Country	**Liberia**
Request ID#	**AFCIA 2021000017**
Title	**Upscaling Lowland Rice Production to improve food security through improved solar powered irrigation practices**
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Summary of Climate Technology Centre and Network (CTCN) technical assistance

The objective of this TA will be to introduce solar powered irrigation technology and practices to intensify rice cultivation and production in one lowland county in Liberia to be selected between Lofa and Bong with the intension of upscaling the technology as an adaptation measure to climate change at a national level.

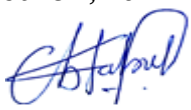
The TA will be divided into 6 main outcomes described below:

- Outcome 1 : Analyse the current irrigation and rice cultivation practices in 1 county of Liberia
- Outcome 2 : Design appropriate irrigation and solar water pumping technologies for SRI based farming in the selected county
- Outcome 3: Select appropriate SPIS technology
- Outcome 4: Pilot a small-scale implementation of the solar pumping system in the selected county of Liberia
- Outcome 5: Elaborate and disseminate training's materials and workshops
- Outcome 6: Formulate an enabling environment roadmap and M&E framework

Agreement:

(If possible, please use electronic signatures in Microsoft Word file format)

National Designated Entity to the United Nations Framework Convention on Climate Change (UNFCCC) Technology Mechanism

Name: Christopher B. Kabah
Title: NDE
Date: June 4, 2021
Signature: 

Proponent

Name: Halala W. Kokulo
Title: Director, Division Land Development and Water Resource/MOA/NDA
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Climate Technology Centre and Network (CTCN)

Name: Rose Mwebaza
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Date: 08/06/2021
Signature: 

1. Background and context

Liberia, as a country, has not fully developed irrigation technology for integration into the agriculture sectors. However, from the Technology Needs Assessment, the country has identified and prioitized it as the number 5 “technology for the agriculture sector”. The technology has the following benefits;

- It guarantees yields of agricultural crops in an increasingly dry climate
- It reduces water and energy consumption for irrigation needs in agriculture
- Irrigation serves as an important tool for ensuring yields in increasingly dry climatic conditions of Liberia when lack of natural moisture of the soil will only grow in the future.
- Irrigation is the most climate-sensitive use of water. The yields and profitability of irrigated land relative to dryland farming tend to increase as conditions become hotter and drier. Currently, due to the change in farming calendar in Liberia as a result of prolong sunshine, most famers are moving to lowland as was reported (EPA, 2019).
- It reduces the water consumed for irrigation as an adaptation to climate change

Liberia is looking into adopting irrigation for intensified rice farming so as to increase rice yields in the country while lowering the water usage. The water usage will be decreased by applying crop targeted drip irrigation thus ensuring sustainable use of the available surface or ground water resources. Due to the high cost of electricity the irrigation practice is to be coupled with solar powered water pumping systems.

2. Problem statement

Liberia is a small West African state with borders in the north with the republic of Guinea, in east with Ivory Coast, in the west, with Sierra Leone and in the south with the Atlantic Ocean. The total land area is estimated at 11 137 000 ha (FAO, 2002). In 2002, the total cultivated area (arable land and area under permanent crops) was estimated at 600 000 ha. The arable land (annual crops) estimated at 380 000 ha and the area under permanent crops accounted for 220 000 ha. The population estimated in 2008 by Liberia Institute of Geo-Information Services (LIGIS) was 3.5 million people, of which 52 % lives in rural communities with the population density of 31 inhabitants per km^2. Agriculture is a major sector of Liberia employing more than 70% of the population.

However, Liberia agriculture system is rain-fed, indicating heavy dependence on rainfall. Climate change has posed serious challenge on all sectors and has adversely threatened sustainable agricultural production in Liberia. Recent data obtained by the EPA shows that warmer temperatures are affecting food crops production and impacting livestock as well. Farmers are complaining about the fluctuation in rain patterns. Observations have shown that May and June are wetter than expected and this carries implication for farm productivity. May and June are predominant planting periods for farmers especially those engaged in upland agriculture in Liberia. Excessive rain during this time of the year washes away plant seeds and sprouting plants thereby causing low productivity (EPA, 2019). Hence, leading to low food production by majority of the rural population of Liberia that depend almost entirely on food crop production as an important source of livelihood and income generation.

Besides, the historical climate change scenarios include increased average annual temperatures of 0.8°C throughout the country, a 15.7% increase of hot nights which lead to decline in mean annual rainfall.

All of these are happening when Liberia is yet to recover from the 14 unbroken years of civil conflict that ruin major agricultural infrastructures ranging from farm electricity, mails for rice production in the targeted agro-ecological zones and coupled with the global recession, Ebola and now COVID-19. Prior to the war, there were estimates about the irrigation potentials of the country (FAO, 2004). Today, there is little or no information about a full or partial control irrigation; surface irrigation, sprinkler irrigation, localized irrigation, percent of area irrigated from groundwater and percent of area irrigated from surface water in Liberia.

The project therefore seeks support to upscale lowland rice production through irrigation technology.

3. Logical Framework for the CTCN Technical Assistance:

	Month[1]														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
***Goal**: Introduce solar powered irrigation technology and practices to intensify rice cultivation and production in one county of Liberia.*															
***Outcome**:* • Outcome 1 : Analyse the current irrigation and rice cultivation practices in 1 county of Liberia • Outcome 2 : Design appropriate irrigation and solar water pumping technologies for SRI based farming in the selected county • Outcome 3: Select appropriate SPIS technology • Outcome 4: Pilot a small-scale implementation of the solar pumping system in the selected county of Liberia • Outcome 5: Elaborate and disseminate training's materials and workshops • Outcome 6: Formulate an enabling environment roadmap and M&E framework															
Mandatory Output: Develop communication documents and implementation work plan															
Mandatory activities: *All implementers must undertake the following activities at the beginning and at the end of the CTCN technical assistance.* **Activity i**: A detailed implementation plan for all activities, deliverables, outputs, deadlines and responsible persons/organizations, including a gender study and an itemized budget for implementing the Response Plan. The detailed implementation plan and budget must be based directly on this Response Plan. **Activity ii**: Based on the work plan, a monitoring and evaluation plan with specific, measurable, achievable, relevant, and time-bound indicators should be developed to evaluate the timeliness and appropriateness of implementation. The indicators selected in the monitoring and evaluation plan should be aligned with the Closure and Data Collection Report template. This will enable the implementer to complete the CTCN															

[1] The project timeline can be adjusted according to the level of development of the participating country.

