr>
<td>SME Technology Clinics</td>
<td>Kenya, Tanzania</td>
<td>• Training of industrial SMEs in Kenya and Tanzania on environmentally sound technology opportunities • Matchmaking between industrial SMEs, technology providers and financing institutions • Increased adoption of environmentally sound technologies by industrial SMEs in Kenya and Tanzania</td>
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“This project has enabled our iron and steel industry to see the dual benefit of energy efficiency measures in terms of financials and sustainability in clear quantitative numbers.”

Surachai Sathitkunarat, Ph.D., Vice President of the Office of National Higher Education Science Research and Innovation Policy Council (NXPO) Thailand

### Business and industry that are just and inclusive

Working with various constituencies under the UNFCCC including business and industry NGOs, youth, women and indigenous communities, CTCN is addressing inequalities in sustainable development to ensure that developing countries have access to and reap the benefits of reliable, affordable climate technology.

CTCN has been creating innovation and inclusion opportunities for youth through its Youth Climate Innovation Labs and Academy, a series of regional innovation sprints and mentoring that targets young innovators in climate action, while building inter-generational bridges in support of transformative technology solutions.

In addition, through the Gender Just Climate Solutions Awards, CTCN has supported several innovation opportunities awarding grassroots and women-led organizations working on:

- Technical solutions (e.g. technologies for mitigation, adaptation, or loss and damage);
- Non-technical solutions (e.g. consumption changes, resilience, and capacity building); and
- Transformational solutions.

Investing in the clean energy transition generates an array of socio-economic benefits in the longer term, including economic growth, job creation, improved livelihoods, support for entrepreneurs and improvements to gender equality.
Next-generation business and industry

CTCN provides business and industry with innovative strategies and practical measures to support sustainable economic development, mitigate GHG emissions and enhance resilience to the impacts of climate change. This involves:

- **Developing low-carbon strategies**: businesses and industries receive support on identifying low-carbon pathways and developing targeted strategies.
- **Small- and medium-scale industries**: CTCN works with the private sector, and especially SMEs to enhance endogenous capacities of innovation by adopting as well as adapting climate technologies to local needs.
- **Focus on hard-to-abate sectors (cement, steel, ammonia etc.)**: cement sector roadmap implementation, steel sector process efficiency and waste heat recovery.
- **Greening of supply chain to large producers**
- **Development of strategies and visions for new sources of energy, like green hydrogen etc.**

### Expected outcomes and impacts

- Reduced climate change impact of industries...
- Enhanced resilience to climate change and increased capacity of SMEs to innovate for climate action...
- Empowered women and youth taking a leading role in the transformation of business and industry...

### About CTCN

The Climate Technology Centre and Network (the implementation arm of UNFCCC’s Climate Change Technology Mechanism, mandated under the Paris Agreement) provides accelerated development and transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries.

CTCN provides a portfolio of 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 is hosted by the UN Environment Programme and is headquartered in Copenhagen, Denmark.

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2. NDEs are technology representatives selected by each country’s government representing 164 parties to the UNFCCC [https://www.ctc-n.org/about-ctcn/national-designated-entities](https://www.ctc-n.org/about-ctcn/national-designated-entities)
3. CTCN’s Network includes members from: National technology and regional climate technology centres, intergovernmental, international, regional or sector organization, research, financial, non-governmental, industry, SMEs, and private sector organizations.
4. National Systems of Innovation (NSI): IPCC defines NSI as: “the set of institutions to create, store and transfer the knowledge, skills and artifacts which define technological opportunities” (Metcalfe, 1995). National systems of innovation reflect a complex mixture of institutions (e.g., financial; legal; scientific and technological; educational), public policies (regarding, e.g., taxation; export/import promotion; science, technology, and innovation), and business and social relationships.
5. Digitalization: Digital technologies impact positively and negatively on GHG emissions through their own carbon footprint, technology application for mitigation, and induced larger social change. Whether the digital revolution will be an enabler or a barrier for decarbonization will ultimately depend on the governance of both digital decarbonization pathways and digitalization in general (medium evidence, high agreement). CTCN will use the approach that positive impacts of digitalization are realized for emission reductions and the creation of resilience.