

## **Status and Challenges in Training on Geothermal Energy in Africa**

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### **ABSTRACT**

In an increasingly competitive global operating environment we must educate and train the very best people, then make sure that they are employed effectively in the interests of industry and of society as a whole. The geothermal industry relies on a spectrum of professionals with varying technical backgrounds and experience. Hitherto, no geothermal training institutions existed in Africa and the majority of geothermal energy professionals currently working in the continent have attended courses at various international geothermal schools, including the United Nations University in Iceland, the University of Iceland, Pisa University in Italy, Kyushu University in Japan and the Geothermal Institute of Auckland in New Zealand, utilising financial sponsorship of the host institutions, international and bilateral agencies.

Kenya is leading in Africa in the development of geothermal resources, largely due to government commitment and well trained workers. Large investments have been made in training local personnel in geothermal exploration development and production activities. The creation of a Geothermal Training Institute in Kenya was therefore envisaged to be an important contribution to address the technical capacity and confidence barriers through shared experience and technical assistance in geothermal exploration, exploitation and utilization in the region. Dedan Kimathi University of Technology with support from the Geothermal Development Company of Kenya and the Kenya Electricity Generating Company has taken the challenge of establishing a Geothermal Training and Research Institute (GeTRI), which will train a new generation of geoscientists, engineers and business leaders in all aspects of geothermal energy production. In this paper, we share the successes and challenges encountered in setting up the geothermal training facility for the East African region.

### **1. INTRODUCTION**

The East African countries of Burundi, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia all lie in the highly volcanic East African Rift, a geological feature endowed with geothermal energy. Studies indicate that geothermal reservoirs with temperatures over 200°C exist beneath the rift (Dunkley et al., 1993). Unfortunately, this indigenous resource has not been fully tapped, in spite of proven long-term success stories in other countries around the world. Countries in the region largely depend on biomass and fossil fuels as a primary energy sources. The over-dependency on thermal and hydropower makes their electricity not only expensive but also unreliable due to the ever-escalating oil prices and erratic weather conditions. In recent years geothermal energy is being prominently more recognized as one of today's renewable energy mix by governments in the region. At present, only Kenya and Ethiopia have some active geothermal operations as part of these countries' electricity generation infrastructure (Teklemariam, 2013; Teklemariam, 2008; Muchemi, G., 2013; Bahati and Tuhumwire, 2002; Fridleifsson, 2001) with a total installed geothermal capacity currently standing at just over 260 MWe for Kenya and 8 MWe for Ethiopia. Development of geothermal resources in Kenya is currently being fast tracked with 280 MWe under development at Olkaria I and IV and commissioning expected by June 2014. Additional 560 MWe under PPP arrangement is also on tender for Olkaria V development. The Geothermal Development Company Ltd (GDC) is currently undertaking production drilling at the Menengai geothermal field for 125 MWe power development. Contracts have been signed with three IPPs under a conversion arrangement and the plants are due to be commissioned by 2015. In both Kenya and Ethiopia, geothermal energy has proved to be reliable and economical, running at 98% availability. Other countries are at various stages of exploration.

Two main reasons often quoted for lack of accelerated growth in geothermal energy exploitation despite its proved economic benefits are the large upfront costs and lack of adequate human expertise. Geothermal development in the East African region (especially in Kenya) has been assisted by many agencies such as the European Investment Bank, the United Nations Development Program, the United States Department of Energy, the Japanese International Cooperation Agency and the United Nations University. By and large, the projects supported by these agencies have had limited time and operational constraints. Assistance has been in form of exploration for geothermal energy resources, direct financing for power plant construction and technology transfer by taking students abroad for specialised training in geothermal energy prospecting and utilization.

