

Opportunities and Challenges in Geothermal Exploration and Development in Ethiopia

Solomon Kebede, Director, Geothermal Directorate
Geological Survey of Ethiopia, Addis Ababa,

Keywords

East African Rift, high enthalpy, Ethiopian Rift, energy mix, stable supply

ABSTRACT

Surface explorations for geothermal resources in Ethiopia began over three decades ago. The geothermal explorations so far have identified over 22 areas that have geothermal resources suitable for electricity generation, with a total potential of 10,000 MW. These resources are considered to have high quality in terms of temperature and chemistry.

Despite the countries long term geothermal exploration and huge potential, the progress of development of geothermal resources has been slow. Deep drilling has been conducted only in two prospects and only a 7.2 MW pilot plant has been installed so far. However, since recent years the country has adopted, a renewable energy mix policy, geared towards the advancement of geothermal resources development, including other renewable energy resources. Accordingly both the public and private sector geothermal projects are being implemented at larger scale than before.

The public sector has focused in developing, the two most explored prospects in the country, the Auto Langanu and Tendaho geothermal fields. Under the public sector, geothermal power plants planned for commissioning by 2020 include: (i) 70 MW plant at Aluto Langanu and 100 MW plant at Tendaho Additional geothermal power plants are expected to be commissioned at Corbetti geothermal field by private sector involvement, with a total capacity of 1000 MW, to be developed under various phases.

Despite the recent efforts to advance geothermal development in Ethiopia, there are challenges that include: (i) high upfront capital costs required and availability of sufficient finance, (ii) risks associated with the exploration phase, and (iii) limitations in local human resource capacity and low level of experience in institutional set up, a legal and regulatory framework.

1. Introduction

Ethiopia started long-term geothermal exploration in 1969. Over the years, an inventory has been built up of the possible resource areas within the Ethiopian sector of the East African Rift system, as reflected in surface hydrothermal manifestations. The inventory work in the highland regions of the country is not complete but the rift system has been well covered. Of the about 120 localities within the rift system that are believed to have in-

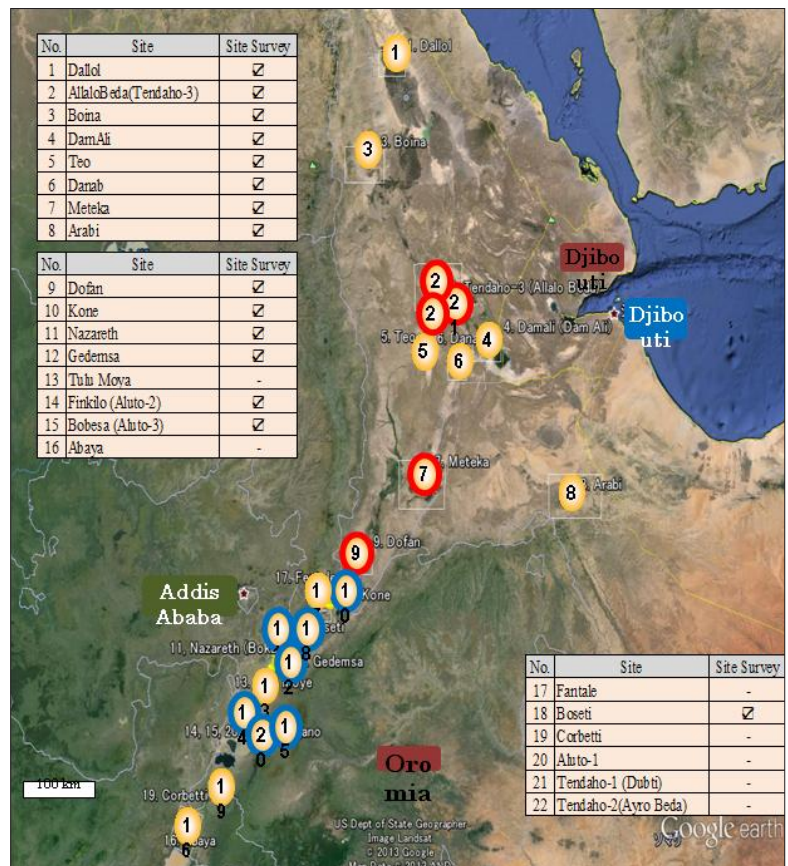


Figure 1. Location map of high enthalpy geothermal resources in Ethiopia.

dependent heating and circulation systems, about two dozen are judged to have potential for high enthalpy resources, for electricity generation (Figure 1). A much larger number are capable of being developed for non-electricity generation applications such as horticulture, animal breeding, aquaculture, agro-industry, health and recreation, mineral water bottling, mineral extraction, space cooling and heating, etc. (UNDP, 1973).

The geothermal resources in Ethiopia are economically viable, due to the following main reasons:

- The resources have high reservoir temperatures ranging from over 200 to 335°C;
- The depth to the reservoirs are economical, ranging from 500 to 2500m;
- The resources have low non condensable gas content and low scaling potential; and
- The geographical location of the resources is very close to existing infrastructures (roads, transmission lines etc).