Closure and Data Collection Report at the end of the technical assistance (please refer to Activity 1.4 and Section 14 of the Response Plan). **Activity iii**: A two-page description of the expected impact of the CTCN technical assistance prepared at the start of the assistance, updated at the end of the technical assistance (a template will be provided). **Activity iv**: A CTCN Closure and Data Collection report completed at the end of the technical assistance (a template will be provided).																
Mandatory Deliverables:																
i) Implementation plan	X															
ii) Monitoring and evaluation plan	X															
iii) Impact description document (initial and final version)	X															X
iv) Closure and Data Collection Report																X
Output 1: Analyse the current irrigation and rice cultivation practices in Liberia																
Activity 1.1: Map relevant stakeholders and establish a stakeholder working group The activity will identify relevant stakeholders among governmental institutions at the national and sub-national levels. These stakeholders will include the NDA, the NDE, the project proponent, as well as entities working in similar or complementary initiatives such as Africa Rice Center, Community of Hope Agriculture Project, Climate Resilient Rice Production Project in West AFRICA (RICOWAS), private sector, civil society, academic institutions and beneficiaries. From these stakeholders, a restrictive working group (up to 8 persons) will be created. The working group shall maintain a gender balance and an adequate representation of vulnerable groups. It will provide a technical overview and a high-level guidance at every stage of the design of the solar irrigation pumping system. For this purpose, the members of the working group should have the capacity to take key decisions with regards to the design of the solar pumping system and ensuring that these decisions are aligned with the strategic priorities of the country.															
Activity 1.2: Conduct a virtual inception meeting An inception meeting will be organised to present the team of experts, the goals, milestones, anticipated deliverables and the role of the stakeholder working group. Outcomes of the inception meeting will be fed into the implementation plan elaborated under Activity i of the Mandatory output. This meeting could be held virtually and is estimated to last 2 hours.																

Activity 1.3 : Diagnose current irrigation system in Bong and Lofa The implementer will do a desktop review of existing regulations, laws, policies, reports, studies or else about current irrigation systems used in Liberia for SRI and rice production. This bibliographical review will be completed by a series of interviews with stakeholders from the selected county or country including ministries, NGO, farmers, academia, private sector, lowland farming cooperatives, gender and youth association to understand the irrigation system used as well as its limits, technological failures, bottlenecks, opportunities, advantages. It is highly recommended for the consultant to interact with Africa Rice Center, Community of Hope Agriculture Project, Climate Resilient Rice Production Project in West AFRICA (RICOWAS), as these entities are implementing "improved rice intensification" in Liberia, in these same counties, and neighbourhood countries. It is expected that 15 interviews will be held either virtually or presential or a mix of both.															
Activity 1.4 Select best pilot sites between Bong and Lofa Based on this initial analysis, the implementer should describe in a report which of the county (Bong or Lofa) will be more adapted to the implementation of a small-scale pilot project. The selection criteria applied in the selection of the county will be clearly defined in the report. A virtual meeting will be held with the stakeholder working group to discuss these results and confirm the choice of the pilot county between Bong and Lofa.															
Activity 1.5 Benchmark international best irrigation practices in SRI from countries with similar socio-economic, geographic and climatic conditions. During this activity, the implementer will benchmark the best irrigation practices for SRI from countries with similar socio-economic, geographic and climatic conditions. Some interviews will be held with the implementing entities / executing agencies as well as beneficiaries of these best practices initiatives to identify the lessons learnt during the implementation, the challenges, the mistake to avoid, the best technologies that help managing the SRI process, and any other relevant information that could be of interest of the selected county in Liberia.															
Activity 1.6 : Identify challenges and requirements in the context of irrigation and rice cultivation practices, taking into account specific barriers for women and youth. A report on the challenges faced by the selected county in the context or irrigation and rice cultivation will be elaborated. This report will also include relevant recommendations on best practices that could and															

should be replicated from other successful international SRI projects to the selected county, taking into consideration the importance of gender and youth.																
Deliverable:																
1.1 Stakeholder mapping report containing a complete stakeholder list as well as a description of the stakeholder working group (including name, position, institution, gender and role of each member).	X															
1.2 Inception meeting report with materials, list of participants disaggregated by gender.	X															
1.3 Diagnosis of current irrigation systems used for SRI and rice production in Liberia		X														
1.4 Selection of the pilot county detailed in a report + minute of the meeting with the stakeholder working group.		X														
1.5 Benchmark of most suitable international irrigation systems for SRI from countries with similar socio-economic, geographic and climatic conditions.		X														
1.6 Report on challenges and recommendations for irrigation and rice cultivation customized to the selected county and taking gender and youth into consideration		X														
Output 2: Design appropriate irrigation and solar water pumping technologies for SRI based farming in the selected county SPIS refers to solar-powered pumps being used for irrigation. SPIS are relatively complex systems, and their design requires not only a fit-for-purpose PV pump system and irrigation infrastructure (supply side), but also an assessment of water requirements and irrigation calendar (demand side), as well as skills and knowledge of the end user. SPIS are nothing new. The first solar-powered pumps were installed in the late 1970s. Nevertheless, it was not until 2009 when the price of solar panels started to decrease dramatically, making solar technologies affordable for agricultural purposes. Since then, there has been a race for the development of more powerful and efficient systems; every year, there are larger pumps on the market that can withdraw water from greater depths. The market potential for both small-scale and large-scale systems is great. Prices continue to drop. The International Renewable Energy Agency (IRENA) is projecting a 59 percent cost reduction for electricity generated by solar PV by 2025 compared to 2015 prices. [2]															
Activity 2.1 Gather data to understand the demand side of the fit-for-purpose SPIS. During this activity, the implementer will gather the fundamental information that will be requested to design a complete SIDS for the selected county in Liberia. The crop water requirements will lead to the choice of the PV pump system, which will also depend on the location, the water source and specific																

[2] http://www.fao.org/3/i9047en/I9047EN.pdf

weather data of the site. The requested information could be difficult to gather remotely. Thus, it is expected that at least one and up to two international experts will travel to the selected county.
Below is listed some data and information that should be gathered. This list is not exhaustive:

Location
Field size and terrain (slopes)
Topography

Water data:
Water resources / quality
Water rights/ volume
Ground water level

Weather Data:
Sunshine hours
Temperature
Location (latitude / altitude)
Rainfall

Soil
Water holding capacity pre-irrigation
Type of soil

Rice crop
Growing season
Root depth
Crop value
Irrigation calendar

The combination of these data will provide the Crop water requirements (ETcrop).
A report will provide a detailed description of this data and will conclude with the irrigation requirements (supplementary and obligatory); the crop coverage (%) as well as the irrigation amount and frequency required.

