



**Mid-Term Review
of
GEOHERMAL EXPLORATION
PROJECT ICE23066-1301**

August 2016

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SUMMARY

The rationale for the Project is highly justifiable. The EARS countries all need electricity and geothermal energy is highly competitive in terms of cost per MW and impact on the environment.

Clean geothermal energy development requires a large amount of capital, know-how and management skills. The Project provided support to carry out the first two stages towards geothermal development, Stage 1: Reconnaissance Studies and Stage 2: Exploration. This is essential as the private sector is reluctant to undertake these initial stages at its own risk, and the Governments lack the necessary resources. In order to carry out these stages and advance to the subsequent stages (3 to 9) the capacity building conducted by the Project is essential and in high demand.

Due to the “short-term” nature of the Mid-term Review, i.e. 2½ – 3 years of operation, focus of the Review has been on Project outputs, and not the long-term outcomes. Moreover, as specified in the ToR, the Review was to concentrate on Ethiopia and Rwanda, with “a stop-over in Nairobi” for assessment of regional projects.

Complementary to the Technical Assistance and other supporting studies financed by the Project, training/capacity building is required in most of the EARS countries.

Stages 1 and 2 are planned to feed into the subsequent and costly Stages 3–9 to be financed by the World Bank (Compact) and other donors. Based on field interviews with some donors it is likely that such funding will be forthcoming provided that the results of Stage 1 and 2 are positive.

The log-frame developed for the Project is clear. It specifies outputs to be reached, although not by country. However, from Section 6.1 in the Project Document it is specified that Stage 1 activities will be carried out in 10 countries, at USD 100,000 for each, and Stage 2 in 9 countries at USD 1m each. Technical assistance and capacity building have a lump sum budget of USD 2m, while Project Preparation and Administration is budgeted at USD 1m, giving a total of USD 13m for the five-year period. However, the Project Document specifies that the Project shall be “demand-driven”. Hence, the actual distribution of funds on countries and type of projects was envisaged to differ from the planned figures above.

The Project had a strong initial emphasis on reconnaissance and explorations studies with as much as 78% of the Project Budget. The Approved Disbursement has, however, been scaled down to 54% by end 2015. Correspondingly, the capacity building expenditures have increased from a planned 15% to 38% of total approved disbursements by end of 2015. Apart from the “demand-driven” character of the Project these changes were due to:

- 1) Poor prospects in Burundi after reconnaissance which did not justify further work and spending, and
- 2) Increased demand for capacity building and training based on positive feedback from countries which have received such support from the Project.

The Review Team sees this shift in expenditures as a positive development based on an increased demand and flexible management of the Project. Moreover, the Review Team fully supports a stronger emphasis on training and capacity building. None of those interviewed disputed this.

It should be noted that 33% of the Project budget as of end 2015 was allocated to Ethiopia, while only 27% went to the ten countries of Tanzania, DRC, Malawi, Zambia, Burundi, Zambia, Eritrea, Uganda, Comoros and Djibouti. Kenya was budgeted to receive the second biggest share of 17%, while regional/general projects accounted for 7%.

The actual disbursement of funds, as compared to approved disbursements, gave an overall disbursement rate of 49%. The lowest rate was for capacity building (39%) while Project Management received as much as 67% of the Approved Disbursements. The main reason for the low disbursement is the under-spending in Ethiopia caused by delays in project implementation.

The cost-sharing between NDF and ICEIDA/MFA as of end 2015 is 35% NDF and 65% ICEIDA/MFA, and not 50/50 as specified in the Agreement between the two parties. One reason for this is that not all project activities are eligible for NDF financing and certain countries have priority in terms of financial support from NDF.

The budgeted USD 13m is based on a contribution from each party of EUR 5m. Since the exchange rate has dropped, the total NDF contribution is now estimated at USD 5.7m, while USD 5.8m is already committed by ICEIDA/MFA, with a total funding of USD 11.5m. According to the 2015 progress report USD 10.963m are already approved for disbursement, leaving only USD 537,000 for new projects during the remaining two years. Clearly, the initial objective to carry out reconnaissance and exploration at USD 1.1m per country will not be met. As outlined in the Progress Report, a revised plan, with more emphasis on capacity building, will be difficult to achieve given the small uncommitted budget.

The cost-efficiency of the activities carried out by the Project management and sub-contractors like ISOR and UNU-GTP is difficult to assess. The costs of Project preparation, management and travels constituted 8% of the initial total budget. By overall standards this is an acceptable cost level, especially as travels to East Africa have been necessary.

Further findings by the Mid Term Review are:

- There are no proven high-enthalpy geothermal resources in Uganda, Rwanda, Burundi, Zambia, Malawi, Mozambique, Comoros and Congo.
- The demand-driven character of the Project works well. If countries request assistance, the Project gives TA to define their needs and to prioritise and prepare projects, etc.
- The establishment of the East African Geothermal Centre of Excellence in Nakuru, Kenya is an important step towards self-sufficient training facilities in the region. It is recommended that it will be supported further by the Project. This might, however, require reallocation of funds since the approved budget for AGCE has already been exhausted.
- The increased emphasis on capacity building and training is regarded as positive.
- The cost of training has been investigated and is found acceptable as compared to the high return. The ratings by the participants in the courses give a very high score.
- The emphasis in the Project on “technical tasks” as specified in Stage 1 and 2 versus capacity building and training is less important in Kenya than in the other countries. Kenya is self-sufficient, but training in Ethiopia is still required and even more important in Tanzania, Eritrea and Djibouti.
- Geothermal resources, which can be developed for electricity generation, are likely to exist in Kenya, Ethiopia, Eritrea, Djibouti and perhaps Tanzania. This is reflected in higher funds being allocated to these countries.
- The split between training in Iceland and local training should be evaluated with respect to cost and benefits for students.
- The risk to Project activities is low regarding technical performance of explorations, but as experienced in Rwanda, wells can be “dry” and prevent further development. The sustainability of further research and development will to a large extent rely on the WB and other donors to assist exploratory drilling and further development of the geothermal fields. Interviews with donors confirmed this.
- Donor cooperation seems to be good and flexible, and the Project has been successful in this respect.

