TECHNICAL ASSISTANCE TO IDENTIFY THE MOST SUITABLE DIRECT USE APPLICATIONS AND TECHNOLOGIES IN LOW-TO-MEDIUM TEMPERATURE GEOTHERMAL SYSTEMS IN SIX AFRICAN COUNTRIES

CTCN REQUEST REF: 2019000050

DELIVERABLE #5: FOURTH PROGRESS REPORT

GUIDELINES AND TOOLS FOR GEOTHERMAL RESOURCE ASSESSMENTS FOR DIRECT USE APPLICATIONS

TRAINING AND CAPACITY BUILDING WORKSHOP SUMMARY REPORT

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I. GEOTHERMAL DIRECT USE TRAINING WORKSHOP SUMMARIES

This report provides a summary of the virtual training and capacity building workshops that were undertaken for the Project Proponents in each of the six project countries – Djibouti, Ethiopia, Kenya, Rwanda, Tanzania and Uganda – in June and July 2021. Each training session was held in a two-hour online group teleconference meeting where training materials were presented by the GreenMax project team covering the following topics in relation to geothermal direct use project development:[1]

1. Technical Evaluation
2. Project Identification
3. Commercial Evaluation
4. User Guide: Financial Model
5. Next Steps: Full Feasibility Study

The training session was interactive and included open discussion/Q&A with all participants. The summaries presented below include a list of the stakeholders who participated in each meeting, the questions and comments that were raised during the Q&A session, responses from the GreenMax team, and any additional input and feedback from participants.

[1] A copy of the presentation that was delivered is enclosed as an **Appendix** to this report.

1.1 DJIBOUTI

i. Workshop Participants

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ii. Workshop Summary

Questions/Comments/Recommendations	Feedback/Contributions/Responses
Name: Omar Abdillahi Assoweh **Organization**: ODDEG **Question:** How were the prices for the fish drying plants established?	**Name**: Koye Alaba **Response**: Prices were an average estimation, but the model is very flexible and allows inputs/prices from different regions to be inserted.
Name: Abdek Mahamoud Abdi **Organization**: ODDEG **Question:** Who will invest in the next phase? What are the next steps for a full feasibility study?	**Name**: Alexander LaBua **Response**: This assignment was only covered the pre-feasibility stage of direct use project development. The content we have prepared can be used as the basis for a subsequent full feasibility study. Many of the assumptions we have made in our analysis will need to be examined more closely with field data during the feasibility stage.
Name: Abdek Mahamoud Abdi **Organization**: ODDEG **Question:** Will direct use applications face local competition?	**Name**: Hezy Ram **Response**: It is difficult to determine which applications would face local market competition, but this is a question to be answered during the full feasibility stage, when a detailed business plan, SWOT analysis and social impact assessment are conducted to appropriately assess local demand for the product or service.
Name: Abdek Mahamoud Abdi **Organization**: ODDEG **Question:** Companies in Japan are currently using geothermal for their heating and cooling as part of their ESG commitments (IKEA as an example). Can sustainable financing tools like green bonds help expand funding for geothermal direct use projects? And are the	**Name**: Hezy Ram **Response**: The full spectrum of financing options were not covered in the presentation; green bonds are certainly one form of sustainable finance that can be used to support direct use technologies and projects. Specific regulation for direct use geothermal are not necessary, as the technology (geothermal) is already well known and understood by the private sector; governments can assist

specific regulatory frameworks required for direct use geothermal?	the market by providing grant funding to offset project development costs.
Name: Abdek Mahamoud Abdi **Organization**: ODDEG **Question:** The site of Ambado - PK20 has the lowest score in your analysis, while Asal Fiale has the highest score. Asal Fiale is mainly vapor dominated with temperatures that reach 350 C°, while Ambado - PK20 has medium to low temperature but can produce heated water for different plants and is located near Djibouti City. Why is Ambado - PK20 the lowest scoring site?	**Name**: Umut Destegul **Response**: The score for Ambado - PK20 was 59 while Asal Fiale 93. After analyzing the data, Ambado - PK20 had lower water temperatures and less potential. The scoring was established by looking at the data that was available. The use of both sites is still recommended, but this should be examined in further detail with more data from the field.