Activity 2.2: Collect data to define PV pump system and irrigation infrastructure (supply side)
In order to select the best technologies and design the system that will enable to irrigate, in the most efficient manner, the SRI of the selected county of Liberia, the following criteria will be analysed and compared. This list is not exhaustive:

Photovoltaic Pump Systems needed is terms of :
Head/ pressure (TDH) (m)
Daily Volume (m^3/day)

Solar generator size ($w_{peak)}$
Sun tracking system

Pump and motor size
(m^3/h) and (kW)

Functionality
Set of irrigation programmes that can be registered
Sensors for monitoring of the water lifting systems as well as data collection on water level measurements (that options can limit the use of water to safeguard the aquifer).
Possibility to activate the solar pumping remotely and monitor performance at any time.
Possibility to obtain daily pumping usage reports or crop management recommendations
Requested technology to benefit from these functions (does it require a smart phone, a specific subscription, other? Please describe).
The results of analysis achieved through activities 2.1 and 2.2, should enable to define the most adapted configuration for SRI in the selected county of Liberia, including the definition of, at least but not limited to, the following criteria .

- Night-time irrigation (diesel pump) required or not.
- Irrigation efficiency of the existing SPIS in the current context, in %
- Solar Surface / Gravity Irrigation ratio
- Type of solar pressurized irrigation systems : drip, sprinkler, centre pivot.

Activity 2.3 : Define the configuration of the SPIS
Using solar-powered pumps for irrigation allows for different configurations depending on

the context of the application. During this activity, the implementer will analyse the best configuration of a SPIS for the selected county and for SRI cultivation. This analysis will include, but should not be limited to the following aspects:

Would the county need a direct pumping, a multi-use system, mini grids set up, a hybrid system, else?

In case of direct pumping the following indicators will be analysed:
- Does the system need PV panels and pump (with DC or AC motor) ?
- With or without water storage (elevated) tank or reservoir ?
- Would an irrigation system (flood, sprinkler, micro irrigation[drip], and irrigation machines required?
- Maximum Power Point Tracking (MPPT) and other electronic/software features that could improve efficiency?
- Variable motor speed and pump volume during the solar day and cloud interfaces.
- Solar-irrigation controller uses volume meter (not timer).
- Does a fertigation system be contemplated? As well as water treatment and cleaning chemicals?
- Efficiency expected in the current context and use?
- Would a weather station be necessary?
- Does Internet of Things function be considered?

For multi-use systems
- Same questions as above plus
- Energy needs?
- Batteries required?

Mini grids pumps
- Are there multiple uses to the PV panels (pumping, solar hone systems, etc)?
- How can the different uses be accounted for and paid for?
- Pump system efficiency?
- Does it make sense to implement a mini-grid system instead of a direct pumping?

Hybrid systems
- Is it necessary to reduce peak demand?
- Does a night-time use is recommended?
- Does the country have electrical grid or diesel pump?

Finally, the report will also consider :

If the soil below the PV panels could be optimized. How could the SPIS be monitored. How can the system be improved to adapt to gender and youth needs?															
Deliverable:															
2.1: Final report on the data requested to understand the demand side of a SPIS			X												
2.2 Final report data requested to define a fit-for-purpose PV pump system and irrigation infrastructure (supply side)			X												
2.3 Report defining the best configuration of the SPIS model for SRI in the selected county of Liberia				X											
Output 3: Select appropriate SPIS technology															
Activity 3.1 Elaborate fact sheets on appropriate technologies for the SPIS configuration defined The implementer will elaborate technology fact sheets of existing SPIS that could respond to the requirements identified for the configuration of the system defined in activity 2.3. The results of this process will be synthetized under matrices that will clearly demonstrate which technologies could ensure the different functions required in the configuration. The report will also rank the technologies based on the results of the technology fact sheets and comparative matrices. Finally, the report will recommend the use of, at least one and maximum 3 technologies with clear explanations for the reasons of this choice.															
Activity 3.2 Define cost estimation of the identified technologies under the configuration designed The cost estimation should include all the components of the SPIS configuration and provide the estimated costs per unit and for an implementation in the selected county of Liberia. The details of the cost should consider the remoteness of the area, the size and configuration of the system, the type of crop, any other uses of the water, where the water will be used, and will also include at least: - Cost of PV panels (per unit and at scale) - Cost of the pumps. - Cost of filtration, fertigation, water storage (if necessary) - Solar pump : unit and at scale - Pump controller - Electric cables - Pump installation - Monitoring equipment - Cost of maintenance (for each component a clear description of how often spare parts should be replaced and costs of these pieces) ?															

- Cost of installation - Cost of operation This study will also include the annual savings expected (in energy and USD), the payback period in Liberia. The GIZ-FAO Toolbox on Solar-Powered Irrigation could provide some useful tools for this: https://energypedia.info/wiki/SPIS_Invest															
Activity 3.3 Organize a one-day workshop with the stakeholder working group A one-day workshop will be organized in Liberia with the stakeholder working group. The objective of this workshop will be to introduce the needs of the county for the culture of SRI, the characteristics of the SPIS system requested to fill these needs, the best configuration designed for an efficient use of the system, and the possible technologies identified along with its estimated full cost (including installation, use and maintenance). It is considered that a full day will be requested for this workshop. In the morning, the results of activity 2 & 3 will be presented. In the afternoon, the stakeholder working group will work to identify and select which technology would fit better the county´s needs (in case more than one technology be shortlisted in activity 3.1) . The workshops will also allow time for questions, comments, suggestions, questions, of the stakeholder working groups. At the end of the session, the stakeholder working group should have agreed on one specific technology (in case more than 1 technology was pre-selected during the activity 3.1).														
Activity 3.4 Organize a 3-hours stakeholders' workshop to present the selected technology A 3-hours presential workshop will be organized in Liberia with the stakeholders mapped in activity 2.1. The objective of this workshop will be to introduce the needs of the county for the culture of SRI, the characteristics of the SPIS system requested to fill these needs, the best configuration designed for an efficient use of the system, and the technology selected by the stakeholder working group in activity 3.3 along with its estimated full cost (including installation, use and maintenance). The stakeholders should be invited at least 1 month in advance, through the most effective channels. A participation of minimum 50 persons is expected. A list of participants by gender will be provided along with the minute of the workshop. The previous reports (from activity 2 and 3) will be dully revised based on the relevant comments that could have been received during the workshops (activity 3.3 as well as 3.4) and final versions of the reports will be circulated.														