- It is recommended that social and environmental impact issues related to the nomads are further considered and that ESIA to be started well before exploration wells are drilled.
- The Project components on the development of legal and policy framework, and support to financial institutions, have not been carried out. The development of an enabling policy framework is by the Review Team regarded as crucial to attract the private sector. This is considered essential to speed up the development of geothermal electricity production, and several other donors like USAID, IFC and DFID give assistance in this respect. Thus, the Project focus on the more technical aspects seems justified.
- The component “*Community in Practice*” on geothermal development for dialogue, learning and information sharing has been carried out to some extent, inter alia through the donor meeting hosted by ICEIDA in 2014 and the co-hosting of the GGDP with the World Bank in Iceland.

Other recommendations of the Review include:

- Set up an appraisal committee to evaluate reconnaissance and surface exploration reports and especially the siting of exploration wells.
- Organize training "on the job" by 1) getting overseas experts to the countries for 6-12 months and work in close cooperation with local experts in certain field like geology, reservoir engineering etc. (Rwanda, Ethiopia), 2) organizing training in other countries where African experts can work for 6-12 months in firms and/or organizations in geothermal countries.
- Conduct refresher courses in various topics concerning exploration and utilization of geothermal energy.
- Repeat the successful short courses in Project Management, Bankable Documents and others in other EARS countries.
- Continue to study drying of agricultural products with a study on cost benefits and other direct uses. This would also benefit other countries with low enthalpy fluids.
- Give both financial and practical (experts for training) assistance to the Geothermal Centre of Excellence in Kenya.
- Put more funding into Tanzania, Eritrea and Djibouti during the latter half of the Project.
- Sort out jointly with NDF the financial situation due to the limited funds left for new projects in the remaining Project period. Possibly, reallocation of unspent funding to the most promising countries could be considered, as well as additional funding by NDF/MFA. The legality/feasibility of such changes needs to be established.
- Facilitate that the relatively small investments done by the Project are leveraged by sufficient funding for the remaining stages. In this respect it could be considered that the Project gets more involved in the preparation of project proposals for further funding of subsequent stages. This could possibly be based on the structure taught in the courses on “Bankable Documents”. Continued close cooperation with the World Bank and other financiers would be required in this respect.

1. INTRODUCTION

This Mid-Term Review (MTR) of the Geothermal Exploration Project is carried out in accordance with Terms of Reference prepared by the Icelandic International Development Agency (ICEIDA/MFA) as specified in a Consultancy Contract between the Agency and Nordic Consulting Group A/S, Norway (Consultant). The Project is funded by ICEIDA/MFA (Lead Agency) and by Nordic Development Fund (NDF), which is co-financier.

The current MTR has been carried out by Helgi Torfason (geologist) and Svein Jørgensen (economist) with Quality Assurance from Omar Bjarki Smarason (geologist). The work comprised:

- Document Review and Inception Report
- Visit to and interviews with ICEIDA/MFA and stakeholders in Iceland
- Email exchanges with Nordic Development Fund
- Field work and meetings in Nairobi, Addis Ababa and Kigali

All meetings requested were carried out. In preparation for the meetings in Africa the Review Team prepared a Questionnaire. All respondents met are listed in Annex 1.

The main objective of the Project is to support geothermal development of the East African Rift Valley Countries (EARS) through the Geothermal Compact which is an informal agreement with the World Bank. The Project is supposed (directed) to complete **Stage 1 Reconnaissance studies**, and if needed, **Stage 2 Surface Exploration** of potential geothermal areas. Also there is an emphasis on **Capacity building and training** in the field of geothermal utilization and policy. The Project support is demand-driven and is planned to extend up to (and possibly through) the stages of exploratory drilling. The aim of the Project is to locate a heat source which can be used to produce electricity and/or extract energy for other uses, and to locate sites for exploration drillholes.

The countries and status of resource identification is as follows:

Eritrea	Proven resource
Djibouti	Proven resource
Ethiopia	Proven resource and a 7.2 MW pilot power plant
Tanzania	Possibly some resources for electricity production
Kenya	Geothermal power plants already running

In Uganda, Rwanda, Burundi, Zambia, Malawi, Mozambique, Comoros and DR Congo no proven high-enthalpy geothermal resources exist for the generation of electricity.

The expected outputs of the Project should include the necessary scientific data, reports and enhanced human skills to enable governments and the private sector to take further actions towards geothermal utilization. Due to the short duration of the Project (2½ to 3 years), the Review mainly focused on outputs since outcomes take a longer time to materialize. Moreover, as specified in the ToR, the Review should concentrate on Ethiopia and Rwanda, with meetings also in Nairobi for assessment of regional/general projects. The Project covers over 20 different sub-projects in thirteen countries, six of which are regional, i.e. extend over more than one country. Also projects specific for Kenya were covered during the field work in Nairobi.

The findings of the Review Team rely on reports and views presented by ICEIDA/MFA and the other stakeholders concerning the development of geothermal resources in the East African Rift Valley. This report is the responsibility of the Consultant and does not necessarily reflect the views of ICEIDA/MFA or NDF.

As a part of the Review a lot of information has been collected and processed. This information is kept in a Project File to be accessed by ICEIDA/MFA if required. The Project File includes the following:

1. Log frame status
2. Meeting schedule
3. Minutes of meetings in Kenya, Rwanda and Ethiopia
4. Short courses by UNU-GTP
5. Calculations of cost of short courses
6. Documents received

2. PROJECT SETTING

The electricity demand in the African Rift region corresponds to about 6,000 MW and is projected to grow rapidly over the next few decades. The estimated geothermal energy potential of the region is 14,000 –15,000 MW or higher. By March 2015 some 595 MW had been installed, most developed since 1981 in Kenya which aims at 5,000 MWe by 2030.

The development of clean energy resources requires a vast amount of capital, technical know-how and skills. Current barriers include 1) high up-front development costs, 2) drilling/reservoir risks, and 3) a long development time. Lack of a conducive and predictable legal and regulatory framework is also perceived as a major challenge for geothermal development in the African Countries.