Despite the country's long history of geothermal exploration and over 10,000 MW potential, the only power plant so far installed is at Aluto Langanu geothermal field. A 7.2 MW capacity pilot geothermal plant was installed in 1998. The main reason for the delay in geothermal development has been lack of priority for geothermal in the Energy sector development plan in the past. As a result the main focus has been given to hydropower development. Hydropower generates more than 90% of electricity in Ethiopia. However, as the rainfall in Ethiopia varies considerably from year to year, the need to diversify the country's energy sources to ensure a stable supply is critical. It also implies that overdependence on hydropower makes energy supply unstable, resulting in heavy strains on the pace of growth in every sector and the whole economy by extension.

In order to avert possible shortfalls and also due to their added advantage in complementing the hydro generation during unfavorable periods of severe droughts, geothermal development in Ethiopia has been given more attention, in recent years.

2. Current Opportunities

In recent years, the country has shifted its policy of relying in a single source of electric power (hydro) to secure energy in the country and thus geothermal sector development is receiving support. As a result a long term geothermal development plan has been established. According to this plan, a total of 2500 MW geothermal power is to be developed by 2030 (Abayneh, 2013).

In order to achieve the long term goal, currently the following geothermal activities are being conducted in Ethiopia:

- A five year project entitled Strategic Geothermal Resource Assessment in the Ethiopian Rift Valley was started in 2009. The target areas of the assessment are Tendaho, Aluto Langanu, Gedemsa, Dofan, Fentale, Meteka and Arabi, Geoscientific studies including: (i) geological, (ii) geochemical, (iii) geophysical (MT, TEM, Gravity and Magnetics) and (iv) Reservoir engineering studies are being conducted in these areas. The objectives of the project are to locate and identify areas (sites) for deep drilling by

acquiring data that can supplement the already available studies, and upgrade and synthesize all existing information in order to establish a geothermal exploration conceptual model for future feasibility studies.

- Ethiopia and Japan conducted a feasibility study for the expansion development of the Aluto Langanu Geothermal Field in 2010 which proved the expansion plan to be feasible. A project for resource evaluation by drilling of three appraisal deep wells and one reinjection well has been designed (West Jec, 2012). The project is financed by the government of Ethiopia, Japanese government and the World Bank. In this project so far the following activities have been carried out: (i) Pre drilling preparation including well pad preparations, maintenance, testing and erection of an existing rig at the project site, and (ii) purchase of drilling consumables from overseas and training of local staff and capacity building required for the project. The drilling of four wells has commenced in October 2013. Additional work to be conducted in parallel with the drilling has commenced, with the assistance of Icelandic international development agency (ICEIDA) and the World Bank, which includes, production wells drilling, site selection and purchase of rigs and additional consumables.
- At Tendaho, a project proposal has been prepared to develop the geothermal resource to 100 MW at various phases. Additional surface studies indicated that, the previously drilled deep wells were not deep enough to encounter the main reservoir. In order to study the feasibility of utilizing the discovered shallow reservoir and further deep drilling, preparatory work has commenced. Currently early stage of work has commenced with assistance of African Rift Geothermal facility (ARGeo), French development agency (AFD), and ICEIDA.
- Japan international cooperation agency (JICA) and geological survey of Ethiopia (GSE) have signed an agreement on June 2013, for geothermal master plan studies in Ethiopia. The project has started by conducting, geoscientific, social and economic surveys in 22 prospects in order to prioritize them.
- Regarding the private sector participation, hot power purchase agreement (PPA) for Corbetti geothermal development has been signed in October, 2013 between the Ethiopian electric power corporation (EEPCo) and Reykavik Geothermal (RG) for the development of Corbetti geothermal field. The agreement considers development of the Corbetti (including Abaya and Tulu Moye) prospects to 1000 MW with estimated investment cost of 4 billion US\$. (Lemma, 2012, RG, 2012).

3. Challenges and Strategies to Overcome

The main challenges could be highlighted as:

- High upfront capital costs required;
- Risks associated with the exploration phase;
- Limitations in local technological and human resource capacity;

- Limitations in experience regarding institutional set up, legal and regulatory framework in geothermal; and
- Insufficient participation of the private sector.

Currently strategies are being designed to overcome the challenges, The most important things planned to be implemented to achieve the objective of rapid geothermal resource development are:

- Define and perform a detailed assessment of options for geothermal sector development, including benchmarking and extensive leveraging of international approaches to managing upfront risks;
- Define core institutional and organizational capabilities required and create an action plan for developing requisite business skills and execution capacity within relevant institutions;
- Detail a portfolio of bankable projects for Ethiopia and how these would be developed based on the various options available to meet the goal of 2500 MW on line by 2030;
- Building capacity in design, development, operation, maintenance, consultancy and gradual manufacturing of electrical equipments as well as appliances; and
- Enhance the role of the private sector by improving the enabling environments.

4. Conclusions

Despite the long history of geothermal exploration in Ethiopia and an estimated 10,000 MW potential, so far only a very little fraction of the total potential is harnessed. In order to avert possible shortfalls and also due to their added advantage in

complementing the hydro generation during unfavorable periods of severe droughts, geothermal development in Ethiopia has been given more attention, in recent years.

Currently geothermal is: (i) integrated in the national energy development plan, (ii) has growing participation of international financial institutions, bilateral donors and development agencies to assist geothermal development projects, and (iii) encouraging the private sector to participate in geothermal development projects.

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