Deliverable:															
3.1 Technology fact sheets					X										
3.2 Cost estimation of the prioritized technologies						X									
3.3 Minute of the stakeholder working group´s workshop including the material (PowerPoint or else), list of participants disaggregated by gender, photos, conclusions.						X									
3.4a Minute of the global stakeholder's workshop including the material (PowerPoint or else), list of participants disaggregated by gender, photos, conclusions. **3.4b** Final reports 2.1 to 2.5 revised based on the comments received during the workshop.						X									
Output 4:Pilot a small-scale implementation of the solar pumping system in the selected county of Liberia															
Activity 4.1: Choose a plot in the selected county for a small-scale pilot implementation of the selected SPIS A small-scale pilot of the SPIS technology will be deployed in the selected county of Liberia. The total budget for this pilot should not exceed 37,500 USD all cost inclusive. The area/plot for the implementation of this pilot will be selected in cooperation with the stakeholder working group and the implementer to ensure that the site provides the characteristics for a successful implementation. The size of the plot will be adjusted to the budget available. A meeting will be held with the implementer and the stakeholder working group on site, in the county, to define the perimeter of the pilot area. The implementer should already be onsite for the previous workshops (3.3 and 3.4) and will take advantage of his presence in the country to make this visit on site.															
Activity 4.2: Plan the implementation of the pilot project The implementer will prepare a detailed implementation plan for the deployment of the pilot. This report will provide in a clear, complete and precise manner all the specificities of the pilot implementation, included but not limited to the technical, human, financial requirements for the implementation of the pilot project in the selected area. This may include but will not be limited to: - Number of people required to deploy the technology - Time required to deploy the technology - Composition elements of the technology (measurements, length, weight, material, connection etc). - Basic implementation guide. - Necessary equipment (including a maintenance guide)															

- Conditions of use - Logistics: work plan, time for the technology to be imported, how would it be routed, if any visa or specifics national authorization will be requested, person in charge of the transportation up to the selected county in Liberia, person in charge of unloading the technology, etc.															
Activity 4.3 : Organize an online meeting to discuss the logistics and implementation of the pilot Following the elaboration of the detailed implementation plan, the implementer will set up a virtual meeting with the stakeholder working group to present the detail of the deployment of the pilot, including the expected timeline and persons in charge of the different steps to be followed to ensure the success of the operation. The implementer will review the work plan based on the relevant comments received and will send back a final version of the implementation plan.															
Activity 4.4: Route the technology to the selected area The implementation plan will be deployed, and the selected technology will be routed to the pilot area. The team leader as well as technical team of experts will be present for the reception of the material. During this activity, the implementer along with the restrictive working group will work on collecting all administrative documents (visa for example) and will coordinate the transportation of the selected technology to the pilot area in Liberia.															
Activity 4.5: Implement the small-scale project in the pilot area In presence of the team leader and technical team of experts, the SPIS system will be installed in the pilot area. The implementer will solve any issues or problems that could make the technology difficult to use, or that could lower the efficiency of the technology. Once this test will be finalised, it is expected that the technology will work, in an efficient way.															
Deliverable:															
4.1: Report on the visit on site to the pilot area with pictures, participants, conclusions						X									
4.2 Detailed implementation Plan							X								
4.3: (i) Report on the meeting to discuss the logistics and implementation of the pilot (ii) Final implementation plan including modifications requested by the stakeholder working group.								X							
4.4 : Report on the deployment of the technology by professionals with pictures								X							
Output 5: Elaborate and disseminate training's materials and workshops															

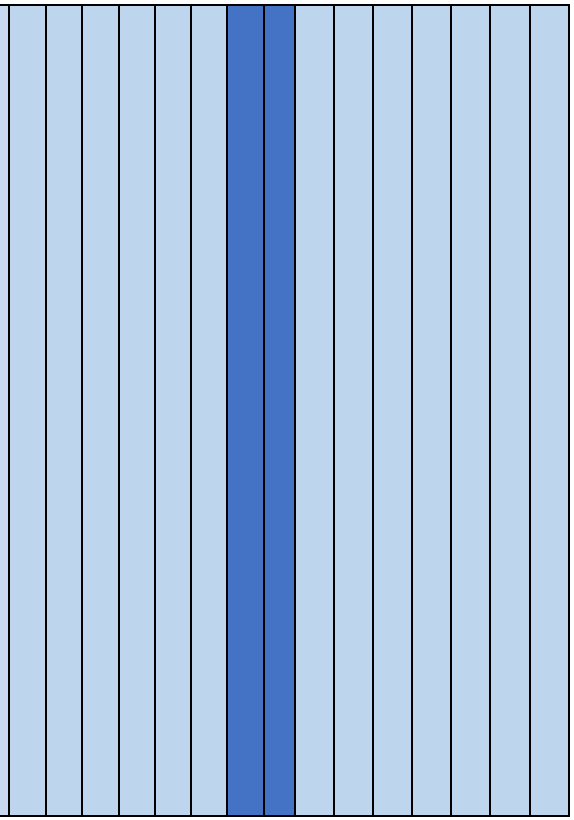
Activity 5.1: Redact a detailed manual on the use and maintenance of the technology

This manual should include all relevant and exhaustive information that the county needs for a correct and effective use and maintenance of the implemented SPIS designed for SRI irrigation.
The long-term sustainability of SPIS depends on well-designed products and quality of installation. Thus, this guide is fundamental to help the rice farmers use efficiently and sustainably this technology.