According to studies conducted by the African Rift Geothermal Development Facility (ARGeo), African Union Commission (AUC), and Japan International Corporation Agency (JICA), the development of geothermal resources is expected to increase rapidly over the next fifteen years. However, at present, there is inter alia a lack of necessary technical expertise to meet the demand. In 2015, UNEP/ARGeo conducted a gap analysis of geothermal technical personnel, which confirmed an increasing need for geothermal scientists, engineers, and technicians across the region (in total 12 000 experts) and similar analyses by AUC (2010) and JICA (2010) show that 900–1000 experts will be needed during the next 10–15 years.

3. THE PROJECT

The main objective of the Project is to contribute to the geothermal development by assisting all East African Rift Valley Countries (EARS) in completing reconnaissance and, if needed, exploratory phase of geothermal development, and to build capacity and expertise in the field of geothermal utilization and policy. As the Project support is demand-driven and will extend up to (and possibly through) the stages of exploratory drilling it is up to each country to decide what kind of assistance is provided. The move forward from positive exploration results and submission of potential geothermal projects into the funding for exploration drilling is the responsibility of respective governments.

An important aspect of the Project is the support to the respective governments to move forward from positive exploration results and submit potential geothermal projects into funding pipelines for exploration drilling.

The specific objective (outcome) of the Project is: *“Enhanced geothermal knowledge and capacity that enables further actions on geothermal utilization in EARS countries”*. The expected outputs are the necessary scientific data, reports and human resources to enable governments and the private sector to take further actions on geothermal utilization. Due to the short duration of the Project so far (2½ to 3 years), the Review Team can mainly focus on outputs since outcomes take a longer time to materialize.

The Project covers 20 different sub-projects in thirteen countries of which 6 projects are regional, i.e. extending over more than one country. As stated in the ToR focus of the Review shall be on **Rwanda and Ethiopia** where the Review Team should review projects and sub-projects in greater detail. The same is the case for **Regional Projects** which have been covered through a visit to Nairobi where information on some of these projects was obtained. Prior to commencing field work, the Review Team had meetings with ICEIDA/MFA, ISOR, RG, UNU-GTP and EFLA in Iceland. Written comments and responses to questions sent by the Team to NDF were received.

References in the Project Document refer to the World Bank **Geothermal Compact**, and the funding from the World Bank and other donors for subsequent phases is regarded by the Review Team to be crucial. Although the World Bank has no formal obligations to the project, it has shown positive interest in the provision of funds for subsequent and much more expensive phases. Meetings with representatives from the World Bank Office in Addis Ababa and in Reykjavik confirmed this, and representatives of the Bank stated that there is good cooperation between the Project and the WB. The nine-stage process proposed for the geothermal development cycle in the current Project leaves further development of the 7 stages to be specified under the Geothermal Compact.

The Project will mainly cater for stages 1 and 2 of the Geothermal Compact and, if funding allows, it could potentially also contribute towards stage 4 (pre-feasibility reports). In parallel to the described stages, the Project will offer financial support to other activities, mainly **technical assistance and capacity building/training**.

The main activities carried out in the first two stages are listed below.

Stage 1: Reconnaissance

Reconnaissance studies are conducted in respective EARS countries with recommendations for further action. At this stage geothermal and other available information is collected, including information on geology, geophysics and geochemistry of the presumed resource. Stage 1 comprises, but is not limited to:

- Study of the available information on the geothermal field, reservoir assessment, characteristics of existing wells etc.
- Chemical analyses of the fluid from surface manifestations and wells where available.
- Gathering of all maps, reports and literature regarding the presumed geothermal field.
- Noting of which data are missing and which additional (existing) data are to be obtained.
- Site visit for first estimate of the field and meetings with local scientists for additional information.
- Recommendations for further exploration and/or drilling.

The cost of this stage is limited to a maximum of USD 100,000 per country x 10 countries = USD 1m.

Stage 2: Exploration

The exploration stage comprises a research program as follows:

- Geological, geothermal and structural mapping.
- Chemical analyses and interpretation of fluids from the geothermal springs and fumaroles.
- Surface geophysical methods including TEM (Time Domain Electromagnetics) and MT (Magnetotellurics) resistivity survey, micro-seismic studies, gravity measurements etc.
- Environmental and Social Impact Assessment for exploratory drilling if applicable.

Geothermal exploration is planned to be conducted in 9 countries at a cost of USD 1m in each country x 9 = USD 9m.

Capacity Building and Training

In support of, and parallel with, the Reconnaissance and Exploration stages, the Project gives assistance to increasing the level of knowledge and capacity on geothermal utilization through:

- Strengthened policy and legal framework for geothermal utilization.
- Capacity building in the participating countries, including training by United Nations University – Geothermal Training Programme (UNU-GTP).
- Strengthened ability of development and financial institutions to engage and support the geothermal development process

The **Project period** is January 2013 to December 2017 with the mid-term as of June 2015. This Mid-term Review focuses on achievements to date, i.e. in practice to end of December 2015. However, the bi-annual progress report as of end of 2015 was only available at the beginning of April 2016.

Table 1 shows 1) Initial Budget figures from the Project Document, 2) Approved Disbursement, and 3) Disbursed Funds by main activity from January 2013 to the end of December 2015.

Table 1. Budgeted, Approved and Disbursed Amounts by Main Activity by end 2015

Activity	Initial Budget		Approved Disbursement		Disbursed Funds	
	USD	%	USD	%	USD	%
10 reconnaissance/ 9 explorations studies	10m	78	5,920,000	54	3,191,000	59
13 capacity building projects	2m	15	4,165,000	38	1,624,000	30
Admin/travel/meetings	1m	8	877,000	8	568,000 ¹	11
Total	13m	100	10,963,00	100	5,383,000	100

As seen from the figures the Project had an **initial strong emphasis on reconnaissance/explorations/studies**, allocating as much as 78% of the Project Budget. The Approved Budget for the same components has been scaled down considerably, to 54 % in the Bi-annual Report. It constitutes 59% of the disbursed amounts by the end of June 2015. Correspondingly, as compared to the initial Project budget, the capacity building expenditures have increased from a planned 15% to 38% of total approved projects by the end of 2015. This can possibly be attributed to the demand-driven structure of the Project. The Review Team does not see such a shift in the allocation as a problem. Rather, as indicated below, the Project should have a strong emphasis on training/capacity building.

