HURDLES TO FINANCING GEOTHERMAL DEVELOPMENT IN ARGeo COUNTRIES, WITH SPECIAL FOCUS ON KENYA

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ABSTRACT

Resource prioritization in geothermal energy development is a core function of policy makers in any country. In Kenya, the known geothermal prospects occur within the Great Rift Valley where widespread volcanic activity and geothermal manifestations signify existence of viable geothermal energy resources, which can be utilized for both electricity generation and direct uses. Geothermal resources in the rift are estimated to be able to support generation of over 2000 MWe. The Country's Least Cost Generation Expansion Program has identified geothermal to be among the least-cost sources of indigenous energy in Kenya. Based on this program, the National Power Development Plan requires an additional 512 MWe of geothermal power to be installed by the year 2020. This requires an estimated funding in the region of US$174 million per field for a 70 MWe power plant. This is a significant figure for a developing country such as Kenya. As would be expected therefore, funding remains the biggest hurdle to developing this energy resource in the country. To meet the indicated target in the next 15 years or so, it is necessary that a reliable cash stream be established. The initial high-risk exploration activities leading to pre-feasibility work should remain the responsibility of public institutions as part of their inventory of the country's resources. Power plant construction can be shared between the public sector and Independent Power Producers. The institutional framework, legislation and legal constraints also need to be addressed to reduce contract or policy uncertainties and expedite licensing so as to attract private developers in the industry.

INTRODUCTION

The East African rift system is widely recognized as the classical example of a continental rift system within numerous central volcanoes that are associated with geothermal activity. Studies indicate that geothermal reservoirs with temperatures over 200^{o}C exist beneath the rift. This resource has not been fully tapped by countries traversed by this geological feature, in spite of proven long-term success stories in other countries around the world.

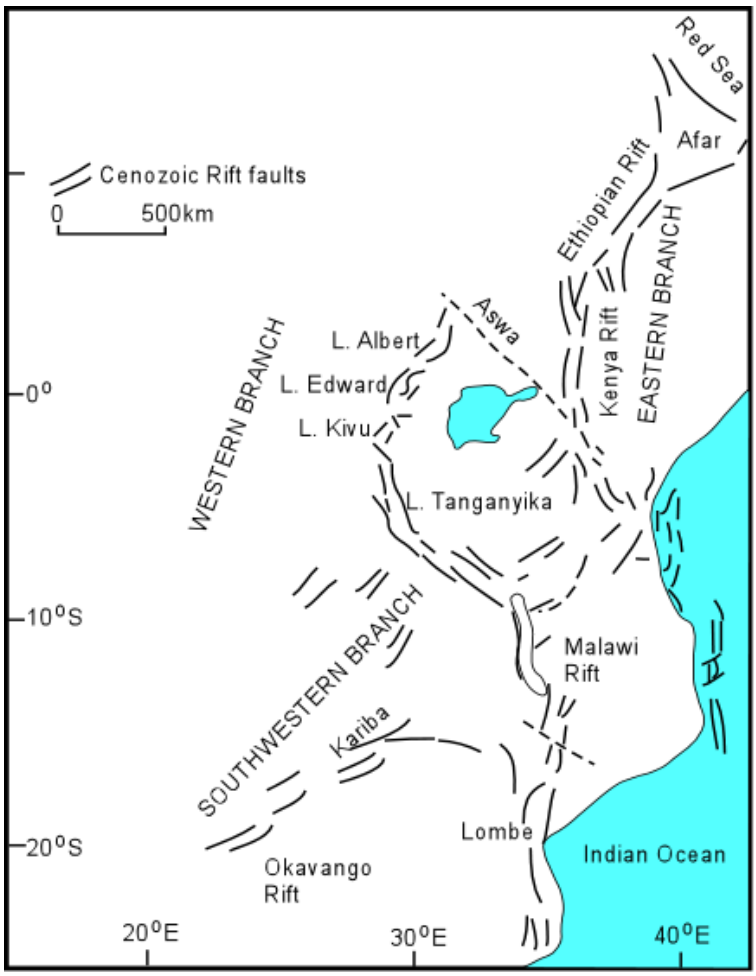

Figure 1: Structural map showing the East African Rift System (From Atekwana et al., 2004)

A general experience from other countries of the world indicates that hurdles that have to be overcome for geothermal resources to be developed can be grouped into two areas, namely, Financial and Institutional (Thorhallsson, 2005).