The manual should include but is not limited to:

- clear indications on when, what and how and how maintenance should be made to the SPIS system: when material should be replaced, where should equipment be purchased, estimated price, estimated time for delivery, conditions of the guarantee for the equipment and its component, and every detail that will be needed by the country to make an efficient use of the technology.
- How and how often should the solar panel be cleaned up.
- How and how often should the pumping system be maintained.
- How and how often should the electrical components be maintained.
- This manual will also include a step-by-step description of the deployment of the technology
- This manual will describe best practices and a clear list of practices to be avoided.
- Other important aspects.

This manual will be designed in English and could be translated, if required into up to 3 more local languages according to the instructions of the stakeholder working group and considering a possible scale-up of the project to other provinces of the country.
This manual will be printed and delivered to the users of the system. An electronic version of the manual in the different languages will be provided to the NDE and the NDA under the format of their choice (iCloud, WeTransfer, usb key, else).



Activity 5.2: Organize a learn by doing workshop The owner of the pilot area as well as all the rice farmers of the selected county of Liberia will be invited to a "learn by doing , on-site workshop". The NDA and NDE as well as City Council of the selected county will support the implementer in getting in touch with the rice farmers. Invitation to this presential workshop will be communicated in the most effective manner, using emails, phone calls, social medias or any other relevant method. This workshop will be a 3 to 4 hours meetings, and will take place in the pilot area, where the SPIS system has been deployed. The implementer will first explain the purpose of this project (oriented to SRI production with solar water pumping system). Then the implementer will explain why this SPIS was selected, how it could be replicated to neighbourhood lands, and more importantly how it works. A full detail of the functionalities will be explained. Part of this training will also describe the maintenance required by the technology. Questions, remarks, doubts from the rice farmers will be addressed. At the end of the session, the manual designed in activity 5.2 will be delivered. It is expected that at least one and up to two international experts should be on-site for this workshop. This workshop needs to be practical and should enable future users of the technology to practice, touch, experiment, and share any questions they could have with regards to the technology. The objective is to ensure that the country is capacitated to use the SPIS and will be able to maintain it. Once the Technical Assistance will be finalized, the owner of the pilot area will be held responsible for its maintenance.															
Activity 5.3: Organize a stakeholder consultation workshop A stakeholder consultation meeting will be organized to introduce the SPIS to the citizens of the selected county. The implementer will explain to the citizens how the technology works, what are the expected impact of the technology, how it could increase the resilience of the county, and provide food security. The implementer will answer any questions from the citizens. Invitations to this stakeholder consultation will be sent at least 10 days before the event and will be posted through different channels to ensure youth, women, farmers, and all citizens of the selected county are informed.															
Activity 5.4: Organise a training to Municipal and National officers															

A training will also be organized in the capital or in the county (to be defined) in the presence of the national and municipal relevant officer, including the ministry of agriculture, ministry of environment, of water use and protection, and else. During this workshop the technical assistance will be briefly explained, and the pilot projects will be communicated. Irrigation technologies functionalities will be explained to them, and the manual designed in activity 5.1 will be shared. The objective of this training is to create the capacity for these leaders to promote efficient irrigation technologies to rice farming communities.															
Deliverable:															
5.1 : Detailed manual explaining the way to use the SPIS system and how to ensure its maintenance designed in English and translated into up to 3 other local languages.								X							
5.2 : Minutes of the "Learn by doing" workshop with the rice farmers of the county with pictures, and a list of participants desegregated by gender as well as materials used if any.								X							
5.3 Minutes of the stakeholder consultation workshop with pictures, and a list of participants desegregated by gender as well as materials used if any.								X							
5.4 Minutes of the training to municipal and national officers with pictures, and a list of participants desegregated by gender as well as materials used if any.								X							
Outcome 6: Formulate an enabling environment roadmap and M&E framework															
Activity 6.1: Design a M&E Framework At national level, reducing dependency on fuel is important and prospects for rural development are enhanced through improved access to water and energy. However, some technical knowledge or service infrastructure is needed to ensure that the system run and are maintained effectively. If not adequately managed and regulated, the risk of fostering unsustainable water use as low energy costs that can lead to wasteful water use, over-abstraction of ground water and low field application. Thus, a M&E framework will be designed (in format of an excel) to monitor and report on, at least the following aspects: - Water accounting: are regular and systematic water accounting carried out regularly? - Water use: Is the use of the water been optimized? - Is optimal use of rainwater and soil moisture, knowing precisely where and when irrigation has to be applied, and then applying it accurately and uniformly, are implemented? - Is the solar energy generated by the system used only for the irrigation system or also for other uses? - Have the solar panels been cleaned as defined in the manual? - Have the pumps been cleaned and maintained as defined in the manual? - Have spare parts been changed as defined in the manual?															

- Have the SPIS help improve the production in quantity? Quality? - Has the SPIS has reduced the consumption of energy? Cost of energy for the farmer? - Has the SPIS enable diversity of culture in the same land? - Has SPIS created changed in the way the rice is irrigated (frequency, quantity)? - Has SPIS enable to have more harvest than before? - Has it empowered women and youth in rice cultivation? - And other criteria to be taken into account. - Does SPIS provided opportunities to increase the frequency in cultivating rice annually (2 times, 3 times)? The implementer will design a M&E system that will enable the rice farmer(s) to monitor the implementation of this technology for SRI production.															
Activity 6.2: Formulate an enabling environment roadmap to scale up the use of SPIS The implementer will define in a report the main recommendations that should be considered to create the enabling environment to scale up the SPIS technology for SRI across Liberia. This roadmap should include, amongst other, a specific section about financing mechanisms that could support the country in scaling up this technology. The report will also review other key aspects that should be considered to create the enabling environment, including but not limited to: **Institutional** - Has Liberia had a groundwater management/ institutional framework that can manage the risk of groundwater over abstraction, leading to depletion and degradation of groundwater resources due to an increase use of SPIS? - Water accounting: Has Liberia benefit from a system that enables systematic report on the status of and trends in water supply, demand, accessibility and use? The risk is that farmers will consume more water than they did before the introduction of SPIS, by: (i) applying more water in the field overall (for example, when shifting from deficit to optimal irrigation, or simply over-irrigating); (ii) expanding the area of land under irrigation; (iii) growing higher-value, but often more water-intensive, crops; (iv) selling water to neighbouring farmers and communities. This risk needs to be monitored and tackled quickly if it happens. **Legislation** - Has Liberia a legislation and regulation of energy and agricultural markets that could help the uptake and up-scaling of solar irrigation systems?															

