

Country	Djibouti, Ethiopia, Kenya, Tanzania, Uganda and Rwanda
Request ID	
Title	Technical assistance to identify the most suitable direct use applications and technologies in low to medium temperature geothermal systems in six African countries
NDE	<ul style="list-style-type: none"> - NDE Djibouti: Idriss Ismael Nour - Email: distri_play@yahoo.fr - NDE Ethiopia: Ms. Yamelakesira Tamene Bekele - Email: yamelakesira516@gmail.com - NDE Kenya: Mr. Kelvin Khisa - Email: kelvinnamukhasi@gmail.com kelvin.khisa@kirdi.go.ke - NDE Tanzania: Dr. Gerald Majella Kafuku - Email: kafukugm@gmail.com gkafuku@costech.or.tz - NDE Uganda: Mr. Maxwell Otim Onapa - Email: m.onapa@uncst.go.ug - NDE Rwanda: Faustin Munyazikwiye - Email: fmunyazikwiye@rema.gov.rw
Proponent	<ul style="list-style-type: none"> - Uganda Ministry of Energy and Mineral Development (MEMD) - Tanzania Geothermal Development Company Limited (TGDC) - Energy development Corporations Ltd – Rwanda - Kenya Electricity Generating Company PLC, Geothermal Development Division - Ethiopian ministry of Mines and petroleum, geological surveys-- Geothermal Resources Directorate - Djibouti office of geothermal development

Summary of the CTCN technical assistance

The technical assistance for direct use of geothermal energy in low to medium temperature geothermal systems was requested by six (6) African countries \ countries in the Eastern Africa region¹ The countries lie within the Great East African Rift Valley (both at the eastern and western branches), a region that possess a remarkable geothermal energy resource potential that can be used for power generation and direct use application.

The technical assistance aims at identifying the resource and its viability of geothermal direct use as well as identification of the most suitable technologies for the resources direct use implementation. This will aim to support the countries to further advance their climate commitments as geothermal energy has great contribution to make in energy sector decarbonization.

The region, save for Kenya and slightly Ethiopia, has been slow in taking advantage of the resource

¹ The countries; Djibouti, Ethiopia, Kenya, Tanzania, Uganda and Rwanda are part of the UN Environment African Rift Geothermal Development Facility (ARGeo) Project whose aims is to support development of the large untapped geothermal resource potential in region with the main objective of reducing the risks associated with the resource's exploration as well as reduce greenhouse gas (GHG) emissions by promoting the adoption of geothermal energy in the region.

27.

in terms of what-Power generation or direct use. The main challenges attributed to this slow uptake being limited financial, technical expertise and inadequate policy and legal framework to guide the energy sector². Most of the countries however have conducted various surface exploration of the geothermal resources. These studies include inventories of potential geothermal resources sites and geoscientific studies to establish existence of viable geothermal systems for direct and indirect utilization. The technical assistance is thus expected to take advantage of these pre-existing data and information.

As the region struggles with low access to energy, harnessing geothermal resources for direct use is seen as a measure that will greatly impact the livelihoods of local communities with strategic geographic advantage. Among the envisioned long-term impact of the technical assistance is the enhanced community resilience and improved livelihood. The thermal energy can be a solution to tackle issues such as post-harvest loss attributed to lack of energy. Energy access in the local areas could spur establishment of industries such as agro- processing plants that would lead to value addition hence improved income through better prices for agriculture products and employment opportunities. Geothermal energy as an example of renewable energy also offers important option that results to climate change mitigation benefits by abating the emissions of greenhouse gases. Geothermal is energy climate proof. It is thus seen as a key solution to the inventory detailing region as the pre-dominant hydropower, which a huge contributor to the region energy mix, is highly vulnerable to climate factors that results to reduced water flow where climate change is seen to exacerbate the situation.

The main objective of this assistance will be to conduct a study on direct use applications of geothermal energy. The assistance is expected to deliver the following key outputs;

Output 1	• Development of implementation planning and communication documents
Output 2	• Identification of the most suitable direct use applications that will improve livelihoods of communities in specific geothermal localities
Output 3	• Identification of direct use geothermal energy harnessing technologies
Output 4	• Market and economic assessment on viability of the identified technologies
Output 5&6	• Capacity building on the identified technologies and technology validation

Among the activities to be implemented through this assistance will ensure strengthened capacity of national geothermal experts through training and regional knowledge sharing. Involvement of various stakeholders to identify the best direct use projects that would be economically viable for the identified sites within the six countries. The main activities of the CTCN technical assistance will include:

- Conduct a comprehensive assessment and analysis of data and information available at national level on geothermal energy specifically relevant too low to medium temperature geothermal systems
- Identify the gaps that could be useful for developing the Low to medium temperature

² According to East Africa geothermal outlook on perspective of geothermal development, (International geothermal Association) 2018

af.



assessment

- Identify, evaluate and formulate a series of recommendations for appropriate technological options to be implemented to harness the geothermal energy for the identified direct use.
- Organize and conduct a regional training session for national geothermal technical experts on practical application of the direct use of geothermal energy and on the technologies identified;
- Develop a tool and guideline for use of geothermal resources to direct use application (whole value chain).
- Description, analysis, and comparison of the environmental sound available technologies, as well as identification of the best option for geothermal utilization
- Conduct a comprehensive analysis of environment forces, market trends, entry barriers, competition, risks, opportunities the direct use projects
- Conduct an evaluation of expected costs of the identified direct use projects

In terms of results and in the short term, the implementation of the assistance will see accelerated efforts in the region to utilize geothermal energy. The pre-feasibility study will inform the decision makers on the resources viability and develop a clear and harmonized policies and means of implementation that leads to action.