1.2 ETHIOPIA

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Ryan Raedi	UNEP	Energy Specialist	
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Assefa Yismaw			
Zelalem Abebe			

ii. Workshop Summary

Questions/Comments/Recommendations	Feedback/Contributions/Responses
Name: Hundie Melka **Organization**: Geological Survey of Ethiopia (GSE) **Question/Comment/Recommendation**: For direct use applications, low to medium geothermal resources are mainly used. The proposal focused on	**Name**: Hezy Ram **Response**: Even with relatively high temperature resources, we can use the resource not only for power generation, but also direct use (cascading system). It can be done with the binary unit if the temperature of the return water is sufficiently high. So, the same resource can

Aluto-Langano which is a high temperature site, already under development for electricity generation. How would direct application be used in this case?	be used for power generation and direct use. Maybe Peter and Umut can provide comments on the specific resource itself. **Name:** Umut Destegul **Response:** When evaluating geothermal resources, it is important to look for a sustainable resource, which is something we took into account in our classification and site selection methodology. Aluto-Langano was scored highly due to its level of development. We know that the power plant has stopped working and there are still issues to be resolved. But highly successful projects in geothermal energy exploitation require a sustainable resource. As a result, our analysis found that direct use and electricity generation can be used together in the form of a cascading system. A lot of data is needed in order to understand a sustainable resource, including for a direct use application. It would be good for Peter to add a bit more. **Name:** Dr. Peter Omeda **Response:** Additionally, Ethiopia has so many resources – high, low, medium temperature – and some sites have minimal data available. Direct use projects are possible at the Aluto-Langano site as a cascaded system. For Abaya, which is a high temperature resource, it can be used for electricity and direct use (e.g., tobacco drying). These are just examples we looked at and there are many other Ethiopian sites to assess in more detail. Some of these other resources can be evaluated with support from other donor agencies / development partners.
Name: Meseret Zemedkun **Organization**: UNEP **Question/Comment/Recommendation**: On the question raised by Hundie Melka, I think the basic objective of direct use applications is to focus on the low to medium temperature geothermal systems. The work done is very good based on the data and the selections made, but the focus is not only on cascaded systems. Ethiopia has over 27 sites with detailed or semi-detailed data already available. A focus on low to medium sites is advised for the Ethiopian GSE team since the work done by GreenMax focuses mainly on cascaded geothermal systems. The work completed under this assignment can be used to help support the livelihoods of those rural communities in the rift, and outside of the rift or even in Addis Ababa.	**Name**: Dr. Peter Omeda **Response**: It seems that this was focused on cascaded for Ethiopia, but I can say that the guidelines can be used in low and medium temperature as well. I think our colleagues at the geological survey can use the model to test other sites and use the guidelines and financial model to see the outcome, since these tools can be used for any geothermal system.
Name: Yamelakesira Tamene **Organization**: UN **Question/Comment/Recommendation**: Thanks to GreenMax for these guidelines, as this project is very important for Ethiopia. Ethiopia has developed a climate resilient green economy strategy with three broad goals: (i) net zero emissions; (ii) building resilient society; and (iii) building green	**Name**: Alex LaBua **Response**: This has been well-noted. Thank you

economy. This project will be significant to achieving these goals. Due to Covid-19, primary data regarding the selected area was not taken. Data availability was the focus. What I recommend is further detailed study at national level using this as a starting point.	
Name: Getnet Tesfaye **Organization**: GreenMax **Question/Comment/Recommendation**: Is the financial model also good for feasibility (or pre-feasibility)?	**Name**: Koye Alaba **Response**: The financial model is intended to be used as a tool for both pre-feasibility and full feasibility studies of direct use projects.
Name: Getnet Tesfaye **Organization**: GreenMax **Question/Comment/Recommendation**: Other potential direct use applications for Ethiopia to be considered in the future: • industrial parks (e.g., Hawasa IP, steam for textile/garment factories for laundry, ironing, cooking, etc.), • flower farms (e.g., Zway area) • leather processing factories (e.g., Mojo town) • agro-industries (e.g. tobacco farms). The probability of development of the above applications is high because: • these will be retrofits, • these have capacity to invest, • they are relatively large sized projects, making it more financially attractive to implement	