- How should Liberia control illegal pumping that may increase?
- Has Liberia benefits from codes and standards to guarantee quality of SPIS?

Access to finance

- Are there any taxes on imported equipment that may distort (and artificially keep up) prices?
- What are the barriers (if any) for small holders to access finance for SPIS technology? How could these barriers be leveraged?
- Financing mechanisms: list of traditional mechanisms, climate finance and innovative mechanisms available for implementing SPIS systems.
- If there a need for investment and incentive programmes: what could or should they be?

Capacity

- Recommendations on systematic training schemes (e.g. vocational training) to avoid the lack of skilled personnel to use SPIS technology
- Ensure that the national and municipal officers as well as farmers understand that SPIS design needs to be fit-for-purpose and requires services (typically private sector) to advise farmers on best system.

Private Sector market

- Optimal operation and maintenance of SPIS requires a certain degree of technical knowledge and skill, so farmers need to be trained and services (extension services or private service suppliers) need to be available.
- Development of technical specifications and standards that can support government authorities in the preparation of tender documents and help manufacturers to work towards common goals. When widely accepted, technical standards can contribute to lower production costs, reduce installation time and facilitate repair. Standards also foster fair and transparent competition, as all actors in the market must play by the same rules. Is Liberia ready for that? List of recommendations.
- Creation of a certification scheme could help to guide end users in choosing the most reliable product and service provider for their situation. Planning, design and installation should follow acceptable standards and after-sales service should be guaranteed. Otherwise, farmers feel insecure about what manufacturer, what configuration and what specifications are needed and where compromises between cost and quality considerations can be made, if any. If systems fail, farmers quickly lose trust in the technology and abandon it.

Activity 6.3 Organize a workshop with municipal and national officers to present the M&E and enabling environment roadmap A workshop will be organized in the capital or in the county (to be defined) in the presence of the national and municipal relevant officer, including the ministry of agriculture, ministry of environment, of water use and protection, NDA, NDE, and other relevant stakeholders. During this workshop the "enabling environment roadmap" will be presented, and discussed, as well as the relevancy and objectives at stake of the Monitoring and Evaluation framework. Following this meeting, possible amendments on the respective documents will be done.															
Activity 6.4 Train rice farmers on the M&E framework The owner of the pilot area as well as all the rice farmers of the selected county of Liberia will be trained to the M&E framework, the objective, purpose, mission, goal of such reporting and how this tool could help them improve their use of the system and increase the SPIS lifetime. It is expected that the training will be held in the county and will last 2 to 3 hours in presence of at least one international consultant.															
Deliverables															
6.1 M&E Framework														X	
6.2 Enabling environment roadmap														X	
6.3 Minute of workshop with the municipal and national officers													X		
6.4 Minute of the training with the rice farmers on the M&E framework													X		

4 Resources required and itemized budget:

Maximum budget for this project is 250,000 USD.
Maximum budget for the small-scale pilot project is 37,500 USD.

Activities and Outputs	**Input: Human resources** *(Title, role, estimated number of days)*	**Input: Travel** *(Purpose, national vs. international, number of days)*	**Inputs: Meetings and events** *(Meeting title, number of participants, number of days)*	**Input: Equipment and resources** *(Item, purpose, buy/rent, quantity)*	**Estimated cost (US $)** *Please indicate the cumulative cost of the activities and outputs and provide an estimated cost range for each activity and the entire Response Plan.*	
					Minimum	**Maximum**
Mandatory Output: Development of the work plan and related communication documents	I1: 9 N1 : 15 N2: 2	None	None	None	7,000	7,600
Output 1: Analyse the current irrigation and rice cultivation practices in Liberia	I1: 25 I2: 16 I3:11 N1: 25 N2: 6	Inception meeting (Activity 1.2)	Stakeholder Working Group (WG) meeting 1 (Activity 1.2): participation of 10 members of the WG at 100 USD/person.	None	25,000	29,000
Output 2: Design appropriate irrigation and solar water pumping technologies for SRI based farming in the selected county	I1: 20 I2: 20 I3:25 N1: 25 N2: 5			None	25,000	28,000

Output 3: Select appropriate SPIS technology	I1:20 I2: 2 I3: 30 N1: 20 N2: 4		Stakeholder Working Group (WG) at 1.500 USD and participation of 10 members of the WG at 100 USD/person.	None	35,000	37,200
Output 4: Pilot a small-scale implementation of the solar pumping system in the selected county of Liberia	I1: 17 I2: 11 I3: 11 N1: 12 N2: 4		Stakeholder Working Group (WG) meeting held online and participation of 10 members of the WG and the 2 international experts at 100 USD/person	Purchase of the material	63,000	67,400
Output 5: Elaborate and disseminate training's materials and workshops	I1: 20 I2: 2 I3: 26 N1: 30 N2: 6	2 international experts travelling for activity 5.2; 2 international experts travelling for activity 5.3; and local participants for activity 5.2;5.3 and 5.4 at 100USD /day	learn by doing workshop + stakeholder consultation workshop + training to Municipal and National officers	None	40,000	46,100
Outcome 6 : Formulate an enabling environment roadmap and M&E framework	I1: 65 I3 : 10 N1: 30	Team leader travelling for 6.2 and 6.3	workshop with municipal and national officers to	None	30,000	34,700

	N2: 10		present the M&E and enabling environment roadmap + training to rice farmers			
Estimated cost range for the entire Response Plan (US$)					**225,000**	**250,000**