Agreement:

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

**National Designated Entity to the UNFCCC
Technology Mechanism**

Name: Faustin MUNYAZIKWIYE

Title: Deputy Director General
Rwanda Environment Management
Authority (REMA)

Date: 29 August 2019

Signature:



Proponent (signature of the Proponent is optional)

Name: Felix GAKUBA

Title: Managing Director

Date: 30/08/2019

Signature:



UNFCCC Climate Technology Centre and Network (CTCN)

Name:

Title:

Date:

Signature:



1. Background and context

1. Common to the requesting countries is the need for the energy transition that focusses on: decarbonization, decentralization, democratization and de-risking investment. This is in response to the Global and continental development policy processes: SDG 2030, Paris agreement 2015 and AU Agenda 2063, It is also in line with the countries National Determined Contribution's (NDC's) where they pledged to generate their power and heat from renewable energy resources including geothermal. Despite most African countries GHGs emission being not significant compared to the global emissions rates. The countries are committed to adopting a low carbon path, with the energy sector being of key focus in the countries mitigation efforts.
2. Decarbonization of the energy sector requires wide adoption of Renewable energy. Geothermal thus offers such alternatives. Geothermal involves no combustion, and most geothermal plants being developed produce near zero air emissions. So, using geothermal helps to offset energy related GHGs. Geothermal energy has several significant characteristics that make it suitable for climate change mitigation. These include global-wide distribution; indigenous resource; production independent of season; immune from weather effects and climate change impacts; effective for on and off grid developments and for provision of base-load power.
3. Energy security is a major issue that these developing countries are struggling with. Energy access remains relatively very low with the population in rural areas being least covered. There is also high dependence to biomass across these nations exacerbating the issue of deforestation and as well as having adverse effects on human health. The countries have hydro power as a great part of their energy mix which is facing sustainability challenges with the current effects of climate change and landscapes & ecosystems degradation causing water stress. This is thus leading to widespread dependency on diesel power generators. Constant fluctuations on fossil prices also increases the vulnerability of the energy sector.
4. The requesting countries fall under the East African Rift system which is part of the large Afro Arabian Rift system going from the Red sea to Mozambique. When the rift leaves the Ethiopian segment, it bifurcates into the eastern and western branches which later rejoins in Tanzania. The eastern branch possesses a high temperature geothermal system suitable for both power production and direct use application. On the other hand, the western branch countries endowed low to medium temperature systems that are more favorable for direct use application.
5. Geothermal energy is at present gaining credibility in Eastern Africa with large size power plants producing electricity and feeding the national grid. In Kenya, about 673 MWe Power is generating from geothermal resources and Ethiopia has a geothermal pilot power plant of 7 MWE. A number of other projects are also emerging in various Eastern Africa countries. This is due to the quality of the natural resource in the Rift Environment and to the regional facilities and procedures implemented during the last few decades which progressively prove their effectiveness.
6. The undergoing development (although efficient and eventually spectacular) however, leave



aside a good number of people, notably the poorest, with infrastructure eventually passing “over their heads”, when resettled by force. This unsustainable approach appears as a paradox when observing that the geothermal resource in the region is in fact located along the rift floor, in low land areas, which are dryer, and where these generally pastoralist, eventually indigenous people live. Heavily affected by climate change, they are more and more affected by draught and fa mine.

7. As a matter of fact, geothermal do not only allow to produce electricity for the grid, but also allows for small size users at community level. This includes production of water, sanitary or agronomy applications and diversified energy uses at various levels (including thermal and electricity). Such devices (these direct systems) are the most developed worldwide, however, it is not widely known in Africa for lack of information and technology transfer.
8. Direct use of geothermal resources highly depends on the local geothermal resources and the local situations. This entails the type of economic activates the locals are involved as a source of livelihood. This guide the determination on the right application for direct use of the resources. Apart from the traditional application of direct use of geothermal resources which include, balneotherapy and cooking wider application of geothermal energy is still relatively low, and its potential remains largely untapped.
9. Currently there are numerous studies that have been conducted regarding geothermal resources in the region, the kind of studies include geoscientific exploration establishing the spatial occurrence and determination of the resource characteristics and temperature *** of the sites.to take this a step further in utilization of this resource there is need for feasibility studies to establish the most applicable direct use projects as well as certain the economic and market viability of the resources
10. It is with this background that this TA aims to identify the potential direct use application and the most suitable technologies that can be used for geothermal utilization. It will also establish the economic and market viability of the identified direct use projects.
11. Access to energy is widely seen as a key element in poverty reduction through enhanced community livelihoods an important goal of the Sustainable development goals (SDGs). It is envisioned that the local communities around the geothermal resources would benefit from the access to energy that can support local industries. For instance, industries that would spur value addition of their locally produced products. This would enable their products to attracted high markets values and thus enhanced livelihood. The increased energy access will thus give rise to new opportunities and drive diversification of livelihood. Utilization of the direct thermal energy in agriculture sectors such as crop drying also present a much need solution to tackling the post-harvest loss.

2. Problem statement

Availability of geothermal energy resources in these Eastern Africa region is promising for power generation and development of direct use projects. This region plans to utilize the opportunities emanating from geothermal energy which include power generation and direct use applications as it the case with Kenya which is leading the way in terms of geothermal power production. Use of these resources is highly prioritized due to its importance in bridging the energy demand gap. Most



countries have conducted pre-liminary geoscientific studies to map the potential sites* and their respective temperature ranges.

In order to drive this further it is therefore imperative to have wider understanding regarding opportunities for direct use projects from technical, financial, market viability perspectives. Understanding of these opportunities will help to make informed decisions regarding the direct use opportunities to develop and utilize. Further, implementation of direct use projects has direct impacts to the community in terms of livelihood income generation and job creation. This in turn is expected to contribute to the national efforts of resilience to climate change.