Financial:

- The initial investment cost is high for geothermal field development; equivalent to buying all the "fuel" up front for decades of operation.
- High-temperature areas (suitable for electricity generation) are mostly in remote volcanic regions away from population centres.
- Investors are frequently sceptical and unfamiliar with this energy source.

Institutional:

- Geothermal has not graduated from being government enterprises or from geological and volcanological institutes.
- There are very few companies selling geothermal steam and geothermal water to designated industrial parks. The present day operators are utilities or companies that have

their primary interests in power generation but have as yet shown limited interest in small-scale industrial uses.

- The geothermal law and leasing of geothermal rights is new or non-existent. Obtaining environmental permits and resource concessions take time.

This paper reviews the current status of geothermal development in Djibouti, Eritrea, Ethiopia, Uganda, Kenya, Tanzania and Zambia (generally referred to as ARGeo countries) and investigates the major hurdles that have curtailed any significant use of the resource. Kenya is taken as an example to see how it has tried to overcome some of these hurdles to become the largest user of geothermal energy in the region.

STATE OF GEOTHERMAL DEVELOPMENT IN ARGeo COUNTRIES

The ARGeo countries have similar energy production and consumption characteristics. Most of them are dependent on fossil fuels as a primary energy source. They use traditional biomass fuels that represent the largest category of energy produced, ranging from 70 - 90% of total energy production (Teklemariam, 2005). Renewable energy sources represent a small portion of total energy production. Hydropower is currently the predominant mode of electricity production in the region (over 70%), yet recent droughts and silting of reservoirs pose questions concerning the reliability of these resources. Thermal production (mainly diesel generation) is used in most of the countries and is the only source of power production in Eritrea and Djibouti. This over-dependency on thermal and hydro power makes the electricity not only expensive but unreliable due to the ever escalating oil prices and erratic weather conditions. Exploration and utilization of geothermal energy resources in the East African region for the last three decades has indicated that the region has a large untapped geothermal resource potential. Using today's technologies, the region has the potential to generate 2500-6500 MW of energy from geothermal power (GEA, 1999). Despite this potential, only Kenya has active geothermal operations as part of the country's electricity generation infrastructure with a total installed geothermal capacity currently standing at 128 MWe. Geothermal has proved to be reliable and economic, running at 98% availability (Mwangi, 2005).

Ethiopia started a long-term geothermal exploration undertaking in 1969 and over the years a good inventory of possible resource areas within the rift has been built. A 7.2 MWe net capacity pilot plant was installed in Aluto Langano area in 1999 (Teklemariam and Beyene, 2005) which operated for a short while before encountering operational difficulties that were essentially due to lack of appropriate field and plant management skills.

In Zambia, reconnaissance survey has been carried out on geothermal areas since the 1950's. A mini geothermal pilot power plant of 200 KW was installed on the basis of limited exploration work at Kapisya Geothermal Project on the shores of Lake Tanganyika. The plant, however, never became operational due to lack of trained manpower and transmission lines to load centres. Plans are in place to restore the plant and make it operational.

In Djibouti, much effort has been expended since the seventies, in view of developing the country's indigenous energy resource. Six exploratory wells have been drilled in the Assal prospect and intercepted a very high temperature system. However, due to the high salinity of the encountered fluids and lack of funds, the resource development has been delayed.

A reconnaissance survey has been carried out on geothermal areas of Uganda since 1935. Recent geo-scientific studies have focused on three geothermal systems, i.e., Buranga, Katwe and Kibiro, all located in the active volcanic belt in the western rift. No drilling has been done in Uganda yet.

The Eastern Lowlands of Eritrea are of potential geothermal interest, and first priority was given to the Alid Volcanic centre for exploration as it has numerous manifestations in the form of hot springs and fumaroles. Detailed geo-scientific investigations are underway in this prospect inferring reservoir temperature of about 250ºC.

The rest of the countries have not made much progress in the exploration and development of this enormous, untapped resource estimated at over 7,000 MWe in the East African Rift. Review of the ARGeo countries' energy development plans indicates that the main cause of lack of exploitation of geothermal energy is limited financial resources and expertise, largely arising from limited conducive legal frameworks and political will.