The cost-efficiency of Project activities are difficult to assess and compare with other development activities. One yardstick is the amount of funds used for project management as compared to the total funds managed. The Review Team has compared Project management and administration costs (budget: USD 1m = 7.7% of total costs) with “standard” administration fee of other development

¹ This figure has been calculated as follows: Total disbursed funds minus costs of reconnaissance and capacity building. According to ICEIDA the figure of USD 568 000 also includes initial work by ISOR which should be deducted. The remaining admin/travel/meeting costs then amount to USD 439 000, i.e. 8% of total costs, which is fully acceptable level.

projects. In general such administration fees should not exceed 10% of total costs, and 8% is regarded as a fully acceptable minimum. But the level will always depend on the character and complexity of the project, which elements and how much is included in the cost figure, and the scale of the project (“economies of scale”). As of end 2015 the totally approved costs of Project preparation, Project management and related travel constitutes 8%, while the same calculation for disbursed funds gives a percentage of 10.3%. It could be expected that actual costs of administration will decrease as a share, inter alia because project preparation is finished, and disbursement to projects will increase (only 49% of approved funding is disbursed). Based on this it could be concluded that the cost-efficiency of project management is fully acceptable. In addition, Partners and beneficiaries in the three African countries visited and in Reykjavik expressed clearly that the Project was well managed. In addition, the partners were pleased with ISOR and UNU-GTP, who were regarded as highly professional and flexible. Meetings with UNEP, WB, AUC and the EU delegation confirm this positive observation.

The cost-sharing between NDF and ICEIDA as of December 2015 is 35% NDF and 65% ICEIDA, not 50/50 as indicated in the agreement. One reason for this is that not all project activities are eligible for NDF financing, and that the NDF has partner countries which receive priority in terms of financial support. In addition, the larger exploration projects funded under the NDF take longer time to prepare and implement, also causing delays. Therefore this ratio is expected to further improve in line with the plan.

The actual disbursement of funds as compared to Approved Disbursements gives an overall disbursement rate of 49%. The lowest rate is for capacity building (39%) while in terms of Project Management, etc, as much as 65% of the Approved Disbursements have been effectuated. The main reason for the overall low disbursement is the under-spending in Ethiopia caused by delays in project implementation, mostly due to customs (import of equipment).

The budgeted USD 13m is based on a contribution from each parties of EUR 5m. Since the exchange rate has dropped, the total NDF contribution is now estimated at USD 5.7m, while USD 5.8m is already committed by ICEIDA/MFA. This gives a total funding of USD 11.5m. According to the 2015 progress report already USD 10.963m are approved for disbursement, leaving only USD 537,000 for new projects during the remaining two years. Clearly the initial objective of carrying out reconnaissance and explorations at USD 1.1m per country will not be met, but as JICA has carried out reconnaissance studies in various countries the demand for such studies has been reduced. And even the revised outlook as given in the progress report with more emphasis on capacity building will be difficult to achieve given the little financing left. How the financiers will meet this challenge is beyond the scope of this Review. Possibly, reallocation of unspent funding to the most promising countries could be considered, as well as additional funding by NDF/MFA. The legality/feasibility of such changes needs to be established.

In terms of geographic focus it should be noted that as much as 33% of the Project budget as of end 2015 is allocated to Ethiopia alone, while only 27% refer to the total for the ten countries of Tanzania, DRC, Malawi, Zambia, Burundi, Zambia, Eritrea, Uganda, Comores and Djibouti. Kenya is budgeted to receive the second biggest share corresponding to 17%, while regional/general projects account for 7%.

4. FINDINGS

The Log frame for the Project is well structured and gives a good basis for concrete planning of sub-projects, but to a lesser extent for the monitoring of their progress as it is not broken down into groups (sub-projects). The outcome of the activities, and the outputs, can only be measured in the number of finished sub-projects. Of 20 sub-projects, 9 are finished, 7 ongoing, 1 is planned and 3 are under discussion. The Project has successfully completed almost half of the sub-projects that are set to finish in 5 years.

Few of the ongoing sub-projects are surface explorations of which some have been delayed for several weeks. The short courses conducted have been positively evaluated by the participants. A conceptual geothermal model for two geothermal areas in Ethiopia (Tendaho and Aluto) and one in Kenya (Suswa) should be finished this year with the siting of the first exploration wells. It should also be mentioned that surface exploration is underway in Alid (Eritrea) and Lake Abhe (Djibouti), as well as planned for two areas in Tanzania.

The Review Team is pleased to observe that the Project in general has contributed to what it had set out to do (albeit delayed in Ethiopia and no Project work on the development of policy framework and finance institutions). Reconnaissance reports and surface exploration reports are being processed and reports from short courses show that an increased level of knowledge has been gained, and according to interviews, put to use.

The present stage of development of 4 geothermal fields is outlined in the figure below. In mid-2016 conceptual models should be finished for three geothermal areas, two in Ethiopia and one in Kenya. The development of a geothermal field is expected to take 7 years but the Project covers only 5 years.

	2014				2015				2016				2017				2018		
	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS	OND	JFM	AMJ	JAS
Tendaho	Preparation etc				EXPLORATION				Reports	Model	Expl.drill	Prefeasb	Env.assessm	Production drilling					
Aluto	Preparation etc				EXPLORATION				Reports	Model	Expl.drill	Prefeasb	Env.assessm	Production drilling					
Suswa	Preparation etc				EXPLORATION				Reports	Model	Expl.drill	Prefeasb	Env.assessm	Production drilling					
Gdemsa	Preparation etc				EXPLORATION				Reports	Model	Expl.drill	Prefeasb	Env.assessm				Evaluation		
Time of the Geothermal Project 2013 - 2017																Evaluation			

Conceptual models and the drilling of the first exploration wells could be finished in 2016 and the Prefeasibility study and Environmental Assessment in 2017, before the Project winds up. A new surface exploration project in Tanzania (Luhoi and Kiejo-Mbaka) should have a similar timeline as Gdemsa in Ethiopia, and would therefore not be completed within the Project timeframe.

Although all the EARS countries have – to a smaller or larger extent – competence in the field, the need for geothermal expertise is rapidly growing. The Review Team therefore fully supports that the demand for expertise should partly be met by AGCE, supplemented by courses/TA run by the Project, other donors and training abroad. The Project should therefore continue to support the development and running of AGCE. Additional funds will be needed for this.