Participation of these regional countries to the global efforts to mitigate climate change provides an opportunity for them to also build climate resilience and promote sustainable economic growth. Direct utilization of geothermal resources will cut down on the emission of GHGs by reducing over-reliance on biomass and fossil fuels. Geothermal energy is one of the few renewable sources of energy able to produce steady power on a 24-hour basis which means countries can depend less on imported fuels and increase their energy security. Being a cleaner source of electricity, geothermal energy will thus play a major role in decarbonizing the power sector.

Population in this region relies heavily on agriculture and agro-industry as the predominant economic activities. However, a common challenge they face is the potential damage to agricultural produce occasioned by poor processing techniques of agricultural products which has resulted to post-harvest losses, whose result is famine and increased levels of poverty. In addition, poor harvests are being recorded because of the erratic and unpredictable weather patterns. Additionally, there is a danger on the stock of fish in our water bodies due to overfishing. Enhanced fish farming practices using direct use application of geothermal resources will reduce the strain on fishing in our lakes. Fish drying using charcoal and biomass contributes significantly to GHG emissions. Deployment of geothermal resources for similar practice will reduce biomass used for this purpose

There is immense untapped potential for direct use application of geothermal resources in the country's key sectors of Agriculture, Manufacturing and Tourism. This is broadly attributed to limitations in finance, personnel's capacity and therefore, this technical assistance will help to map out all the possible direct use opportunities and the relevant technologies capable of being supported by the vast geothermal resources, for the betterment of the lives of communities living around these geothermal prospects.

3. Logical Framework for the CTCN Technical Assistance:

<p>Objective: The main objective of this assistance will be to conduct a review on low to medium temperature geothermal systems for direct use applications.</p> <p>Outcome: The assistance will promote use of geothermal energy in low to medium temperature geothermal systems whose expected outcome is to bridge the energy demand gap for productive uses especially in the rural areas whose population key challenge is access to energy and energizing agricultural and relevant products for food security, education, health etc... In this sense this TA will enhance community resilience as well as contribute towards climate change mitigation through provision of low cost, clean and environmentally friendly energy.</p>										
<p>Output 1: Development of implementation planning and communication documents</p> <p>Activity 1: All implementers must undertake the following activities at the beginning and at the end of the CTCN technical assistance.</p> <ul style="list-style-type: none"> (i) A detailed work plan of all activities, deliveries, outputs, deadlines and responsible persons/organisations and detailed budget to implement the Response Plan. The detailed work plan and budget must be based directly on this Response Plan; ii) Based on the work plan, a monitoring and evaluation plan with specific, measurable, achievable, relevant, and time-bound indicators used to monitor and evaluate the timeliness and appropriateness of the implementation. The monitoring and evaluation plan should apply selected indicators from the Closure and Data Collection report template and enable the lead implementer to complete the CTCN Closure and Data collection report at the end of the assignment (please refer to item iv below and section 1.4 in the Response Plan); iii) A two-page CTCN Impact Description formulated in the beginning of the technical assistance and update/revised once the technical assistance is fully delivered (a template will be provided); iv) A Closure and Data Collection report completed at the end of the technical assistance (a template will be provided). 	1	2	3	4	5	6	7	8	9	10

<p>Deliverable 1:</p> <ul style="list-style-type: none"> - Detailed work plan - Monitoring and evaluation plan - CTCN Impact Description - Closure and Data Collection report 		<p>Output 2: Identification of the most suitable direct use applications in low to medium temperature geothermal systems that will have climate impacts and improve livelihoods of communities in specific geothermal localities</p>		<p>Activity 2.1: Review of existing low to medium temperature geothermal systems resource assessment and Identify gaps in data & information and select the suitable sites and or validate the suitability of selected sites. This will also include a review of any existing direct use of the resources (if any).</p>		<p>Activity 2.2: Stakeholders consultation, to include but not limited to, local communities, national geothermal practitioners, local and national authorities. This will map the livelihood and economic activities and will help to analyse and categorize possible opportunities for direct utilization of the geothermal energy</p>		<p>Activity 2.3: Assess and estimate the local energy demand for productive uses for the local communities in the identified sites -Based on the finding in activity 2.2- (e.g. crop drying, milk pasteurizing, fish farming, beauty therapy, horticulture etc.)</p>		<p>Activity 2.4: Systematic identification of local potential of geothermal direct use projects</p>		<p>Deliverable 2</p> <ul style="list-style-type: none"> - Report on the comprehensive review and analysis of existing data and information on low to medium temperature geothermal resources in the identified specific sites. - A report on stakeholders' identification, engagement and 	
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<p>their contribution</p> <ul style="list-style-type: none"> - A report on local livelihood sources, economic activities with various potential geothermal direct use applications and the climate impacts with estimated local energy demands for the selected sites communities. - A report on the application of the geothermal direct use and the viable projects 									
<p>Output 3: Identification of direct use geothermal energy harnessing technologies</p> <p>Activity 3.1; Select and prioritize the most appropriate technologies for identified geothermal direct use projects. For each technology option selected, the following will be detailed: (i) the description of the technology; (iii) the benefits; (iv) the disadvantages; (v) financial costs and needs; (vi) the institutional and infrastructural capacities required; (vii) factors hindering its implementation; (viii) the factors favoring its implementation; and (ix) a case study.</p>									
<p>Deliverables 3:</p> <ul style="list-style-type: none"> - A report on technology options identified, assessed and considered appropriate for the identified direct use geothermal application. The report should include a preliminary analysis of the various available technology options for direct use application 									
<p>Output 4: Market and economic assessment on Commercial viability of the identified technologies (to test the viability and sustainability of the proposed projects)</p> <p>Activity 4.1; Estimate the expected costs of the identified geothermal energy technology direct use projects</p>									
<p>Activity 4.2; Conducting a cost comparison of the identified geothermal energy technology direct use with conventional systems</p>									
<p>Activity 4.3; comprehensive analysis of environment forces, market</p>									

