the projects because considering the vision and context of rural communities ensures technology acceptance and appropriation.

ARUWE has a communication and dissemination strategy to support the replicability of the technology. Some of the women of the cooperatives apply to be ambassadors and visit local communities to promote the creation of energy cooperatives and the installation and use of renewable technologies.

This strategy of ambassadors has generated important inputs for the scaling up of technologies. In the community meetings, during the pedagogy and training days the communities propose new uses or actors who may be interested in them. For example, although the use of solar panels and briquettes began as a project for the energy security of homes, health centres now use the panels to guarantee energy for their maternity services, and restaurants use briquettes in their kitchens. In this way, the technologies have many opportunities for expansion.

The decentralized and cooperative energy model of ARUWE has generated co-benefits for social and economic development, especially of rural women. Women are the decision-makers regarding the energy value chain; likewise, for the production and commercialization model of briquettes. This has allowed them to gain economic independence and start small businesses that are supported by the village savings and loans associations initiative, a rotating financial mechanism, created by the same cooperatives, that supports their members with liquidity for their agricultural projects or to respond to emergencies or household needs. The income generated by the commercialization of climate technologies also enables their scaling up; for example, each cooperative decides the percentage of the income that will be saved to reinvest in machinery and supplies, and the percentage to be invested in marketing, awareness and advocacy. Women ambassadors use the income to finance travel, workshops and meetings with stakeholders.

### 3.1.10. Pioneering triangular cooperation on renewable energy technology transfer in Ghana and Zambia, with China and the United Nations Development Programme

**Participating countries:** China, Denmark, Ghana and Zambia

**Partners:** UNDP country offices in China, Ghana and Zambia, Danish International Development Agency, Energy Commission of Ghana, Ministry of Energy of Zambia, Administrative Centre for China's Agenda 21 at the Ministry of Science and Technology of China, China Agricultural University

**Start of technology uptake process:** 2015

**Climate technology:** Solar and small hydropower, biogas and biomass cooking stoves

**Contribution to NDC implementation:** Reduction of energy sector emissions in Ghana and Zambia through the uptake of renewable energy technologies

Further information:
China–Ghana–UNDP project website: https://www.undp.org/china/projects/china-ghana-south-south-cooperation-renewable-energy-technology-transfer.
China–Zambia–UNDP project website: https://www.undp.org/zambia/projects/china-zambia-south-south-cooperation-renewable-energy.

**Climate technology:** The project supported the development of enabling environments in Ghana and Zambia and the transfer of renewable energy technologies for solar energy, small hydropower, biogas and biomass cooking stoves under the framework of South–South cooperation, fostering the uptake of those technologies in different local contexts.

**Uptake of the climate technology:** The China–Ghana/Zambia–UNDP triangular cooperation project resulted in the transfer of renewable energy technologies and in national policies and private sector partnerships that continue to facilitate the scaling up of renewable energy technologies in Ghana and Zambia. In addition, the project strengthened China's capacity for South–South cooperation on renewable energy technology transfer.

The project contributed to fulfilling the demands of Ghana and Zambia to increase universal energy access, increase the share of renewable energy in the national energy mix and promote the productive uses of renewable energy by enhancing the exchange of expertise and technology. The project also helped experts from China, Ghana and Zambia to work together towards the achievement of the SDGs and their respective NDC targets.

The project derived from the need to disseminate renewable energy technology and to scale up for climate-resilient growth. It supports access to energy and sustainable resource consumption through trials and demonstrations of biogas, biomass and solar energy for productive uses. Given that the project involves China,

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Denmark, Ghana, Zambia, UNDP and multiple other parties, collaborative approaches have been adopted to guarantee successful outcomes and the sustainability and repeatability of the project, including a focus on:

- Strong government support. Government institutions in Ghana and Zambia implement the project, ensuring local ownership and buy-in and mutual learning among the involved countries. The Ministry of Science and Technology of China and the Ministry of Commerce of China have not only provided technical support but also encouraged some Chinese enterprises and renewable energy technology research institutions to provide assistance in terms of knowledge, experience and equipment;
- Clarifying the responsibilities and division of labour among all parties, forming dedicated teams for different purposes and establishing relevant mechanisms that will be more effective for the progress of the project. Periodic discussions among stakeholders took place in the form of online meetings, site visits, manufacturer visits and matchmaking events;
- Stakeholder coordination, which is fundamental and includes the establishment of linkages, understanding and collaboration among research institutes, private sector entities and government counterparts through different communication platforms;
- Exploring the establishment of an efficient management and communication mechanism through the UNDP country offices, thus building a bridge for cooperation between the three countries. The setting up and operation of the project management office has enhanced China's participation in project management and further strengthened communication between China and the two partner countries;
- Actively creating an enabling environment for South–South cooperation on technology transfer and strengthening the capacity-building of multiple parties, improving the quality of trilateral cooperation while effectively promoting the localization of cooperation results and adding a long-term momentum to the development of the partner countries' renewable energy industries.

In the transfer of renewable energy technologies (e.g. solar, small hydropower, biogas and biomass cooking stoves), the local demonstration projects and the sustained capacity-building activities for local personnel, local stakeholders were actively involved and empowered to replicate and improve local solutions, thus promoting the sustainable application of technologies for adaptation. Indigenous practices and knowledge, such as community consultations and peer-to-peer learning, proved to be effective approaches for the transferred technologies to be accessible and adaptable. All of these above factors will enable the project to improve the current power-insufficient status of Ghana and Zambia, including the limited power supply from the traditional grid systems, which has restricted the development of the local economies during the past decades. The project was funded by the Danish International Development Agency.

Under the project, one small hydropower plant was installed in Chipota Falls, Zambia, and three sites were selected after an expert evaluation for the potential construction of small hydropower plants in Ghana. In Ghana, the demonstration projects included a biogas project and a biomass project in the Kumasi Institute of Tropical Agriculture, the Ejura solar biomass hybrid dryer project and the Tamalugu 15 kW DC solar irrigation project.


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**Gender-responsiveness:** The project ensured gender balance in the project teams in China, Ghana and Zambia and in the project activities, for example through a balanced composition of female and male participants in stakeholder consultations, workshops and trainings.

**Contribution to NDC implementation:** The project contributed to the NDC targets of Ghana and Zambia with regard to reducing emissions from the energy sector and expanding the use of energy from renewable sources.

**Challenges and lessons learned:** The main challenges that the project faced can be grouped into cultural challenges, standard challenges and communication challenges:

- Cultural challenges: some technologies, such as biogas and small hydropower plants, need to consider the local practices for organic waste treatment. Dairy cattle farms in Ghana and Zambia typically only have cattle numbering in the scores, which may not generate enough cow dung for the biogas system to operate continuously. After a study in Ghana, the design of the feedstock supply for the biogas system was optimized and multiple types of feedstock, including cow dung, kitchen waste and crop residue, could be accepted for digestion. Another cultural challenge example can be seen in the site selection of a small hydropower facility in Zambia, for which it was important that the local tribal leaders agreed to the site study before the onsite investigations were conducted;
- Standard challenges: people in Ghana prefer cooking with a large pot heated by burning charcoal, which generates a lot of pollutants. The specific stove structure for the pot size in Ghana was designed after several rounds of visits and discussions. Also, during the preparation of solar devices for Ghana and Zambia, it was necessary to verify the local standard on grid system so that major parameters are correct;
- Communication challenges: owing to time difference and the distance between China and Africa. Matchmaking events, technical trainings and a catalogue of available technologies therefore became important channels and tools for information exchange between the three countries.

**Long-term sustainability, replicability and potential for scaling up:** The project adopted a new demand-driven approach for technology matchmaking to ensure that the transferred technologies will be sustainable, including in the areas of solar, small hydro power, biogas, and biomass cook stoves). The capacities for renewable technology transfer of all the stakeholders were improved significantly.

Under the project, the Technology Transfer South–South Cooperation Centre was jointly established by UNDP and the Ministry of Science and Technology of China to build institutional capacity for future South–South cooperation projects in the area, which will take into account good practices and lessons learned from the cooperation with Ghana and Zambia. In addition, a think tank that focused on renewable energy technology transfer was set up successfully with the involvement of various stakeholders, including government entities, enterprises and universities. During the implementation of the project, local demand was studied and suitable renewable energy technologies were collected from across China. This led to the formation of an online platform for technology matchmaking, which will enable precise matching of technologies between suppliers and users and long-term renewable energy technology transfer.