Rationale for Power Sector Reform

The bulk of the existing literature, often equate reform with deregulation or, more specifically, the drastic reduction of government participation in the power sub-sector. This view has been bolstered by numerous studies that appear to equate poor performance in the sub-sector with high state intervention. Studies carried out by Africa Energy Research Network, AFREPREN, (Karekezi et al., 2000) indicate that in Africa, most of the entities in the energy sector such as electricity utilities are state-owned and it is, therefore, not surprising that reforms have tended to minimise the state's involvement in the power sector. The need for embarking on comprehensive power sector reform arose from two primary concerns. First is the dissatisfaction over the poor technical and financial performance of the state-owned power utilities. The study demonstrated that most of the utilities in Africa register poor performance. The second concern is the inability of utilities and the Government to mobilise sufficient investment capital for the electricity sub-sector's development and expansion. Other reasons for power sector reforms include (1) introducing competition, (2) tariff reform, (3) minimise government's regulatory role and (4) amending energy Acts. It is envisaged that if the aforementioned scenarios are addressed then investors may be attracted to infuse funds into the energy sector.

Recent surveys (Wamukonya, 2003) in 48 sub-Saharan African countries revealed that, in contrast to other regions in the developing world, sub-Saharan Africa has been the slowest region in reforming its power sector. Among the ARGeo countries, Uganda leads in the number of reforms in the energy sector followed by Kenya, Zambia, Ethiopia, Tanzania and Eritrea at the bottom of the list. The majority of the countries reforming their power sector have mainly invited IPPs to offset the generation shortfall experienced by the state-owned utilities. There appears to be much slower progress reforms aiming at minimising or withdrawing government control of the power sector, such as establishment of independent regulatory agencies. Unfortunately, even those countries with commendable reforms, recent discouraging developments in these countries (notably Kenya, Uganda and Zambia) have cast doubts over commitments to these reforms, (Karekezi and Mutiso, 2000; Engorait, 2003).

Limited Technical Information on Geothermal Technologies

Even if the legal framework and the political conditions were ideal to attract investment inflows to the geothermal industry there is need for a proof of the existence of a geothermal resource. The information from many of these countries (with the exception of Kenya and Ethiopia) is not sufficient enough to attract investment. Many of the geothermal projects in each country are in their conceptual or early planning stages. These projects include surface geo-science studies, exploratory drilling and reservoir assessment studies. A few, such as in Kenya and Djibouti, require power plant design and equipment. Some countries are shopping for business partners to develop or bid on new or existing geothermal projects.

The feasibility studies on Lake Assal area recommended the development of a 30 MW geothermal plant. Work on this will require more drilling of more wells and testing, reservoir assessment, treatment of the exceptionally high salinity, plant design and equipment. As yet, there is no technical solution to the salinity problem and financing to the project has not been secured. Hence there is insufficient technical information to attract private sector participation.

Accelerated surface exploration activities in Eritrea have been hampered by lack of enough trained scientists. In the recent past this has been partially addressed by technical assistance from the Germany Government through the GEOTHERM Programme. Technical investigations are needed for Alid prospect (including detailed surface geo-scientific studies) to enable siting of exploration wells, culminating in a 5-MW pilot plant.

Currently, hydro-electricity provides around 97% of Ethiopia's electricity. This has tended to overshadow development of the country's geothermal resources. Despite the fact that the Ethiopian Ministry of Mines, under whose portfolio development of geothermal energy falls, has a sizable number of trained scientists and engineers, this expertise has not been fully utilised. Another possible cause of the lukewarm approach to geothermal energy development was the shut down of the Aluto Langano pilot plant.

Uganda, like its northern neighbour, Ethiopia, heavily relies on hydropower. Although there appears to be a will on the part of the government to develop geothermal, little has been done to harness it. Uganda largely depends on donor funding, which has been easy to secure from the World Bank and other development partners. Unfortunately, this money has gone to financing large hydro projects instead of geothermal.

Up to recently, geothermal exploration activities in Uganda have been very slow; this has largely been because of limited funding and lack of local expertise on geothermal energy technologies. The Uganda Government has recognised that it does not have enough geothermal technical data to offer interested developers. To address this gap, it has appealed and received technical assistance from the governments of Iceland and Germany to carry out surface exploration.

The Tanzanian Government views its power from hydro as the most important indigenous source for commercial energy. In recent times, its dependency is slowly shifting to natural gas. Tanzania is endowed with a huge geothermal potential which has not been tapped, and has only been explored to a limited extend, largely due lack of technical expertise. Geothermal, though not yet exploited in Tanzania is worth considering as one opportunity to contribute to stabilising energy

supply and energy prices. To do this, there is need to enhance the policy, legal and regulatory framework so that an international partner can be found.