<p>trends, entry barriers, competition, risks, opportunities the direct use projects (SWOT Analysis)</p> <p>Activity 4.4: Develop business and financial models for selected geothermal technology direct use project projects (a case example)</p> <p>Deliverable 4</p> <ul style="list-style-type: none"> - A Report on the Commercial viability (economic and market feasibility) of the selected geothermal technology direct use projects 	
<p>Output 5: Capacity developed on the procedures for identification of technologies and development of conceptual models of low to medium geothermal systems for direct use application.</p>	
<p>Activity 5:1: Prepare relevant training materials/guidelines from resource assessment to technologies</p> <p>Activity 5:2: Implementation of the training. The training will target national technical staff working in the field of geothermal and preferably on the direct use. In this regard 2 experts from each of the 6 requesting countries will be selected. The aim will be to enhance their technical knowledge of the use of various geothermal technologies for direct use projects. A case studies/example of the identified projects will be used as a reference for training materials. The CTCN NDE and the GCF NDA will also be invited to increase ownership and discuss follow-up actions</p>	
<p>Deliverable 5:</p> <ul style="list-style-type: none"> - Guidelines on tools and methods for geothermal resources assessments for direct use application (whole value chain- from resources assessment to technology identification to project designs). - A report on the training of geothermal technology direct uses. 	
<p>Output 6: Validation workshop on the results of the Technical assistance</p>	



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<p>Activity 6.1 conduct a final regional Validation workshop of the results of the technical assistance at the end of the technical assistance, a final validation workshop will be organized in Nairobi for the presentation technical assistance results. The workshop will target decision makers from the six countries, regional and local partners involved in this sector.</p>			
<p>Deliverable 5</p> <ul style="list-style-type: none"> - Validated final Report of the technical assistance. 			

4. Resources required and itemized budget:

Activities and Outputs	Input: Human Resources (Title, role, estimated number of days)	Input: Travel (Purpose, national vs. international, number of days)	Inputs: Meetings/events (Meeting title, number of participants, number of days)	Input: Equipment/Material (Item, purpose, buy/rent, quantity)	Estimated cost Please accumulate the costing at Activity and Output level and provide an estimated costing range for each activity and the total Response Plan	
					Minimum	Maximum
Output 1: Development of implementation planning and communication documents	6-person days @500				3000	
Output 2: Identification of the most suitable direct use applications in low to medium temperature geothermal systems that will have climate impacts and improve livelihoods of communities in specific geothermal localities						
Activity 2.1; Review of existing low to medium temperature geothermal systems resource assessment and Identify gaps in	Direct use Engineer; 15 days@500				7500	



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<p>data & information and select the suitable sites and/ or validate the suitability of selected sites. This will also include a review of any existing direct use of the resources (if any).</p>						
<p>Activity 2.2: Stakeholders consultation, to include but not limited to, local communities, national geothermal practitioners, local and national authorities. This will map the livelihood and economic activities and will help to analyze and categorize possible opportunities for direct utilization of the geothermal energy</p>	<p><i>Senior Geothermal expert 12 days@500</i></p>	<p><i>Travel cost for an international expert at 3,000 per country (3000*6)=18000</i></p>	<p><i>There will be 6 events (one event per country); at cost of 2000 per event. This cost is to facilitate the NDE/proponent to organize for the stakeholders meeting venue/meals and stationeries needed (2000*6)=12000</i></p>			<p><i>36,000</i></p>
<p>Activity 2.3: Assess and estimate the local energy demand for productive uses for the local communities in the identified sites -Based on the finding in activity 2.2- (e.g. crop drying, milk pasteurizing, fish farming, beauty therapy, horticulture etc.)</p>	<p><i>Direct use Engineer -12 days Senior Geothermal expert (review the deliverable of this activity) – 3 days Total no. of days 15</i></p>					<p><i>7500</i></p>

<p>Activity 2.4; Systematic identification of local potential of geothermal direct use projects</p>	<p><i>days@500</i></p> <p><i>Direct use Engineer (8days)</i></p> <p><i>Senior Geothermal expert (2days)</i></p> <p><i>Total no;10 days@500</i></p>			<p>5000</p>
<p>Output 3: Identification of direct use geothermal energy harnessing technologies</p>				
<p>Activity 3.1; Select and prioritize the most appropriate technologies for identified geothermal direct use projects. For each technology option selected, the following will be detailed: <i>(i)</i> the description of the technology; <i>(iii)</i> the benefits; <i>(iv)</i> the disadvantages; <i>(v)</i> financial costs and needs; <i>(vi)</i> the institutional and infrastructural capacities required; <i>(vii)</i> factors hindering its implementation; <i>(viii)</i> the factors favoring its implementation; and <i>(ix)</i> a case study.</p>	<p><i>Direct use Engineer (30days)</i></p> <p><i>Financial Analyst (5 days)</i></p> <p><i>Senior Geothermal expert (3 days)</i></p> <p><i>Social scientist- gender expert (2 days)</i></p> <p><i>Total no of days=40 days@500</i></p>			<p>20000</p>
<p>Output 4: Market and economic assessment on Commercial viability of the identified technologies</p>				
<p>Activity 4.1; Estimate the expected costs of the identified geothermal energy technology direct use projects</p>	<p><i>Direct use Engineer, (10 days)</i></p> <p><i>Financial Analyst (10 days)</i></p>			<p>10000</p>