The triangular cooperation model under the United Nations framework is replicable and sustainable, and led to the launch of a China–Ethiopia/Sri Lanka triangular cooperation project on renewable energy technology transfer. The project is funded by the Ministry of Commerce of China and Ethiopia and Sri Lanka equally. The project aims to create a sustainable, accessible and cleaner energy supply for Ethiopia and Sri Lanka, especially for the agroindustry sector. The project is currently being implemented and will see biogas, solar and biomass technologies from China being demonstrated in Ethiopia and Sri Lanka. The experience accumulated during the Ghana/Zambia project will be important for the success of this project. The Technology Transfer South–South Cooperation Centre, the think tank, the appropriate sustainable development technology catalogue, as well as administrative measures, will provide support to the implementation of the Ethiopia/Sri Lanka project. Cooperation through international organizations and multilateral mechanisms such as the United Nations is creating a new model of government-led and expert-supported assistance. This model of triangular cooperation can be adapted to benefit other country settings.

### 3.1.11. Improving water supply management in Grenada through a geographical information system-based monitoring and control system for water loss reduction

**Participating country:** Grenada

**Partners:** Wood Public Limited Company, GISCAD Ltd., Grenada Water Stakeholder Platform

**Start of technology uptake process:** 2017

**Climate technology:** GIS and web-based GIS data mapping platform

**Contribution to NDC implementation:** Improved water resource management

Further information:
CTCN technical assistance: https://www.ctc-n.org/technical-assistance/projects/improvement-water-supply-management-grenada-through-gis-based.

**Climate technology:** GIS and web-based GIS data mapping platform to reduce water loss through better leakage management control and faster detection and repair of pipe systems

**Uptake of the climate technology:** As a SIDS, Grenada is highly vulnerable to hurricanes, storms and flooding caused by climate change. Such events have led to damage to key infrastructure, including in the water sector. In addition, climate change is aggravating water scarcity problems, with increasing average temperatures, more erratic rainfall, more frequent heavy rainfall events, saltwater intrusion in groundwater owing to sea level rise and more severe droughts. The country has repeatedly experienced major droughts, during which the production capacity of the domestic water supply systems was reduced by up to 75%. An assessment of the United Nations Economic Commission for Latin America and the Caribbean found that the country's water demand could exceed its water supply as early as 2025. Tackling water loss is therefore critical to enabling the country to better adapt to climate change and climate variability.

GIS modelling and data analysis can increase efficiency in water service management and delivery, data processing, calculations, reporting and decision-making, thus creating a powerful platform for water loss management interventions. NAWASA identified GIS-based monitoring and control approaches as a suitable management tool to reduce water loss across the country. Through CTCN technical assistance, the Climate Technology Network member Wood Public Limited Company and the Caribbean GIS solution provider GISCAD Ltd. supported NAWASA to establish in-house GIS structures and procedures, build capacity for data management and system integration, and apply GIS technology in pilot district metered areas. First, Wood Public Limited Company and GISCAD Ltd. reviewed and refined the available data sets, before training NAWASA staff on the use of new GIS-based data collection tools and on the detailed mapping and remapping of the pipeline distribution network in two pilot zones, which more than doubled the recorded pipe network length. Then, joint work was undertaken to digitize meter readings and locations and workflows for the leak detection crew and for the capture of materials used to improve inventory management. Finally, the new data sets were integrated in a web-based GIS mapping platform to visualize the findings and achievements.

The CTCN technical assistance also used South–South cooperation as an approach for effective knowledge transfer by facilitating a study tour of NAWASA staff to Trinidad and Tobago and a virtual exchange with multiple Caribbean water agencies to share experiences in the use of GIS-based technologies for water management. The work under the CTCN technical assistance programme served as an important contribution to the approval of the Climate Resilient Water Sector in Grenada project, funded by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection under the International Climate Initiative, the GCF