Geothermal resources are confirmed to exist in Ethiopia and Kenya and are being used in the production of electricity. These two countries also have substantial technical expertise (particularly Kenya), and they even assist neighbouring countries in exploration and training. Thus, it could be discussed if so much of the Project budget should be allocated to Stage 1 and 2 in countries/areas where the risk related to the source of energy is considered by local experts to be low and the level of competence high. It should therefore be considered if these countries can manage on their own in the search and exploration of the resource. They, however, might need assistance in the drilling process, evaluation of the resource, design and building of power plants. In the Western Rift Zone it is now considered unlikely that high temperature geothermal resources for electricity production exist. It needs, however, to be evaluated if geothermal energy is present for other uses such as drying, air cooling etc. It is pointed out that short courses in direct use of geothermal energy would be useful in those countries.

Table 2. Geothermal Exploration Stage 1 Tendaho, Alalobeda and Aluto Langano, Ethiopia

ACTIVITY	WORK PERFORMED	ASSISTANCE FROM PROJECT	REVIEW TEAM COMMENTS
1.1 Study of available information on the geothermal field, geology, reservoir assessment, characteristics of existing wells etc.	Carried out	Assistance given by the Project	Reports by ISOR received in final stage of editing.
1.2 Chemical analyses of fluid and gas from surface manifestations and wells	Carried out - data reviewed	Assistance given by the Project	Reports by ISOR received in final stage of editing.
1.3 Gathering of all maps, reports and literature regarding the presumed geothermal field	Carried out - data reviewed	Assistance given by the Project	Reports by ISOR received in final stage of editing.
1.4 Outline which data are missing and which additional (existing) data are to be obtained	Carried out - data reviewed + gap analysis	Assistance given by the Project	Reports by ISOR received in final stage of editing.
1.5 Site visit for first estimate of the field and meetings with local scientists for additional information	Carried out - data reviewed	Assistance given by the Project	Reports by ISOR received in final stage of editing.

Table 3. Geothermal Exploration Stage 2 Tendaho, Alalobeda and Aluto Langano

ACTIVITY	WORK PERFORMED	ASSISTANCE FROM PROJECT	OUTPUT/COMMENTS
2.1 Geological, geothermal and structural mapping in <ul style="list-style-type: none"> • Tendaho Alalobeda • Aluto Langano 	Surf. Expl. Geol. Surf. Expl. Geol.	Full assistance given by the Project Carried out by ELC	Final geol. report 2015 Feb - without maps Draft geol. report 2015 July - without maps
2.2 Chemical analyses and interpretation of fluids from the geothermal springs and fumaroles	Carried out	Assistance given by the Project	Reports by ISOR received in final stage of editing.
2.3 Surface geophysical methods including TEM (Time Domain Electromagnetics) and MT (Magnetotellurics) resistivity survey, micro seismic studies, gravity measurements etc	Tendaho: MT finished TEM finished Gravity. finished Micro seism. finished Aluto: MT finished TEM in progress Gravity. finished Micro seism. in progr.	For both: Full assistance given by the Project Carried out by ELC	Reports delivered to Review Team for these areas: Gravity report on Tendaho
2.4 Environmental Impact Assessment for exploratory drilling if applicable.	Not planned		<i>[ESIA for Aluto is covered under the WB programme]</i>

Table 4. Geothermal Exploration Capacity Building

ACTIVITY	WORK PERFORMED	ASSISTANCE FROM PROJECT	OUTPUT/COMMENTS
3.1 Strengthened policy and legal framework for geothermal utilization.	Not in Project		IFC and USAid have been working with Ethiopia on this
3.2 Courses and training carried out including that of UNU-GTP. Equipment purchased, Training courses abroad	E1 - Short course in Well design. E2 - Short course in Bankable Documents E3 - Short course in Proj.Management	Assistance given by the Project for all courses	Report - good course, useful 30 students Report - good course, useful 25 students Report - good course, useful 15 students - (male/female 12/3)
3.3 Strengthened ability of development and financial institutions to engage and support the geothermal development process	Not in Project	None	

Capacity building has been conducted through short courses, training on the spot and abroad. In all some 246 people have attended the short courses and workshops and 3 students have been on a 6 months course in Iceland (Ethiopia 2, Rwanda 1) and one is planned for 2016 (Djibouti).

Short courses have been and will be held in Kenya, Ethiopia, Rwanda and Djibouti. The courses are organized by UNU-GTP, and they have in general been both relevant and successful. The following topics have been covered in the courses, training and workshops conducted under the Project:

- Deep Geothermal Exploration
- Training in Drilling
- Short Course for Decision Makers (repeated once)
- Workshop for Geothermal Development Donors
- Well Design and Geothermal Drilling Technology
- Preparation of Bankable Documents (repeated once)
- Geothermal Project Management (repeated twice)

Through the review of the course documents, which also include ex-post ratings by the participants, it is apparent that attendants are satisfied and regard them as high quality courses, delivered by very able experts. During field visits some attendants of the courses were met, and they were all pleased with the training and its usefulness for their work.

It is difficult to assess the cost-efficiency of training/courses, as costs will vary depending on the type of course, what is paid by the organiser and how much by the participants. The teacher/participants ratio is also important. (But as underlined in international literature, it is the difference in terms of better service delivery that really matters).

The Review Team requested cost calculations of short-term courses from the UNU-GTP. One of the two detailed examples received was for a short course on Geothermal Project Management with 25 attendants. The cost calculation was assessed item by item and found to be consistent both in terms of amount of work (hours used in preparation, travel and training) and the cost per hour/day. The opinion of UNEP/ARGeo is that courses given by the Project are of high quality and not excessively expensive when compared with other courses and allowing for quality of teachers and high travel costs. Prices of courses vary greatly, but as an example a 3 week summer school on energy at The University of Reykjavik costs 1.900 US\$ for tuition and 1.600 for accommodation, in all some 3.500 US\$. A tailor-

made course including cost of teachers traveling to Africa and stay will consequently be more expensive.