1.3 KENYA

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ii. Workshop Summary

Questions/Comments/Recommendations	Feedback/Contributions/Responses
Name: Dr. Peketsa Mangi **Organization**: KenGen **Question/Comment/Recommendation**: Regarding social considerations, how are vulnerable and marginalized populations addressed within institutional and governance frameworks? More specifically: (a) In terms of communities that have the legal right to the land, when KenGen was seeking to develop geothermal resources in Kenya, local communities would claim to have "legal rights" to the land. They are mainly squatters (communities that claim to own the land when they actually don't). Instead, we should consider, for characterization purposes as marginalized/vulnerable groups. For planning, this forces developers to have to compensate all parties (for owners, marginalized communities, and resettlements). This issue is important as current laws often conflict rather than	**Name:** Barbara Kenya **Response:** (a) It is important to consider how local laws adapt to meet the needs of affected communities, including to address issues of marginalized communities and resettlements to ensure that project development is sustainable and the impacts on the community are minimized. This will also be done while taking into consideration political influence in regard to institutional and regulatory frameworks process. With regards to land tenure issues, the government of Kenya looks at minorities (vulnerable/ marginalized populations), which are defined by ethnicity or the 70/30 rule. In the global context, for example, we characterize these groups as indigenous people – individuals who have self-identified as indigenous or a group of people whose culture or heritage is being lost, hence their human rights are affected by virtue of development or differences of accessibility of land.

complement one another regarding environmental and social considerations. (b) With regards to the financial model, did Koye capture these environmental costs that Barbara discussed in his model?	Therefore, when classifying this needs to be very clear. If populations are not considered indigenous and rather squatters, their human rights and dignity are still protected, including resettlements (if applicable). The Land Act/IC performance standards as it stands now attempts to address these land ownership issues. As such, these social considerations should be factored in financial models (environmental cost) and mitigated properly for sustainability. **Name:** Koye Alaba **Response:** (b) We did not include environmental or social considerations in the financial model. However, we do recommend that a full feasibility study be undertaken to analyze how these costs would be factored into the project, including resettlement and mitigation costs. While it is not currently included, the model is flexible enough so that when the actual figures are presented, the values can be inserted into the model.
Name: Dr. Peketsa Mangi **Organization**: KenGen **Question/Comment/Recommendation**: Regarding the financial model: (a) Does this model assume that the well has shallow depth? (b) In a retrofit/existing well environment, this scenario would be viable when a better analysis of inputs/outputs is recorded since the initial drilling of wells are very expensive. .	**Name**: Koye Alaba **Response**: (a) Yes. The assumption in the model is based on desk research, not actual figures. The values from the report / in the model came from a previous actual case study in Rwanda. However, the sensitivity analysis shows the bigger picture. It is a better instrument to measure how viable a project will be (economies of scale). (b) If there is an existing well that the project can receive hot water from, the financial model then should be modified such that the cost of well drilling and associated costs should be modified to ~0. In the operating cost section, there should be a cost due to water being procured from the existing well. In these scenarios, operating costs will be higher while capital cost is reduced.
Name: Judith Mugambi **Organization**: CTCN **Question/Comment/Recommendation**: How close does the community need to be to the actual geothermal heat source for a given direct use project?	**Name**: Dr. Peter Omenda **Response**: Communities living very close to the geothermal resources/project sites should be targeted, as it is generally not feasible to transporting the heat over great distances.