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<p>Activity 4.2; Conducting a cost comparison of the identified geothermal energy technology direct use with conventional systems</p>	<p><i>20 days@500</i> <i>Direct use Engineer (8 days) Financial Analyst (12 days)</i> <i>20 days@500</i> <i>Direct use Engineer, 7days</i> <i>Senior Geothermal expert 7days</i> <i>Financial Analyst 3days</i> <i>Social scientist- environmental and gender expert-3 days</i> <i>20 days@500</i> <i>Direct use Engineer, 7days</i></p>					<p><i>10000</i></p>
<p>Activity 4.3; comprehensive analysis of environment forces, market trends, entry barriers, competition, risks, opportunities the direct use projects (SWOT Analysis)</p>	<p><i>20 days@500</i> <i>Direct use Engineer, 7days</i> <i>Senior Geothermal expert 7days</i> <i>Financial Analyst 3days</i> <i>Social scientist- environmental and gender expert-3 days</i> <i>20 days@500</i> <i>Direct use Engineer, 7days</i></p>					<p><i>10000</i></p>
<p>Activity 4.4; Develop business and financial models for selected geothermal technology direct use project projects (a case example)</p>	<p><i>20 days@500</i> <i>Direct use Engineer, 7days</i> <i>Senior Geothermal expert 7days</i> <i>Financial Analyst 3days</i> <i>Social scientist- environmental and gender expert-3 days</i></p>					<p><i>10000</i></p>

5. Profile and experience of experts

Experts required	Brief description of required profile
Senior geothermal Expert	The expert should have extensive knowledge on project management and development and should be conversant with conceptual model of low to medium geothermal systems
Geothermal Direct use expert	Mechanical engineer - thermal applications (heat extraction) to various productive uses - cascaded utilization; ORC; Food preservation technology and pasteurization; Agri-industrial processes, aquaculture, greenhouse
Financial/business analyst	With knowledge of energy matter development of business models for community-based projects
Social scientist	With knowledge on; <ul style="list-style-type: none"> - community development focused on geothermal issues - gender mainstreaming and - projects social and Environmental Impact assessments

6. Intended contribution to impact over time

In the short term, as the assistance is expected to test the economic viability of direct use projects in specific sites within the region; availability of such information is expected to accelerate efforts to coordinated and coherent actions that will spur investment to realize to tap into the geothermal potential of this region.

In concrete terms, putting into practice the data, knowledge and skills acquired in the context of the technical assistance provided by the CTCN should allow, in the long term:

- The implementation of geothermal energy direct use technologies appropriates to the identified sites in the requesting 6 countries;
- The continuous updating of the regional and national databases;
- Strengthening the resilience capacity of people living in the project localities as a result of availability of energy that is instrumental in supporting and diversifying their livelihood. This can be envisioned in the following ways
 - o Reduced loss of livelihood e.g. through prevention of post-harvest losses that are mainly attributed to improper drying of the produce
 - o Establishment of local industries such as agro-processing plant that would result to production of agricultural value-added products, hence increased income and employment opportunities
- Greenhouse gases abatement; Geothermal technologies for power generation or direct use operate with little or no greenhouse gas emissions. Geothermal energy development has thus great CO₂emission reduction potential when substituting fossil sources of energy.

7. Relevance to NDCs and other national priorities

Concerns over climate change, the volatility of commodity prices, the need to address energy security and the desire to support economic development through improved provision of clean, reliable and affordable base-load electricity means that geothermal resource development is high on the political agenda for many countries where potential exists. Interest is emerging across East Africa, facilitated by a wide range of donor initiatives, in addition to the uptake in activity in Kenya nascent geothermal programmes are developing in the other countries in the region;

Djibouti

NDC 2015; chapter 1; on national contribution for attenuation strategy and planning-Pg.6 Djibouti is committed to reducing its emissions by up to 60% compared to the business-as-usual scenario (conditional and unconditional part). The NDC identify that nearly 55% of those emissions come from the “Energy” category, making it a priority sector for the implementation of mitigation options (Pg.2). Consequently, Djibouti has prioritized adoption of renewable energy with Geothermal being outline a key Pg.6.

NAPA 2007; provision of access to energy is seen as an enable for effective implementation of the country adaptation strategies

Ethiopia

NDC; plans 64%reduction of GHGs from the BAU scenario by 2030 in this effort it plans to expand electric power generation from renewable energy(pg.2). energy is also seen as key to achieving its adaptation priorities where power generation from geothermal, wind and solar sources to minimize the adverse effects of droughts on predominantly hydroelectric energy sector is targeted (pg.6)

Ethiopian Green Energy - NAMA; whose objective is to develop a rural electrification program, starting with pilot projects using RE mini grids

Other relevant

- The National Adaptation Programme of Action (NAPA) since 2007; The Ethiopian Programme of Adaptation to Climate Change (EPACC2011);
- Climate Resilient Green Economy Strategy (CRGE).
- Climate Change Technology Needs Assessment Report of Ethiopia, 2007

Kenya

Kenya NDC; seeks to abate its GHG emissions by 30% by 2030 relative to the BAU. Expansion in geothermal, solar and wind energy production, other renewables and clean energy options. It also plans to prioritize Clean energy technologies to reduce overreliance on wood fuels. pg. 2

Other relevant

- National Climate Change Response Strategy (NCCRS 2010),
- National Climate Change Action Plan (NCCAP 2013)
- National adaptation plan 2015-2030
- Climate smart agriculture strategies

Rwanda

NDC; key priority areas are low carbon energy mix with a vision to establish new grid connection from renewable energy (pg.16)

TNA and technology Action plans for climate mitigation and adaptation 2012; prioritizes the development of geothermal energy technologies

NAMA 2015; geothermal enlisted among priority renewable energy options for the countries

Tanzania

NDC; makes a commitment to reduce greenhouse gas emissions economy wide between 10-20% by 2030. In both the mitigation and adaptation promotion of clean technologies for power generation are prioritized; and diverse renewable sources such as geothermal, wind, solar and renewable biomass.