Development of geothermal resources relies on a spectrum of professionals with varying technical backgrounds and experience. Since the 1970s the majority of geothermal energy professionals have attended courses in the United Nations University in Iceland, the University of Iceland, Pisa University in Italy, Kyushu University in Japan and the Geothermal Institute of Auckland in New Zealand, utilising financial sponsorship of the host institutions, international and bilateral agencies (Hochstein, 2005; Fridleifsson, 2004). Unfortunately, there are fewer opportunities, around the world, for geothermal training than there were in the 1980's and 1990's. The United Nations University – Geothermal Training Program (UNU-GTP), in conjunction with the University of Iceland, is at present the only international graduate school offering specialized training in all the main fields of geothermal science and engineering (Fridleifsson, 2005; Mwangi, 2003) lasting anywhere between 3 and 18 months, depending on the program. The Kenya Electricity Generating Company (KenGen) and the Government of Kenya (through the Geothermal Development Company, GDC) with financial and technical support of UNU-GTP currently facilitate an annual three-week short course on exploration for geothermal energy resources to which participants from African countries with geothermal energy potential are invited.

Hitherto, no geothermal training institutions existed in Africa. For quite some time, there were discussions on the possibilities of setting up a geothermal training centre (in one of the countries in the East Africa region) to offer training in all aspects of geothermal technology from exploration through development to power station operations. Further, the training centre was envisaged to serve as a scientific and engineering instrument pool for use by Eastern African countries to promote geothermal energy as a cheap source of renewable energy (Mariita, 2012; Georgsson, 2012). Finally, such an institution would act as data bank.

## **2. GEOTHERMAL ENERGY EXPERTISE IN KENYA**

Kenya has the largest number of trained and experienced geothermal workers in the East African region. The majority of these trained geothermal professionals are working with the Kenya Electricity Generating Company (KenGen), the Geothermal Development Company (GDC) while others are with the Ministry of Energy. A few have left the industry and gone to universities and private consultancy. There are 4 PhD holders in GDC, 1 in KenGen, 4 at local Universities and several hundred with MSc and BSc in GDC, KenGen and the Ministry of Energy. Over 180 Kenyans have gone through the Short Course on geothermal exploration held annually in partnership between UNU-GTP, GDC and KenGen (Mariita, 2012). Both GDC and KenGen have collaboration arrangements with local Universities in carrying out joint research in geothermal related issues. There are a number of experts undertaking research in geothermal sector covering exploration, reservoir engineering, environment and power plant engineering. These include: 2 reservoirs engineers at Kenyatta University, 6 environmental scientists at Pwani, JKUAT and Moi Universities, 2 exploration scientists at Dedan Kimathi University of Technology, 2 geothermal geologists at University of Nairobi.

The Kenya Electricity Generating Company and the Geothermal Development Company have used their expertise in the last 10 years to offer consultant services, mainly in surface exploration for geothermal resources to several countries in the region, including Zambia, the Comoros, Rwanda, Djibouti, Malawi, the Sudan and Saudi Arabia.

## **3. ESTABLISHMENT OF A GEOTHERMAL TRAINING AND RESEARCH INSTITUTE IN KENYA**

Dedan Kimathi University of Technology (DeKUT) is a government chartered institution of higher learning in Kenya. The university has been collaborating with the main geothermal industry players, namely, Kenya Electricity Generating Company (KenGen) and the Geothermal Development Company (GDC) over the last three years in carrying out joint research in geothermal related problems. This collaboration has resulted in the establishment of the Geothermal Training and Research Institute (GeTRI) at DeKUT which is training a new generation of geoscientists, engineers and business leaders in all aspects of geothermal energy production. Considering the available trained capacity and distribution, it is clear that there is some trained capacity within the two companies to manage most aspects of geothermal resources research and utilization. However, there is need for both KenGen and GDC to increase the number of staff in exploration and to improve the quality of capacity in areas such as reservoir evaluation and modelling, feasibility studies, design of steam gathering system and power plant design and reservoir management where capacity is not adequate. GeTRI is contributing, through the education of graduate students, partnerships with industry and other training universities, in applying an interdisciplinary curriculum encompassing geo-science and engineering.

The Institute is expected to become both the national and regional centre of excellence in geothermal training and research; offering the first-ever comprehensive program that brings together world-class experts to teach all elements of geothermal energy from resource discovery to utilization, including drilling, reservoir engineering, plant design, environmental impact and applicable business principles. Already the first group of 20 students from KenGen and GDC who would have been sent to training institutions abroad (e.g., Iceland and New Zealand) are undergoing a 2-year MSc training at GeTRI, saving enormous amounts of money in foreign exchange. The programme is also envisaged in the near future to attract students from the general public and from other East African countries.