The cost per student in three short courses studied in detail (cost tables are found in the Project File), which includes accommodation and travel, ranges from USD 3 210 to 4 769, and the average cost per attendant was USD 3 536. As information about only three courses were available with 13, 23 and 30 students, it is difficult to fully generalize from these data. The cost is, however, found acceptable, not at least because the training was carried out by highly experienced and able lecturers from abroad. In this respect it should, however, be considered for future reference whether qualified teachers from the region can be combined with fewer ones from Iceland, as has been the case in some of the courses.

Rating of the courses has been done by the participants after each course. Almost all the participants give the courses top score, i.e. 96–100% of the students state that the courses satisfy their expectations (knowledge, methodology, content and quality of lecturers). The majority of them also express that they can use the knowledge gained in their work.

It was suggested on several occasions in interviews that courses like Geothermal Project Management and Preparation of Bankable Documents should be repeated. It was also pointed out that the utilization of geothermal resources in the East African Rift Valley would require an increased number of geothermal experts. JICA (in 2010) estimated that for 2010–2020 some 903 experts would be needed in Kenya, Ethiopia, Djibouti, Tanzania and Uganda. To be able to supply these experts it is necessary to educate a good number of people every year and also to provide more intense overseas training e.g. in Iceland, Italy, New Zealand, Japan and USA.

From interviews in Kenya, Ethiopia and Rwanda it is apparent that capacity building and training is very high on their list of priorities regarding the use and development of the geothermal resources. The African Geothermal Centre of Excellence (AGCE) would be crucial in this respect. In several instances it was also suggested that refresher courses in various topics related to geothermal exploration, utilization and related subjects would be welcomed.

AGCE was established in 2015 and is supported by a number of donors including ICEIDA/MFA, NDF, JICA, UNEP/ARGeo. The AGCE is situated in Nakuru, Kenya but it is an African institution, managed by GDC. The aim of the centre is to provide practical and theoretical on-the-spot training in various subjects concerning geothermal energy. It was pointed out that it is very important to the African countries to have their own training centre and also to have partners and affiliates that will carry out complementary training such as UNU-GTP, Geothermal Institute of Auckland and others. A roadmap for the AGCE was to be produced in March 2016, but the centre has already begun to operate and is also using the KenGen's facilities in Naivasha.

A number of experts interviewed mentioned the importance of AGCE and UNEP/ARGeo and others regard it as a very important facility for training and education. The Review Team agrees with this and regards it as a highly important and much needed institution for training local scientists in geothermal research and utilization. As mentioned earlier un-approved Project Funds could be used for this purpose.

Gender equality is not an easy task as geothermal research, drilling, engineering, construction work and developing has for a long time been a male dominated industry. Only 15% of lecturers in the courses given by the Project are female: 35 male and 6 female. Nevertheless, there are signs that gender equality is developing gradually. In 1985-87 no women were involved geothermal research in Kenya, when one of the authors of this report worked there and the situation was most likely the same in other African countries. In meetings, during the field trip, female experts were in the minority, but women are heading offices in Rwanda and Kenya. One female was present in the Review Team's meetings in Ethiopia. Other relevant information is:

- Of the 35 people met in meetings 5 were women or 15%.
- Meetings in Iceland in January: 15 attendants, 2 female.
- In Ethiopia, Short Course on Drilling: 30 attendants, 1 female.
- In Ethiopia, Geothermal Modelling, all attendants were male but of the two teachers one was female.
- In Ethiopia, Geothermal Project Management: 25 attendants, 3 female.
- In Kenya, Geothermal Development for Decision Makers: 24 attendants, 3 female.
- In Kenya, Decision Makers; Burundi, DRC, Rwanda: 13 attendants, 1 female.
- In Kenya, Validation Workshop: appr. 63 attendants, 13 female.
- Tanzania, ISOR Survey Field Team: 6 researchers, 1 female.

Our observation that gender equality is growing is a positive move for the industry and the people of Africa. However, it might be hard to force it in areas where male dominance is part of the heritage and culture. Gender equality has to come from within, and should be encouraged by establishing a precedent, which is not done in the running of the Project.

Logistics in Kenya, Ethiopia and Rwanda are not easy. It was mentioned several times that customs are generally slow which can cause delays in deliveries and eventually in the Project activities. This can increase cost if fieldwork is held up and foreign experts have to extend their stay and hire-time of equipment increases.

It was noted in all the countries visited that ownership of land is not regarded a big problem for exploration or for the construction phase of power plants and pipelines. In these countries all land is regarded as government owned except in Kenya where private ownership is common. If farmers or nomads have to move their houses they get compensated (Kenya). Pipelines and power lines can cause obstructions but are not considered a problem by those interviewed. Pipelines do, however, obstruct migration of animals and stripping of pipelines by local people for metal is considered a problem in Kenya.

Laws and regulations are being revised in Kenya and Ethiopia as current mining laws are used to deal with geothermal areas, but are in many instances badly suited for that. It is time consuming to change laws and get new ones accepted. In the Project Document it is mentioned that the assistance is supposed to address policy and legal framework. During the field work it was found that the UK is providing assistance and both IFC and USAid are working with Ethiopia on this issue, and Kenya is almost finished drafting new laws.

The Project components on the development of legal and policy framework, and support to financial institutions, have not been carried out. The development of an enabling policy framework is by the Review Team regarded as crucial to attract the private sector. This is considered essential to speed up the development of geothermal electricity production, and several other donors like USAID, IFC and DIFID give assistance in this respect. Thus, the Project focus on the more technical aspects seems justified.

In Ethiopia it was learned that revision of laws is very slow and not all parliamentarians favour that private companies are developing geothermal fields. The production of energy should, in their view, be carried out by the government to ensure a just tariff for electricity to consumers. On the other hand, it was noted that the Rwandans welcome private investment in the energy sector.

Private investment in geothermal energy production was discussed in all field meetings. In all the meetings the view was that if energy production was completely in the hands of private firms, tariff to consumers would be higher than if the production was in the hands of public companies. The reason for this is the high risk associated with drilling the first wells for exploration and production. It was argued that if surface exploration and drilling of exploration wells was conducted by the government and energy source established, it would not be a risk for private firms to build the power plants

and tariff should not need to be any higher. On top of this, the government can both control the tariff and/or subsidise the price of energy.