Technology Needs Assessment (2016); Identify and priorities low carbon technology needs, which can help Tanzania to meet her energy development needs at the same time mitigating GHG emission. (Chapter 3 page 34&35)

National Adaptation Plans (2007) Improving and increasing clean thermal power generation explore Invest in alternative energy sources, develop community based mini hydropower (Chapter 6 page 27)

Tanzania Climate Change strategy 2012; Improving the energy availability to reduce deforestation, energy, diversification and efficiency of her major energy consuming sectors. Pg. ii).

Low Emissions Development Strategies (2012); Enhancing capacity for low emission development and access to clean energy solutions.

Other relevant document includes; The Renewable Energy Strategy (2014)

Uganda

NDC; increase the amount of renewable energy capacity by at least 1,100 MW compared to business- as- usual by 2030, with priority technologies including hydro, solar, biomass and geothermal.

National Development Plan (NDP); Geothermal resources envisioned to support government's strategic direction as set in the Second National Development Plan (NPD II) and Vision 2040

National Adaptation Plan; renewables including geothermal priority to reducing vulnerability and addressing adaptation

NAMA; key strategy includes to Achieve a total of at least 3,200 Mega Watts renewable electricity generation capacity by 2030, up from 729 MW in 2013.

8. Linkages to relevant parallel on-going activities:

The technical assistance provided by the CTCN will contribute to the implementation and realization of the ongoing effort to harness the geothermal power in the region. This is in order to ensure energy security while ensuring a low carbon development economy is realized. Below are some of the ongoing work in the geothermal field.

EAGER - the East Africa Geothermal Energy Facility - an independent advisory facility established in May 2015 and funded by the UK Department for International Development (DFID). Has been working in the East Africa region with the aim of providing high-quality, on-demand advice to public and private stakeholders involved in developing geothermal energy for power generation in Ethiopia, Kenya, Rwanda, Tanzania and Uganda. Their main work is in Removing policy and regulatory barriers to investment in geothermal power generation in East Africa. To attract private investors interested in developing or financing geothermal projects there must be a transparent legal and regulatory framework in place which address issues such as geothermal resource rights, licensing and concessioning, and is properly enforced. <https://www.adamsmithinternational.com/explore-our-work/east-africa/kenya/enabling-the-development-of-geothermal-energy-in-east-africa/>

African Development Bank (AfDB) is supporting development of geothermal energy in the region. Kenya for instance has received approval from the Climate Investment Funds' Clean Technology Fund (CIF-CTF) for a US \$29.65-million concessional loan to co-finance up to two geothermal projects to increase the country's power capacity, particularly drawing on untapped geothermal resources in the Rift Valley. The programme will build on the energy advancements already underway in the successful development of the country's showcase Menengai Geothermal Field. <https://www.afdb.org/en/news-and-events/kenya-to-tap-into-rift-valley-geothermal-resources-and-strengthen-private-sector-investment-in-renewable-energy-15569/>; this financing is expected to support in; creating a demonstration effect showing that the structure is economically viable for private investors; providing support and building a track record in a nascent market; and Reducing the country's dependence on hydro and thermal power sources by contributing to deployment of up to 70 MW of clean, reliable and base-load renewable power. The program is part of the CTF's Dedicated Private Sector Program (DPSP), designed to finance programs that can deliver development results, impact, private sector leverage and investment at scale and can be deployed rapidly and efficiently.

The Global Geothermal Alliance (GGA) - Launched at COP21, serves as a platform for dialogue, co-operation and coordinated action between the geothermal industry, policy makers and stakeholders worldwide. The GGA is a coalition for action to increase the use of geothermal energy, both in power generation and direct use of heat. It calls on governments, business and other stakeholders to support the deployment of realizable geothermal potential. The Alliance has an aspirational goal to achieve a five-fold growth in the installed capacity for geothermal power generation and more than two-fold growth in geothermal heating by 2030. All the requesting countries save for Rwanda are members of this alliance.

UN Environment – GEF ARGeo project; The African Rift Geothermal Development Facility (ARGeo) Project is a GEF funded project being implemented by United Nations Environment Programme. All the 6 requesting countries are members of this project. It aims at supporting the development of the large untapped geothermal resource potential in the Eastern Africa region with the main objective of reducing the risks associated with the resource's exploration. ARGeo also aims



to reduce greenhouse gas (GHG) emissions by promoting the adoption of geothermal energy in the region. The project has comprehensive program of financial, policy and technical instruments for the promotion of geothermal energy that will directly support the development of viable geothermal energy resources in the African Rift. The project is also designed to actively reduce barriers and to stimulate and facilitate investment through public and private sector partnership through a drilling risk mitigation und, a technical assistance and institutional strengthening program among the activities currently include short course trainings to fill the capacity gaps of East African countries and strengthen the institutional and infrastructural capacities to start execution of surface exploration activities.

MFA-ICEIDA- Regional Geothermal Programme: The Icelandic International Development Agency (ICEIDA) and the Nordic Development Fund (NDF) launched in 2012 a project to support geothermal exploration in East Africa. ICEIDA is the Lead Agency in the Geothermal Exploration Project with joint co-financing of NDF. The project is the initial phase of the Geothermal Compact partnership, initiated jointly by the Ministry for Foreign Affairs in Iceland and the World Bank. The World Bank's Energy Sector Management Assistance Program (ESMAP) serves as the focal point at the Bank for the Compact.