5 Profile and experience of experts

Experts required	Brief description of required profile
International experts	
Team leader and expert in water irrigation for agriculture	- Team Leader and expert in water agriculture and irrigation - Master's in agriculture, water management, climate change adaptation, agriculture engineer, or similar. - At least 10 years of experience in the nexus agriculture, irrigation, food security. - At least 5 references demonstrating experience in the design and implementation of irrigation system in developing countries. - Experience in capacity building, organizing workshops and capacity building - Experience in managing complex projects in the presence of various stakeholders. - Previous experience in Africa or in Liberia will be valued.
Expert in rice production and SRI	• Master or above in agriculture, food production, agronomist, agriculture engineer, or affiliate • Minimum of 10 years' experience in food production in developing countries • At least 5 references in the SRI production scheme. • Experience in capacity building. • Previous experience in Africa will be valued.
Expert in solar irrigation pumping system	• Master or above in solar energy, solar irrigation system, water management, agricultural engineer, food production, or affiliate • Minimum of 10 years' experience in irrigation for agriculture purposes • At least 5 references in designing solar water pumping systems in developing countries. • Experience in capacity building. • Previous experience in Africa will be valued
National experts	
Rice production expert (N1)	- Master or above in agriculture, food production, water management, agricultural engineer or affiliate - Minimum 8 years' experience in water management in Burundi or in the East Africa. - At least 5 experiences in rice production in Africa. - Presence in Liberia desired or availability to travel frequently and for long periods.
Gender expert (N2)	- Sociologist, anthropologist, gender management graduate or affiliate. - Minimum 8 years of experience in carrying out socio-economic surveys. - Gender experience in the context of water management, food production, food safety, agriculture or similar. - At least 5 references in Africa.

	- Presence in Liberia desired or availability to travel frequently and for long periods.
Communication expert (N3)	- Journalist, master or above in communication, or affiliate - Minimum 8 years of experience in developing communication documents, capacity building presentations about sustainability or environment, agriculture, food security, Climate Change or affiliate - At least 5 references of trainings, workshops, capacity building on environment, sustainability, climate change, water, agriculture, food security or similar in Burundi. - Presence in Liberia desired or availability to travel frequently and for long periods.

6 Intended contribution to the expected impact of the technical assistance

Liberia as a country has not fully developed irrigation technology for integration into the agriculture sectors. However, from the Technology Needs Assessment, the country has identified and prioitized it as the number 5 technology for the agriculture sector. The technology has the following benefits;

- It guarantees yields of agricultural crops in an increasingly dry climate
- It reduces water and energy consumption for irrigation needs in agriculture
- Irrigation serves as an important tool for ensuring yields in increasingly dry climatic conditions of Liberia when lack of natural moisture of the soil will only grow in the future.
- Irrigation is the most climate-sensitive use of water. The yields and profitability of irrigated land relative to dryland farming tend to increase as conditions become hotter and drier. Currently, due to the change in farming calendar in Liberia as a result of prolong sunshine, most famers are moving to lowland as was reported (EPA, 2019).
- It reduces the water consumed for irrigation as an adaptation to climate change
- It promots three to four seasons of rice cultivation

Liberia is looking into adopting irrigation for intensified rice farming so as to increase rice yields in the country while lowering the water usage. The water usage will be decreased by applying crop targeted drip irrigation thus ensuring sustainable use of the available surface or ground water resources. Due to the high cost of electricity the irrigation practice is to be coupled with solar powered water pumping systems.

7 Relevance to NDCs and other national priorities

Under Liberia's National Adaptation Plan (NAP), several works have been done to identify and fine solutions in addressing the threats posed by Climate change. One such effort was the climate risk and vulnerability assessment that developed action plan for the agriculture sector. Besides, the ongoing Technology Needs Assessment for the agriculture sector however complements other national initiatives in addressing the problem of Climate change.

The project is aligned with:

Agenda for transformation (AfT, 2013)
National Policy and Response Strategy on Climate Change (NRSCC,2018)
Coastal Add-On project (CAP)
National Environmental Policy of Liberia (2003)
National Disaster Management Policy of Liberia (2012)
National Adaptation programme of Action (NAPA, 2008)
INDC
NDMA Nation hazard contingency plan

8 Links to relevant parallel activities:

Under Liberia's National Adaptation Plan (NAP), several works have been done to identify and fine solutions in addressing the threats posed by Climate change. One such effort was the climate risk and vulnerability assessment that developed action plan for the agriculture sector. Besides, the ongoing Technology Needs Assessment for the agriculture sector however complements other national initiatives in addressing the problem of Climate change.

System of Rice intensification (SRI) was introduced in Liberia in late 2012 through the farmer union network (FUN) on trial basis. It was not until January 2014 that "Improving and Scaling up the System of Rice Intensification in West Africa" (SRI-WAAPP) began in Liberia. In 2016 there was a project financed by the Japanese and Ministry of Agriculture (MOA) to promote SRI in 5 counties in Liberia,

namely Grand Bassa, Bomi, Grand Cape Mount, and Montserrado. There have been efforts to improving food security in the country through rice production, processing and marketing through the Liberian rice campaign held in April 2019. However there haven't been sufficient efforts to boost irrigation especially renewable energy powered rice irrigation

Liberians eat rice as a staple food, and The World Bank has been promoting a new rice variety in has a three-month growing period, plus the prospect of increased yields from 2 tons/hectare to about 4–5 tons/hectare in the lowlands, which many farmers consider a new era for rice production in Liberia. This has created a lot of hope. This TA would build on this effort by seeking to find suitable solar powered irrigation technologies to further boost rice production in the lowlands.

Other relevant projects are the initiatives implemented by Africa Rice Center, Community of Hope Agriculture Project, Climate Resilient Rice Production Project in West AFRICA (RICOWAS). It is expected from the implementer to connect with these initiatives as this TA is complementary to these ongoing projects.

9 Anticipated follow-up activities after this technical assistance are completed:

It is expected that, following this TA implementation, the SPIS small-scale pilot project will be maintained operational, and that the enabling environment roadmap and M&E framework would be considered by Liberia as steps to be undertaken to promote solar pumping irrigation system to the country in a sustainable way. Solar irrigation pumping systems are complex and needs to be defined as a fit for purpose mechanisms. SPIS is a technology that requires maintenance and the existing market conditions. This TA has been drafted to drive Liberia to this enabling environment.