1.4 RWANDA

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ii. Workshop Summary

Questions/Comments/Recommendations	Feedback/Contributions/Responses
Name: Gilbert Haganje **Organization**: EDCL **Question/Comment/Recommendation**: All of our resources have been classified as inferred resource. Why? What needs to be done, what gaps needed to be filled to get to that stage of indicated resources? (later commented that they could have a discussion to find out what gaps to fill that allow them to move to the next step)	**Name**: Umut Destegul **Response**: From the data that has been shared, when we used the selected criteria to assess the potential sites, the results indicated that the resource was an 'indicated' resource. Some parts of Rwanda have been analyzed extensively, while other regions rely on regional data; there is a need for both local and regional data to be analyzed to obtain a comprehensive result. Focusing on the tables we have shared with you, we created tables where we filled in scores for each site. For Bugarama, we need more geographic data and heat flow data from geophysics, liquid pressures, permeability, fluid flow estimated and some other criteria we can look into that needs to be provided for the site to be improve its classification score according to our methodology.
Name: Gilbert Haganje **Organization**: EDCL **Question/Comment/Recommendation**: Assuming there is a hot spring which a developer wants to use as a geothermal resource for a spa, but a local community considers the resource to be their own (due to the hot spring being near a lake/water resource, say 50m, with the hot spring within that 50m). How can this	**Name**: Barbara Kenya **Response**: This dynamic is common in geothermal development. Typically, a community does not legally own the resource; rather the national government will have laws in place to define how a community could own a resource or be compensated for rights to develop it. The hot spring being 50m from the lake is a non-issue because that is a natural occurrence. Another important question to answer is whether local laws define how far from the hot spring a community or developer should be? What do the laws of the country say

kind of issue be addressed appropriately between the community and the developer?	regarding access to natural resources / development of hot springs, water resources, etc.? Once the institutional/regulatory framework is defined, the next step would be to conduct an impact assessment; how can this be cost-shared without infringing on the rights of the community? What are the costs of mitigating negative impacts/risks throughout the project cycle? Generally, when there is a community that is going to be affected, investors are very shy to get involved with that project, so it has to go through critical analysis and risk assessment before a decision is made, based foremost on the rules and regulations of the country.
Name: Gilbert Haganje **Organization**: EDCL **Question/Comment/Recommendation**: (a) As the financial model would take time to understand, could you share this tool with us so we can exercise another time for ourselves to understand it? (b) You have showed us a model for fish drying and vegetable drying, but I also want to see how this model can work with the construction of a spa. I shared our inputs from the report with Alex, on what we expected, as we want to know what is required to construct a spa. (c) I am Asking because in the three sites, geothermal spa was not analyzed, and this was communicated to Alex. We also gave comments about some areas, for example, rice drying in Bugarama, pyrethrum drying in Karago, and so on, where we would like clarification.	**Name**: Koye Alaba **Response**: (a) Yes, all of the training materials will be shared with workshop participants. (b) The analysis for a geothermal spa facility is included in the financial model. From the inputs in our model, we found that the major factor affecting the viability of the spa operation is the ability to attract enough visitors per year, which will also impact revenue. The assumed 14,000 visitors per year in the model was based on information from the existing spa in Kenya (Olkaria), and with this figure, we find that the facility may not be viable. Therefore, the ticket pricing and number of annual visitors would be a make-or-break factor for operating a geothermal spa in a commercially viable and profitable way. The model and corresponding user guide will be shared after our presentation can be used for further analysis. **Name**: Alexander LaBua **Response**: (c) We included analysis of various grain drying applications which would apply to rice, and although the geothermal spa application not specifically analyzed in the case of Rwanda, the findings and frameworks of analysis from other countries can also be applied to Rwanda. As Koye demonstrated, the financial modeling tool and user guide can be used at the next stage of a full feasibility study and more detailed financial analysis done to determine the viability of that technology.
Name: Eugene Karangwa **Organization**: EDCL **Question/Comment/Recommendation:** What are the parameters assumed for the well drilling to cost 30,000 USD: (size, depth)?	**Name**: Koye Alaba **Response**: The assumption used in the model was based on a study done for fish drying in Gisenyi. It will be important to carry out an actual full feasibility study to find out debt required and what the exact costs and temperatures (inputs) would be, since what we currently have are placeholders. However, based on our desk research, we found that well drilling costs increase to $500k; at that level, the project would not be viable.