Besides this, very few private companies have shown an interest in the development of the geothermal fields in the East African Rift Valley, e.g. Reykjavik Geothermal is the only private firm in Ethiopia aiming to develop the resource from exploration to production. In Kenya, however, GDC has signed a contract with three independent power producers to construct three power plants, each 35 MW. They will purchase steam from GDC and generate electricity and sell to the national power company (KPLC). This development is important for donors, who might want to alter their policy regarding aid, if independent companies are successful in energy production using one of these two different kinds of approach.

Competence of the East African countries in geothermal exploration and research has increased rapidly for the last 20–30 years. It was pointed out that in some of the short courses given by UNU-GTP the lecturers come from Kenya and Ethiopia. These countries have sent over 200 of their own scientists to Iceland, New Zealand, Japan, Italy and USA for training. The view of representatives of KenGen is that Kenya is self-sufficient as regards geothermal scientists and they are now able to advise other countries in East Africa. The Review Team is a bit reluctant to go along with that view.

Local competence is important, and progress needs to be supported by donor countries because more manpower is needed for the necessary development of geothermal resources in these countries. Training overseas and in the East African Geothermal Centre of Excellence in Kenya will help to raise knowledge and technical skill in the next 5–10 years. Competence, knowledge and skills of the persons interviewed in Kenya, Ethiopia and Rwanda support this view. The role of overseas countries will soon be mainly as appraisal body and as advisors to a well established geothermal community in Africa.

GDC in Kenya is a government institution that was established in 2008 to fast track the development of geothermal resources in the country. In Ethiopia it was mentioned that perhaps they should also set up a similar institution with the same aim. This would probably rely on new and improved legislation about such companies.

Equipment purchased through the Project has been successfully put to use in all the countries visited:

- In Kenya equipment has been procured for the GDC geochemical lab in Nakuru and it has been upgraded for appraisal to be an Internationally Accredited Lab. GDC noted that ISOR has through the Project been of great help in upgrading the lab. In the field meetings it was mentioned that it is very important for East African countries to have an accredited lab in Africa and not have to send samples overseas.
- Ethiopia has got equipment for surface exploration, including 4 vehicles. All equipment has been in constant use and made it possible to carry out field studies.
- In Rwanda equipment was purchased in connection with drilling in Karisimbi (2 microscopes, 2 laptops, monitors, printer, scanner and software, tools for fieldwork, geochemical equipment, and water level reel). This equipment is still in use and has made a difference in EWSA research work.

5. CONCLUSIONS

The overall conclusions of the Review Team are:

1. The Project Support to the development of geothermal energy in EARS countries is highly justified, both in terms of explorations and capacity building. However, the sustainability of this

support depends on the success of drilling, skilled manpower and the subsequent funding of further development into electricity production. Five countries have proven resources, and the donors interviewed indicate that funding for the more expensive phases will be coming. Thus, the chance of reaching its goal (outcome) is assessed as promising.

2. The Project support has changed significantly during the 3 years of operation, from a planned heavy emphasis on reconnaissance and explorations (78% of Project budget) to more support for capacity building. The demand for skilled people in the field is expected to rise considerably. Thus the Review Team fully supports this change of direction.
3. Reconnaissance studies have, according to received documents, been carried out in Zambia, Tanzania and Burundi, as compared to planned 10 EARS countries specified in the Project Document.
4. Surface exploration have been or are being carried out in Ethiopia (Tendaho Alolobeda, Aluto Langano and Gdemsa), Kenya (Suswa), Eritrea (Alid), Djibouti and planned in Tanzania (Luhoi, Ngozi and Kiejo-Mbaka), i.e. in five countries as compared to 9 countries planned in the Project Document. Thus, the number of surface exploration studies is nine albeit in fewer countries.
5. Capacity building/training, mainly through cost-effective short courses and on-the-job training has been carried out and are positively judged by attendants in course ratings.
6. Equipment for geothermal exploration and analysis has been purchased and put to use in Kenya, Rwanda and Ethiopia. A good and useful work has been carried out by upgrading the chemical lab in Nakuru, Kenya to becoming an accredited lab.
7. As much as 33% of the budget has been allocated to Ethiopia alone and 17% for Kenya, while the 10 other countries receive only 27% the budget. Since Kenya and Ethiopia are among the most advanced in the geothermal field, a stronger focus on the other countries with proven resources should be considered.
8. The cost-efficiency of Project activities has been reviewed in light of international experience. The cost of management is at a fully acceptable level, and the training carried out is cost-effective. The cost of short courses is similar to high level geothermal courses in Iceland. Care should be taken to have as many students as possible attending these courses to keep cost per student down. Both the management of the Project and training carried out receive a positive feed-back from partners and recipients of the training.
9. According to the 2015 progress report, USD 10.963m are already approved for disbursement, leaving only USD 537,000 for new projects during the remaining two years. Clearly the initial objective of carrying out reconnaissance and exploration at USD 1.1m per country will not be met. And even the revised outlook as given in the progress report with more emphasis on capacity building will be difficult to achieve given the limited funds that still remain. How the financiers will meet this challenge is beyond the scope of this Review.

One of the expected results of the Project is “*Strengthened policy and legal framework for geothermal utilization*”, and support to financial institutions in the field. However, this task is not mentioned in any of the documents received, and does not seem to have been carried out. The development of an enabling policy framework is, by the Review Team, regarded as crucial for the involvement of the private sector to develop and manage future geothermal electricity production. Several other donors like USAID, IFC and DIFID give assistance in this respect. Thus, the Project focus on the more technical aspects seems justified.