10 Benefits in terms of gender and co-benefits:

Imbedded into the design of the activities:	Access to water is a primary concern and challenge for many rural households, whether for drinking and domestic use, or irrigation and livestock use. With climate change driving changing rainfall patterns in many rural geographies, access to small-scale irrigation systems is becoming an increasingly important tool for reducing farm production risks and improving the well-being of small-scale farmers. But not all farmers are able to access the benefits these systems provide—women in particular are often left out of the picture. Therefore, this technical assistance will set a specific focus on challenges and barriers for women and youth. Small-scale irrigation systems and solar water pumping in rice cultivation have various other co-benefits, including higher yields which lead to an increased food security and the improvement of livelihoods of local communities.
Gender and co-benefits of the activities:	Past experiences show that there are significant benefits of solar pumping solutions for women. It allows the women farmers to become net producers , generate income from market sales and substantially increase their household nutrition intake and food security (Burney et al., 2009). Also, gender characteristics play an important role in terms of energy decision-making (IRENA, 2016).

11 Main national stakeholders in the implementation of the technical assistance activities:

National Stakeholder	Function in the implementation of the technical assistance
NDE - Ministry of Agriculture	Support, supervision, quality check, connection to relevant stakeholders (from public and private sectors), member of the stakeholder working group
NDA	Support, supervision, quality check, connection to relevant stakeholders (from public and private sectors), member of the stakeholder working group
Environmental Protection Agency (EPA)	Stakeholder
Ministry of Mines and Energy (MME)	Stakeholder
Project Proponent	Support, supervision, quality check, connection to relevant stakeholders (from public and private sectors), member of the stakeholder working group
Energy, Environment and Climate Change Advisor to the President of Liberia	Stakeholder – possibly member of the stakeholder working group
Heads of Standing Committees on Environment and Natural Resources of the Senate and the House of Representatives	Stakeholder
WASH Commission	Stakeholder – possibly member of the stakeholder working group
Community Youth Empowerment (CYE)	
Ministry of Gender, Children and Social Protection (MoGCSP)	Stakeholder – possibly member of the stakeholder working group
Ministry of Internal Affairs (MIA) Alliance Consulting Engineers (ACE)	Stakeholder
University of Liberia	Stakeholder
Ministry of Commerce and Industry (MoCI)	Stakeholder
Initiative for Youth and Children Advancement (I-IYOCA)	Stakeholder
City Council of the selected county	Stakeholder – possibly member of the stakeholder working group
Rice Farmers cooperation/Union	Stakeholder – possibly member of the stakeholder working group
Others to be defined during the mapping of stakeholders	

12 Contribution to the SDGs:

Goal:	Sustainable Development Goal	Direct contribution from CTCN TA
1	End poverty in all its forms everywhere	Yes, the project aims at improving rice production through SRI and solar water pumping irrigation. Liberia is dependent on agriculture to ensure its food security. Better irrigation systems can also improve the quality of life of farmers.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Yes, the project aims at improving rice production through SRI and solar

		water pumping irrigation. Liberia is dependent on agriculture to ensure its food security. Better irrigation systems can also improve the quality of life of farmers.
3	Ensure healthy lives and promote well-being for all at all ages	
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
5	Achieve gender equality and empower all women and girls	This TA includes gender in all the outcomes.
6	Ensure availability and sustainable management of water and sanitation for all	The solar pumping irrigation system, if correctly managed, enables a better and more efficient use of the water.
7	Ensure access to affordable, reliable, sustainable, and modern energy for all (consider adding targets for 7)	Solar pumping systems are also related to RE as they work with solar energy.
	7.1 - By 2030, ensure universal access to affordable, reliable and modern energy services	
	7.2 - By 2030, increase substantially the share of renewable energy in the global energy mix	Yes, it will increase the share of solar energy produced.
	7.3 - By 2030, double the global rate of improvement in energy efficiency	
	7.a - By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	Solar pumping will be a new technology introduced in Liberia as it is not very common at this stage.
	7.b - By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support	
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	
10	Reduce inequality within and among countries	
11	Make cities and human settlements inclusive, safe, resilient and sustainable	
12	Ensure sustainable consumption and production patterns	
13	Take urgent action to combat climate change and its impacts	
	13.1 - Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	Beneficiating from an irrigation system is a way to increase the resilience of the populations at times

		of drought and ensure food security as well.
	13.2 - Integrate climate change measures into national policies, strategies and planning	An enabling environment roadmap and M&E framework will be drafted.
	13.3 - Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	Many trainings are planned to ensure that national and municipal officers are trained to SPIS as well as rice farmers.
	13.a - Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	
	13.b - Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities	Yes, a roadmap will be designed, taking into consideration gender and youth, to support the scale up of the technology.
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	

13 Classification of technical assistance:

Please tick the relevant boxes below	Primary	Secondary
☐1. Decision-making tools and/or information provision	X	
☐2. Sectoral road maps and strategies	X	
☐3. Recommendations for legal reforms, policies and regulations		X
☐4. Financing facilitation		X
☐5. Private sector engagement and market creation		X
☐6. Research and development of new technologies		X
☐7. Feasibility of technology options	X	
☐8. Piloting and deployment of technologies in local conditions	X	

☐9. Technology identification and prioritization	X	

Please note that all CTCN technical assistance contributes to strengthening the capacity of in-country actors.

14 Monitoring and evaluation process

Upon contracting the implementing partners to implement this Response Plan, the lead implementer will produce a monitoring and evaluation plan for the technical assistance. This monitoring and evaluation plan must include specific, measurable, achievable, relevant, and time-bound indicators that will be used to monitor and evaluate the timeliness and appropriateness of the implementation. The CTCN Technology Manager responsible for the technical assistance will monitor the timeliness and appropriateness of the Response Plan implementation. Upon completion of all activities and outputs, evaluation forms will be completed by the (i) THE COUNTRY on overall satisfaction level with the technical assistance service provided; (ii) the Lead Implementer on the experience and knowledge gained through the technical assistance; and (iii) the CTCN Director on the timeliness and appropriateness of the activities and outputs.

Abbreviations and acronyms

CFC	Climate Finance Centre
CIS	Commonwealth of Independent States
CTCN	Climate Technology Centre and Network
EBRD	European Bank for Reconstruction and Development
EU	European Union
GCF	Green Climate Fund
GHG	Greenhouse Gases
HVAC	Heating, Ventilation and Air Conditioning
NDA	National Designated Authority
NDC	Nationally Determined Contribution
NDE	National Designated Entity
SNiP	Construction Norms and Regulations of the Soviet Union
TA	Technical Assistance