TANZANIA

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ii. Workshop Summary

Questions/Comments/Recommendations	Feedback/Contributions/Responses
Name: Cynthia Kuringe **Organization**: TGDC **Question/Comment/Recommendation**: Question for Koye on capital expenses. For the case of well drilling, is it a well specifically for direct use or is it for a power plant for power generation then later used for direct use applications? Please clarify whether the estimate is specific for direct use or for a well drilled then later used for direct use?	**Name**: Koye Alaba **Response**: The assumption we made is that the well drilling cost is specifically for direct use projects. The figure is low because we assumed a shallow well will be required.
Name: Erasmus Hyera **Organization**: TGDC **Question/Comment/Recommendation**: (a) The first question is about the SWOT analysis for the project. I want to know when you were preparing this project specifically for Kiejo-Mbaka, did you apply a SWOT analysis? (b) For the financial model, is it is for direct use with or without power (i.e., cascaded systems)?	**Name**: Umut Destegul **Response**: We are looking for two phased analyses for the specific project site. The first is classification, followed by project status where we look into more details about the sustainability of the resource. Here Tanzania provided us with five documents, country-wide and specifically for Kiejo-Mbaka, so we used that input data to fulfill the criteria. We conducted our analysis based on these documents and the information that was made available for our review. **Name:** Hezy Ram **Response:** The SWOT analysis tool can be used for any application – I just provided vegetable drying as an example. Vegetable drying was selected for consistency, because it is the same application Koye used in the financial model. But you can apply this same analysis to other applications.

	Name: Koye Alaba **Response:** The model specifically focuses on direct use geothermal projects. If there is a well and it is mainly for power generation, then this model would be altered so that the well drilling costs would be taken away from the CAPEX and the costs of procuring the water from the well that is for the power plant would then be included in the OPEX. That would give a sense of the viability of the direct use project, which would be supplementary to the main power plant model.
Name: Philibert Phillimoni **Organization**: TGDC **Question/Comment/Recommendation**: Dr. Omenda, mentioned a study on Enhanced Geothermal in Tanzania. Can you provide this study?	**Name**: Dr. Peter Omenda **Response**: Yes, I will send you the paper via email (accessible here)[2]

[2] http://theargeo.org/fullpapers/fullpaper/High%20heat%20generating%20granites%20of%20Tanzania_Final%20(1).pdf

1.5 UGANDA

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ii. Workshop Summary

Questions/Comments/Recommendations	Feedback/Contributions/Responses
Name: Edward Isabirye Mugaddu **Organization**: MEMD **Question/Comment/Recommendation**: Taking Buranga as an example, the most prevalent crop grown in the area is cocoa. It would therefore be interesting to model this crop as opposed to fruit.	**Name**: Koye Alaba **Response**: Although we did not specifically analyze for cocoa, the fruit drying model can be adapted for cocoa.
Name: Godfrey Bahati **Organization**: MEMD **Question/Comment/Recommendation**: Is the financial model only for a confirmed resource? For geothermal financial modelling, I would think the specifications of the geothermal resource are critical, for example flow rate, temperature either actual or estimated. A model incorporating both the technical and financial aspects would probably then be ideal.	**Name**: Koye Alaba **Response**: The model that was prepared was made to assess commercial viability. The data certainly affects the capex output. We carried out the sensitivity assessment to compensate for the lack of data.

Name Godfrey Bahati **Organization**: MEMD **Question/Comment/Recommendation:** Are the financial models going to be the same for hot water drilling instances?	**Name:** Koye Alaba **Response:** The model can be adapted for the instances with hot water drilling.
Name: Benjamin Twesigye **Organization**: MEMD **Question/Comment/Recommendation**: Is the associated weighted scoring of geothermal project development better than UNFC classification? If yes, how?	**Name**: Umut Destegul **Response**: Please refer to our report, specifically a description of the methodology. We based our classifications on a 2018 study that summarizes several scoring codes.

APPENDIX: GEOTHERMAL DIRECT USE TRAINING MATERIALS

The following training materials were shared with each of the Project Proponents and are enclosed separately as an appendix to this report:

- **Technical Guidelines:** Geothermal Resource Assessment Site Selection Technical Guidelines

- **Training Presentation:** Direct Use Geothermal Training PowerPoint Presentation (specific to each country), including a step-by-step User Guide for how to use the financial model

- **Financial Model:** Consolidated financial model, including all relevant inputs and financial calculations for the following direct use geothermal applications:

  - Fish drying
  - Fruit drying
  - Vegetable drying
  - Rice drying
  - Pyrethrum drying
  - Greenhouse heating
  - Geothermal spa
  - Tea drying
  - Tobacco curing
  - Milk pasteurization
  - Chicken hatcheries

- **Recording:** A recording of the teleconference was also made available to all workshop participants.