6. RECOMMENDATIONS

Recommendations and ideas for the Project are:

1. Continue emphasis on capability building through short courses.
2. Set up an appraisal committee to evaluate reconnaissance and surface exploration reports and especially the siting of exploration wells.
3. Organize training “on the job”:
 - By getting overseas experts to the respective country for 6–12 months, working in close cooperation with local experts in certain field like geology, reservoir engineering etc. (Rwanda and Ethiopia)
 - By organizing training in other countries where African experts can work for 6–12 months in firms and/or organizations in geothermal countries. This has already been done in Iceland with promising results for experts from Rwanda, Ethiopia and Kenya
4. Conduct refresher courses in various topics concerning exploration and utilization of geothermal energy. These courses could be given in cooperation with the African Geothermal Centre of Excellence.
5. The successful short courses in Project Management, Bankable Documents and others might be useful to other EARS countries.
6. In Rwanda it is recommended to continue studying drying of agricultural products with a study on cost benefits and other direct uses. This would also benefit other countries with low enthalpy fluids.
7. Both financial and practical (experts for training) assistance should be given to the Geothermal Centre of Excellence in Kenya.
8. It is recommended that in the latter half of the Project more aid should be put into Tanzania, Eritrea and Djibouti.
9. Sort out jointly with NDF the financial situation due to the limited funds left for new projects in the remaining Project period. Possibly, reallocation of unspent funding to the most promising countries could be considered, as well as additional funding by NDF/MFA. The legality/feasibility of such changes needs to be established.
10. Facilitate that the relatively small investments done by the Project are leveraged by sufficient funding for the remaining stages. In this respect it could be considered that the Project gets more involved in the preparation of project proposals for further funding of subsequent stages. This could possibly be based on the structure taught in the courses on “Bankable Documents”. Continued close cooperation with the World Bank and other financiers would also be required in this respect.

Reykjavik 2016; January 18 and 19

ICEIDA/Ministry of Foreign Affairs

1. Gísli Pálsson – Head – M&E
2. Engilbert Guðmundsson – Ex director general of ICEIDA
3. María Erla Marelsdóttir – Ambassador, Director General - Dir. of Int. Developm. Cooperation
4. Davíð Bjarnason – Program manager

RG - Reykjavik Geothermal

5. Þorleifur Finnsson – Managing director, Head of project development
6. Gestur Gíslason – Managing director, Geochemist
7. Hjálmar Eysteinnsson – Director, Geophysicist

Efla - Consulting Engineers

8. J. Rúnar Magnússon – Manager, Geothermal Energy
9. Sunna Björg Reynisdóttir – Geothermal and District Heating expert

ISOR - Icelandic Geosurvey

10. Ólafur Flóvenz – Director General
11. Bjarni Richter – Marketing- and Project Manager, Geologist
12. Daði Þorbjörnsson – Geologist

UNU-GTP - United Nations University

13. Ingimar Guðni Haraldsson – Deputy Director

ICEIDA /Ministry of Foreign Affairs

14. Gísli Pálsson – Head - M&E
15. Davíð Bjarnason – Program manager

Africa 2016: February 8 to 15

Kenya

GDC - Geothermal Development Company

16. John Lagat, geologist – in care of training
17. Rosmary Okello, teacher – in care of training
18. Mariam Yunus – in care of human resources
19. Sarah Lagat – Centre of Excellence
20. Paul K. Ngugi - Managing director and CEO, latter part of meeting

KenGen - Kenya Electricity Generating Company

21. Peketsa Mangi, Chief Research and Consultancy Manager
22. Ronoh Kibet, Geothermal Projects Engineer – in care of projects
23. Abel Rotich, Geothermal Development Director (attended the meeting for a short while)

UNEP - United Nations Environmental Programme

24. Dr. Mezeret Teklemariam Zemedkun, Program Manager
25. Moses Mbego, assistant to Dr. Zemedkun

Ethiopia

EGS - Ethiopia Geological Survey

26. Solomon Kebede, Director

EEPCO - Ethiopian Electric Power Corporation

27. Fikru Woldemariam, Division Chief
28. Neway Abera, Project Manager

WB – World Bank

29. Issa Mare Diaw, Senior Power Engineer
30. Kenta Usui, Energy specialist

AUC – African Union Commission

31. Rashid All Abdallah, Energy Expert

RG - Reykjavik Geothermal

32. Jón Örn Jónsson, project manager

Rwanda

EWSA - Energy Water and Sanitation Authority

33. Uwera Rutagarama, reservoir engineer

EUD - European Union Delegation

34. Julius Mugambira, programme officer

Iceland, Reykjavik 2016 Mars 03

WB - World Bank

35. Þráinn Friðriksson, Geothermal Expert

ANNEX 2 ACRONYMS

AGCE	Africa Geothermal Centre of Excellence
AGDS	African Geothermal Data System
ARGeo	African Rift Geothermal Development Facility
AUC	African Union Commission
BGR	The Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe)
BGRM	The French Geological Survey
CERD	Centre d'Etude et de Recherché de Djibouti
DFID	Department for International Development
DRC	Democratic Republic of Congo
EAC	East Africa Community
EAGER	East African Geothermal Energy
EAGP	US-East Africa Geothermal Partnership
EARS	East African Rift Valley Countries
EDCF	Energy development, Rwanda, with the Geothermal Unit
EDCL	Energy Development Corporation Limited, Rwanda
EEA	Ethiopia Electric Agency
EEP	Ethiopian Electric Power
EEPCo	Ethiopian Electric Power Corporation
EGS	Ethiopian Geological Survey
ELC	Electroconsult, Italy
ESIA	Environmental and Social Impact Assessment
EU	European Union
EUD	European Union Delegation
EWSA	Energy Water and Sanitation Authority
GDC	Geothermal Development Company
GGDP	Global Geothermal Development Plan (WB)
GRMF	Geothermal Risk Mitigation Facility
GSE	Geological Survey of Ethiopia
GTP	Geothermal Training Program
ICEIDA	Icelandic International Development Agency
IFC	International Finance Corporation (member of WB)
ISOR	Islenskar Orkurannsoknir / Iceland Geosurvey
IPPs	Independent Power Producers
JICA	Japan International Corporation Agency
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electricity Transmission Company
KPLC	The Kenya Power and Lighting Company
MFA	Ministry of Foreign Affairs (Iceland)
MoE	Ministry of Energy
MT	Mid Term Review
MTR	MagnetoTelluric (geophysical exploration methods)
NCG	Nordic Consulting Group
NDF	Nordic Development Fund
ODDEG	Djiboutian Office for Geothermal Development
ProDoc	Project Document
REG	Rwanda Energy Group Limited
RG	Reykjavik Geothermal
TA	Technical Assistance
TEM	Time Domain Electromagnetics (geophysical exploration methods)
ToR	Terms of Reference
UNEP	United Nation Environmental Programme
UNU-GTP	United Nations University – Geothermal Technical Programme
USAID	United States Agency for International Development
WB	World Bank