The geothermal potential in Africa is mainly in the East Africa Rift Valley States (EARS) covering 13 countries from Eritrea in the north to Mozambique in the south. The project aims to mitigate and distribute the risk associated with geothermal exploration thus contributing to the acceleration of geothermal development in the region. The main objective of the Geothermal Exploration Project is to assist all EARS countries in completing the exploratory phase of geothermal development and build capacity and expertise in the field of geothermal utilization and related policy. The project support will extend up to the stages of exploratory drilling.

<http://old.iceida.is/english/partner-countries/regional-cooperation/>

New Zealand Africa Geothermal Facility Programme: The New Zealand - Africa Geothermal Facility has been established as a partnership programme between New Zealand and the Africa Union Commission to support and accelerate development of East Africa's geothermal resources. It is implemented under a NZ-AUC Partnership Arrangement, signed at the African Union Headquarters in Addis Ababa, Ethiopia in June 2017. The overall goal of the NZ-AGF is to expand access to affordable, reliable and clean energy in East African nations through the increased use of geothermal energy resources, and targets countries within Eastern and Southern Africa that have identified geothermal potential and are eligible for Geothermal Risk Mitigation Facility funding, specifically: Ethiopia, Kenya, Rwanda, Tanzania, Zambia, Uganda, Eritrea, Djibouti, Comoros, Burundi and Democratic Republic of Congo.

The facility can offer responsive, flexible technical assistance and capacity building services and aims to alleviate barriers to development, improve understanding and regulation of geothermal resources, and progress projects and, de-risk and secure financing for investment. The Facility was established in 2017 and has a budget of NZD\$10 million for operation over a five-year period.

<https://www.mfat.govt.nz/assets/Aid/New-Zealand-Africa-Geothermal-Facility.docx>

US - East Africa Geothermal Partnership Programme: The U.S.-East Africa Geothermal Partnership (EAGP) was established in September 2012 to promote the development of geothermal energy resources and projects in East Africa. It also encourages and facilitates the involvement of the U.S. geothermal industry in the region. The EAGP program is a public-private partnership between the U.S. Agency for International Development (USAID) and the Geothermal Energy Association (GEA) and is implemented by the U.S. Energy Association (USEA). EAGP currently focuses on three priority countries: Ethiopia, Kenya, and Djibouti.

EAGP operates in association with US Power Africa initiative. With the goal of doubling access to power in sub-Saharan Africa, Power Africa will use a wide range of U.S. government tools to

support investment in Africa's energy sector. From policy and regulatory best practices, to pre-feasibility studies and capacity building, to long-term financing, insurance, guarantees, credit enhancements and technical assistance, Power Africa will provide coordinated support to help African partners expand their generation capacity and access <https://www.usea.org/program/EAGP>

In Kenya, the Geothermal Development Company (GDC) has set up a Demonstration Unit in Menengai comprising of four projects; a mini greenhouse and aquaculture utilizing geothermal energy to maximize production and quality of the crops and fish, alongside a Containerized Laundry and Dairy Unit. The main purpose for these units is to showcase to the investors and educate local communities, schools and universities on how Geothermal energy can be used directly, how cascading of energy can be achieved and what actual economic and environmental benefits can be achieved. Currently, data is being collected from the units, after whose compilation actual results shall be produced, which shall be used as reference during the expansion of the projects and the setting up of an industrial heat Park around the geothermal prospects in future. <http://theargeo.org/fullpapers/DIRECT%20USE%20OF%20GEOTHERMAL%20ENERGY-%20AN%20UPDATE%20OF%20THE%20MENENGAI%20DIRECT%20USE%20PILOT%20PROJECT%20IN%20KENYA.pdf>

Other also include the KenGen-Eburru Project on water harvesting.

As the project above demonstrate there has been a lot of focus on geothermal exploitation mainly for electricity generation with a remarkable development seen in countries like Kenya and Ethiopia. It can also be noted that there are initiatives looking into direct use application. This assistance with thus aim at continuing these efforts in identification of the economically viable direct use potential in specific localities as identified by the requesting countries TA as well as identifying the most appropriate technologies for their exploitation.

9. Anticipated follow up activities after this technical assistance is completed:

This technical assistance involves the provision of support to the eastern Africa region to enable it to plan for exploitation of the geothermal resources that is unique to the region. The assistance focus is on harnessing the geothermal energy for direct use application through identifying the potential direct use and the relevant technologies. The assistance will also entail an assessment of the economic viability of the identified projects and capacity building of the region technical experts on direct use of geothermal resources.

Geothermal energy is envisioned to bridge the energy demand gap especially in the rural areas whose population key challenge is access to energy. In this sense the long-term contribution of this TA will be on enhanced resilience as well as mitigation of climate change through provision of clean environmentally friendly energy.

In the short term; since the TA is a pre-feasibility study, among the anticipated follow up activity include but not limited to the following;