## **4. COLLABORATION WITH INDUSTRY**

The Geothermal Training and Research Institute has been set up to offer training in all basic aspects of most geothermal technology disciplines. It is providing the required training needs to participants and has limited introductory theory and practical classes to those who do not have previous training in geothermal technology. GeTRI's program engages in both basic and applied research aspects of geothermal technology that will enhance the discovery, efficiency and recovery of geothermal resources and their utilization through cutting edge geo-science and engineering disciplines. The Institute is working closely with all local geothermal industry partners, the Geothermal Association of Kenya, the International Geothermal Energy Association and international training institutions. The curriculum has been developed by full participation of KenGen, GDC, the Ministry of Energy and international collaborating universities.

The university, KenGen and GDC have formed a Joint Steering and Advisory Committee whose role is review of the training programs from time to time to ascertain their relevance to industry and recommending any changes necessary. Further university-industry collaboration exists in the sharing of facilities. Since the university does not have adequate or appropriate physical resources such as laboratories, equipment, data and computer software, both companies, through memoranda of understanding, avail such facilities for students for free for academic purposes, including fieldwork supervision.

Students are required to write a thesis using really data from the various disciplines of geothermal energy technology resulting in a decision and management process. For the benefit of both the university and industry student research projects are envisaged to try and solve really problems being faced by the geothermal industry in developing and exploiting geothermal energy. Data for such projects is generously provided by the industry.

Other collaborative activities include: (i) sharing of manpower resources in the training of target programs related to Geothermal Energy Exploration, Drilling Engineering, Reservoir Management, Industrial Engineering, (ii) boosting and enhancing development through research, training, innovation and technological development in the areas of Geothermal Energy Technology and (iii) enhancing professional skills of staff in the industry through training, staff interactions and exchange of experiences and information such part-time lecturers from industry.

## 5. CHALLENGES ENCOUNTERED

Training institutions have to deliver timely and relevant programs for national development. Both the training institutions and the geothermal industry often have to work towards improved balance between labour supply and demand, a better trained workforce and increased employability of the trainees. Failure to address capacity development by geothermal companies will inhibit these companies' ability to support delivering the changes in skills and competencies needed to achieve their strategic goals. This may lead to the geothermal companies not being competitive or being an employer of first choice. For a training program on offer by an institution to be attractive to prospective students, it has to be seen by the geothermal industry as being a useful skill to possess; that is, it has to increase the chances of employment. Initially GeTRI's MSc geothermal training program has targeted staff of the geothermal industry for upgrading of their qualifications. Unfortunately, these students cannot be released by their companies for studies for long periods of time since they are full time employees. Hence the timing of the lectures and related activities for these type of students has to be flexible so as to enable them be both full time workers and part-time students. As the industry grows and the need for more staff is created, students from the general public and those from outside Kenya will be invited.

Development and exploitation of geothermal energy depends on multi-disciplinary methodologies, ranging from earth sciences (such as geology, geophysics, and geochemistry), engineering and even none core earth sciences such as geospatial information and mathematics. Currently, Kenya has very few qualified personnel to teach post graduate geothermal programs. The few potential instructors work within KenGen, GDC and the Ministry of Energy and are not readily available for full time teaching efforts at a university. These can handle the various topics on exploration and drilling. However capacity lacks in steam field and power plant design and operation. Therefore, there has been need to invite international visiting professors, part-time lecturers from local universities and industry (KenGen and GDC) to facilitate those courses which cannot be handled by DeKUT staff. This has made the geothermal training program slightly more expensive than other programs at the same academic levels.

## 6. CONCLUSIONS

As the geothermal industry is expected to grow in Kenya and in the other countries through which the Eastern Rift Valley runs, as governments focus more on this indigenous energy resource, the Geothermal Energy Training and Research Institute has been established at an opportune time. The Institute has been founded as a response to an existing need in the geothermal industry (within Kenya and beyond), namely, to develop capacity to exploit this energy resource. The training programmes place emphasis on modern techniques of surface exploration, drilling, resource assessment and management; but they also offer sound knowledge on traditional methodologies. Close collaboration with industry is important in ensuring that the training programs meet the needs of industry as well as provide students with a hands-on experience by being attached to industry. Part-time lecturers from industry do provide the practical knowledge, not usually available in a university setting.

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