The Zambia Electricity Supply Corporation (Zesco) has announced that it is probing the feasibility of venturing into geothermal electricity generation. However the utility lacks the expertise to revive the Kapisya geothermal plant. Technical assistance has been extended to Zesco by the Kenya Electricity Generation Company (KenGen) to rehabilitate and re-commission the existing Kapisya plant and to investigate the possibility of increasing capacity. KenGen has also carried preliminary surface exploration at Chinyunyu Hot springs, near Lusaka.

Towards the objectives of faster exploration and development of geothermal resources in the region, multi and bi-lateral efforts are being made. Among these, the African Rift Geothermal Energy Development Facility (ARGeo) Project is a critical component. The objective of the project is to promote geothermal resource utilization by removing the risks related to resource exploration and development and by reducing the cost of power development project implementation. The ARGeo Project is planned to deliver a package consisting of financial and technical inputs as a means of realizing that promotion.

THE KENYA'S EXPERIENCE IN FINANCING GEOTHERMAL DEVELOPMENT

The Least Cost Generation Expansion Plan (KPLC, 2001) identified geothermal energy to be the least-cost base load source of power for Kenya. This requires that 512 MWe of geothermal power be installed by the year 2020. Reforms in the power sector in Kenya have opened up the industry to private sector participation and competition. This has necessitated a review of the manner in which financing of geothermal projects is being undertaken in the country, in order to enhance operational efficiency and cost-effectiveness. Geothermal projects are capital intensive. Like other projects of a similar nature, their feasibility in terms of technology, financial and market viability need to be verified prior to their execution. Among the key tools that have been widely used in Kenya to determine the feasibility of geothermal projects, *inter alia*, are the Economic and Financial analyses.

Phases of Geothermal Development and their Costs

Resource Exploration

In Kenya, the government is responsible for carrying out surface reconnaissance work and exploration drilling before offering a prospect to an IPP for development. The output of a successful surface study programme is the siting of exploration wells. This stage involves drilling at least 3 deep (2,000-2,500 m) exploration. The total cost of surface work, drilling of the three wells, testing is about US$ 8 million.

Resource Assessment

Again, this is left to the government. The resource assessment stage involves appraising the proven field to determine the extent of the reservoir. This requires drilling of at least 6 - 9 deep wells which account for about 30-50% of the steam required for a 70 MWe power plant. The six appraisal wells cost about US$ 16 million, including testing and Environmental Impact

Assessment. It is a requirement that a resource is proved to between 50-100% of the anticipated steam requirement before it can attract a private investor.

Power Plant Development

Ordinarily, the data provided by appraisal wells is capable of verifying all the hypotheses about the resource, including any postulated natural-state models, including confirming that the reservoir is productive and contains enough fluids with appropriate characteristics. This stage involves drilling of about 18 production wells at a cost of about US$ 45.5 million inclusive of testing. Design, construction of the power plant, steam gathering systems and interconnection of transmission lines brings the total cost to about US$ 150 million.

HURDLES TO FINANCING GEOTHERMAL PROJECTS IN KENYA

Kenya, like other ARGeo countries, has been faced with several difficulties in the development of its geothermal resources, the greatest of which has been the large capital outlay that is needed to bring it online. It has also taken time to have the necessary legal framework for geothermal activities and attain the expertise for exploration and exploitation.

Commercial financing and country risk barriers

Commercial financing barriers arise as a result of the high up-front costs of geothermal energy projects, especially before a resource is confirmed. Very few institutions can lend money when the future income from the development is actually uncertain. This increases the project's financial risk profile.

Kenya approaches bilateral and multilateral agencies who have been able to offer loans or credits to at concessionary rates with attractive repayment terms. However, these institutions tend to have time-consuming and structured procedural requirements that at times go beyond the specific project requirements. This is exemplified by the financing of Olkaria II Geothermal Power Project, where the World Bank, European Investment Bank (EIB) and Kreditanstalt Für Wiederaufbau (KfW) of Germany were involved. The International Development Association (IDA) was the lead financier of this project and provided a sum of SDR 86.6 million (equivalent to about US $ 125 million) towards the construction of the power plant, amongst other sectoral needs. This was on condition that KenGen was able to raise from its internal resources between 20-25% of its capital expenditure requirements annually.