- Development of further targeted feasibility projects
- Development of action plan to plan on the implementation of the identified potential direct use projects
- Continued knowledge dissemination to other various stakeholders from the technical experts trained as part of this assistance; e.g. follow training to local communities on the direct use potential of available geothermal resources
- Updating of regional and national databases/information portals related to the region's

geothermal resources

10. Gender and co-benefits:

<p>Imbedded in design of the activities:</p>	<p>In the development agenda of the countries in this region highly recognize issues of gender mainstreaming as part of their social pillar, the gender issue is increasingly integrated into the various national frameworks of public development policies. Thus, the technical assistance provided by the CTCN will help strengthen this support for the gender dimension in the context of energy access and the resultant enhanced resilience building:</p> <ul style="list-style-type: none"> - A balanced choice of experts, women and men, as far as possible, to be considered in capacity building /training on the subject matter. - Specific data focusing on gender and women's vulnerability will be collected and analysed and the results should contribute to a better integration of women's concerns into access to energy and their linkages to bridge social. - The gender approach will be addressed and integrated in all activities possible
<p>Gender and co-benefits intended as result of the activities:</p>	<p>CTCN assistance will consider the gender dimension through the selection of national and regional women experts with the skills and expertise required to participate in the training sessions and other planned activities.</p> <p>In addition, through the results of the collection and analysis of specific data focused on gender issues and women's vulnerability, in relation to coastal risks, the CTCN's assistance will provide a unique opportunity for policymakers to tackle this vulnerability through adaptation plans and appropriate technologies that will be developed based on the assessment of climate risks and hence strengthen the adaptive capacity of the vulnerable population through transparent and inclusive mechanisms of social participation in the implementation of adaptation interventions, designed with a gender and human rights approach. This TNA will ensure good representation of all genders in the entire process; in stakeholders' consultations, capacity building, in the formulation of technology action plans among others. This can be realized through the envisioned long-term impact of this CTCN assistance at building local, national and regional resilience capacity.</p>

11. Main in-country stakeholders in implementation of the technical assistance activities:

In country stakeholder	Role in implementation of the technical assistance
<p>NDEs for the 6 countries</p>	<p>NDEs ensure coordination and implementation of activities at national level in line with priorities as identified in this TA. They are the technical arms and thus constitute the main beneficiaries of the technical assistance. They will be responsible for coordinating, implementing and monitoring the activities of the CTCN assistance.</p>
<p>Ministry of Energy and/ or Environment /main agencies in who oversee development of Geothermal energy in the 6 countries</p>	<p>The ministries in charge of the environment and Energy are the main focal points in this assistance and acts as the Lead Agency for geothermal resources development</p>

<ul style="list-style-type: none"> - Uganda Ministry of Energy and Mineral Development (MEMD) - Tanzania Geothermal Development Company Limited (TGDC) - Energy development Corporations ltd – Rwanda - Kenya Electricity Generating Company PLC, Geothermal Development Division - Ethiopian ministry of Mines and petroleum, geological surveys-- Geothermal Resources Directorate - Djibouti office of geothermal development <p>Other key ministries may include; Agriculture, Industry, Tourism</p>	<p>They are responsible for validating and recognizing the TA results in decision-making processes in countries.</p>
<p>University and research centers</p>	<p>Universities and research centers working in renewable energy technologies will be involved in the development of suitable direct use projects and the identification of the relevant technologies</p>
<p>Local Authorities</p>	<p>Local authorities are responsible local governance and decision making at the communities and are key partners in the knowledge of sites; including matters of land tenure and livelihood and will act as focal points in execution of dialogue with the community members regarding the potential direct use projects.</p>
<p>NGOs and private sector</p>	<p>Non-Governmental Organizations (NGOs) and the private sector can initiate or participate in TA process, for example by strengthening the capacity of actors.</p>

12. SDG Contributions:

Instructions: Please complete the grey section below for a maximum of three SDGs that will be advanced through this TA. A complete list of SDGs and their targets is available here:

<https://sustainabledevelopment.un.org/partnership/register/>.

Goal	Sustainable Development Goal	Direct contribution from CTCN TA (1 sentence for top 1-3 SDGs)
1	End poverty in all its forms everywhere	Among the envisioned long-term impact of the technical assistance is the enhanced community resilience and improved livelihood.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	
3	Ensure healthy lives and promote well-being for all at all ages	
4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	
5	Achieve gender equality and empower all women and girls	
6	Ensure availability and sustainable management of water and sanitation for all	
7	Ensure access to affordable, reliable, sustainable, and modern energy for all (consider adding targets for 7)	The energy is a high priority sector as it is a key driver of a low carbon growth path in the region
	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	The requested assistance aims to increase the countries energy mix through geothermal energy. In

		this context the TA will identify environmentally sound technologies that will ensure provision of energy from renewable sources to local communities
	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	This TA will serve to achieving this goal in identification and prioritization of clean technologies
	7.b - By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, 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	All TAs should indicate relevance to Goal 13 and at least one target below (13.1 to 13.b).
	13.1 - Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	The envisioned long-term impact of the technical assistance is the enhanced community resilience and improved livelihood
	13.2 - Integrate climate change measures into national policies, strategies and planning	
	13.3 - Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	Practical training for national and regional experts will strengthen their technical capacity geothermal direct uses and technologies for their exploitation
	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	The TA long term impact is to enhance local communities' resilience; through access to clean and climate proof energy that would allow for livelihood diversification
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:

<i>Please tick off the relevant boxes below</i>	<i>Primary</i>	<i>Secondary</i>
<input type="checkbox"/> 1. Technology identification and prioritization	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 2. Research and development of new climate technologies	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 3A. Feasibility studies for specific known climate technology options	<input checked="" type="checkbox"/>	<input type="checkbox"/>

<input type="checkbox"/> 3B. Piloting of known technologies in local conditions	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 4A. Law, policy and regulatory reform recommendations	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> 4B. Sector specific roadmap or strategy design	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/> 5. Finance facilitation and market creation	<input type="checkbox"/>	<input type="checkbox"/>

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

14. Monitoring and Evaluation process

Upon contracting of the implementing partners to implement this Response Plan, the lead implementer will produce a monitoring and evaluation plan for the technical assistance. The 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)* NDE about overall satisfaction level with the technical assistance service provided; *(ii)* the Lead Implementer about the knowledge and learning gained through delivery of technical assistance; and *(iii)* the CTCN Director about timeliness and appropriateness of the delivery of the activities and outputs.