Legislative Framework

The power sector reforms since the 1960s have been undertaken largely through instigation by the World Bank as a condition for extending power sector development assistance to the Government of Kenya. As the Government continued to seek further development funds from the Bank, more reform conditionalities were introduced covering tariffs and rationalization of the power sector activities.

Prior to 1994 there were no significant power sector reforms, which could influence market entry by independent power producers and distributors (IPPs and IPDs). The power sector was

therefore dominated by state owned companies and issues relating to tariff adjustments, private sector participation and mobilization of capita had to be approved by the Government. On these matters, political considerations rather than commercial viability of the state owned companies dictated the level and timing of the necessary authorities.

These controls acted as trade and investment barriers leading to inefficient allocation of scarce resources and therefore discouraged private investment. To correct this situation that had impacted adversely on general economic performance and growth, the government repealed many of the Acts related to the energy sector in the early 1990s, resulting in minimising or withdrawing government control of the power sector, such as establishment of an independent regulatory agency, unbundling and privatisation of the generation sub-sector. Removal of these investment and trade barriers soon began to have a positive impact on both domestic and foreign investors since they could enter and leave the power market based on prudent business considerations. An IPP has entered into the generation of electricity using geothermal fluids. Currently Orpower4 Inc. is generating 12 MW_e with plans to generate a total of 48 MW_e in the next few years.

Training

Since the advent of geothermal research in Kenya, the Kenya Electricity Generating Company (KenGen) has made extensive use of geothermal institutes around the world to enhance capacity development. KenGen geothermal experts attend various local and international workshops and symposia. The Company has also established a Geothermal Training School that offers on the job training in geothermal technology and other courses.

The professionals in the Olkaria Geothermal Project manage out all phases of geothermal exploration, development, production and generation without the use of resident consultants. The knowledge gained has been used in offering consultancy services on geothermal exploration in Zambia and Rwanda. The areas that are not adequately provided with qualified personnel include; steam gathering system design, simulation studies and power station design. Future trainings will target these areas.

Other options for funding geothermal development in Kenya

It has been realised that donor funds are not only inadequate but do not come on time or have too many conditions attached, hence the need to explore other avenues for funding. Various options are being considered. Nevertheless, they are not mutually exclusive; they can be used in a combination depending on the funding requirements. Some of these are: (1) setting aside some KenGen Profits and/or Taxes for the development of geothermal resources, (2) redirecting the differential interest that the Ministry of Finance receives from KenGen when it on-lends funds from development partners. This can be directed to research and development activities on geothermal energy development sector, (3) introduction of a Geothermal Energy Levy, (4) encouragement of Public Private Partnerships such as those found in the Philippines and (5) encourage Early Generation from the first few wells drilled.

CONCLUSIONS AND RECOMMENDATIONS

Geothermal energy is an attractive alternative to imported fossil fuels. Because geothermal is not affected by the vagaries of weather, it could even have an edge over hydro generation in some cases. To be able to sustain and improve on this, a substantial amount of funding is necessary. The initial high-risk investment stages of geothermal exploration and reservoir assessment should continue to be borne by governments which should therefore set up geothermal companies which will be responsible for the initial stages of development. This initial risk having been minimised, the later stages of geothermal resource development, which include steam pipeline and power plant construction, can be shared between public institutions, IPPs and providers of finance.

Private power producers need to approach geothermal projects as any other business venture, in which the return from investment should be commensurate with the attendant risks, with an eye on the bottom line, pay back time, and the internal rate of return of the project. The main incentives which attract private operators are appropriate financial packages and viable and exploitable geothermal resources. This can be achieved by deliberate policies that focus on the promotion of the environmental benefits of geothermal energy as well being an indigenous renewable resource. An enabling legal framework is also necessary to ensure equitable treatment of all players in the industry.

The East African countries with the geothermal resources can achieve a lot by co-operating especially in surface investigations. The technical aspects of geothermal projects in East Africa have hitherto relied on separate equipment and expertise source, which have then been removed from play at the end of each project. Expertise and equipment can be pooled. With one pool of instruments, technicians, and other experts, the hard-won lessons of learning how specific instruments and methodologies work and can be best applied to a given type of study area and will not be lost when individual projects are completed. The East African Geothermal Training School that is being established in Kenya by the United Nations University is a move in the right direction. A lot can be gained from Kenya.

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