

Collaboration between Industry and Universities in Geothermal Energy Training in Africa - a case for Dedan Kimathi University of Technology

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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. Kenyan geothermal industry, and in particular the Kenya Electricity Generating Company (KenGen) and the Geothermal Development Company (GDC), is slowly responding - and sometimes painfully to the pressures of global competition. Local universities, hitherto, have seemed less able and willing to change to meet their own challenges by collaborating with their partners in industry in science and engineering education and training for increased profitability and improved service delivery.

Under the Renewable Energy Efficiency Partnership (REEEP) initiative (established after the Johannesburg Summit in 2002), one of the main activities for the United Nations University Geothermal Training Program (UNU-GTP), has been to conduct short (3-4 weeks) courses in selected countries in Asia, Latin America and Africa on Exploration for Geothermal Resources. Kenya's geothermal industry has been collaborating with UNU-GTP in facilitating these short geothermal training programs since 2005. The over 400 participants trained so far have come from Kenya and other African countries with geothermal resources, which include Algeria, Burundi, Cameroon, Comoros, Djibouti, DR Congo, Egypt, Eritrea, Ethiopia, Malawi, Mozambique, Niger, Nigeria, Tanzania, Uganda, Rwanda, The Sudan, Yemen and Zambia. Dedan Kimathi University of Technology (DeKUT) has also recently launched a 2-year MSc Geothermal training program; an effort that is envisaged to address, not only geothermal energy technology transfer, but research on really problems encountered by industry during their operation activities. In this paper we review the successes and challenges that have been encountered in establishing and carrying out these training efforts.

1. INTRODUCTION

Today, there is more interest than ever before in geothermal energy resources. Geothermal energy is being earmarked in many parts of the world as the main source of the energy to be developed, since it is a "Green & Renewable" form of energy with minimal environmental degradation compared to the other sources, including concerns over continued increases in world oil prices. Further, it is an available natural resource in these countries with minimal running cost once it is installed. In the year 2010, the Geothermal Energy Association reported that both the number of countries producing geothermal power and the total worldwide geothermal power capacity under development appear to be increasing significantly according to the US Geothermal Industry sources (USGeo, 2010).

In the East African region, Kenya is leading in the development of this indigenous resource. Geothermal resources in Kenya have been under development since the 1950's and the current installed capacity stands at about 273 MWe against total potential of about 10,000MWe. All the resources developed so far and high temperature prospects are located within the Kenya rift valley where they are closely associated with Quaternary volcanoes. Olkaria geothermal field is so far the largest potential site with current installed capacity of 269MWe from three power plants owned by Kenya Electricity Generating Company (155 MWe) and Orpower4 (110 MWe) and Oseria (4 MWe).

Development of geothermal resources in Kenya is currently being fast tracked with 280MWe under development at Olkaria IV and I and commissioning is expected by June 2014. Additional 560MWe under PPP arrangement with KenGen 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 developments. Contracts have been signed with three IPPs under a conversion arrangement and the plants are due to be commissioned by 2015. Other power developments are lined up for the period between 2015 and 2016 where additional 1800 MWe will be commissioned. Detailed exploration and drilling will be undertaken in the prospects of Suswa, Longonot, Baringo, Korosi, Paka and Silali volcanic fields. It is expected that exploration drilling will result in 400 MWe being committed for development in these prospects for power plants to be commissioned by 2017. All these developments should result in about 5,000MWe being developed from geothermal resources in Kenya by year 2030. This is an ambitious plan that is envisaged to replace 30 percent of the total electricity consumption in the country with renewable energy by that year. Other countries (e.g., Tanzania, Uganda) are at various stages of exploration. Ethiopia produces some power but plans are in place to commence drilling in the coming months after a long lull of many years. Djibouti has had exploratory wells but has experienced technical problems with the fluids. Recently, Rwanda has carried out exploratory drilling.

A lot of research effort and funds have gone into geothermal development and hence substantial information exists on location and potential of geothermal resources in the East African region. Present development has largely been on high enthalpy use for power generation with some interest being placed on low enthalpy direct uses. Several factors can be attributed to this scenario. Some of

the recognised barriers, include, Markets, Commercial financing, Exploration Risk, Legislative Framework, Political Risks and Technological Constraints. However, investigations carried out by this author indicate that while these factors do contribute to the slow expansion on direct and indirect uses of geothermal resources in the region, only two can be regarded as significant but even these can be addressed. These two are financing and technological, including limited human capacity (Fridleifsson, 2004 and 2005; Hochstein, 2005).

The core business of a university is research and dissemination of knowledge. On the other hand, industry exists to provide goods and services, generally for a profit, by applying knowledge generated by research institutions. There is, therefore, need for collaboration between universities and industry. Traditionally, research and training collaboration between companies and universities has focused on the benefit to industry from the provision of long-term support and opportunities for the training of able students as potential future employees. Focus is slowly shifting to using universities; not only to train future staff for industry but offer in-service programs that enhance existing staff knowledge base and careers. For example, the geothermal industry is looking for knowledge and concepts from high-risk exploratory to new technology areas that can impact its core business of energy production. Collaboration can bring new and different perspectives, as well as increase R&D flexibility. Industrial management, scientists and engineers need to be given new technologies that they may not have in-house in order to make them competitive, through training, by universities.

Realising that faster development of geothermal resources in developing countries, especially in Africa, is being constrained by limited trained and experienced personnel, the United Nations University, under the Renewable Energy Efficiency Partnership (REEEP) initiative, has collaborated with Kenya's geothermal industry in facilitating an annual 3-4 weeks short geothermal training course since 2005. Participants have come from Kenya and other African countries with geothermal resources, which include Algeria, Burundi, Cameroon, Comoros, Djibouti, DR Congo, Egypt, Eritrea, Ethiopia, Malawi, Mozambique, Niger, Nigeria, Tanzania, Uganda, Rwanda, The Sudan, Yemen and Zambia. Dadan Kimathi University of Technology (DeKUT) has also recently launched a 2-year MSc Geothermal training program; an effort that is envisaged to address, not only geothermal energy technology transfer, but research on real problems encountered by industry during their operation activities.

2. UNITED NATIONS UNIVERSITY GEOTHERMAL SHORT COURSES IN EAST AFRICA

An accelerated effort in geothermal development can only be achieved if there are adequate trained local experts who can handle most of the activities at various stages of development. With plans for ambitious development of geothermal energy, Kenya has taken interest in training its manpower and provision of budgetary support for geothermal resource assessment. (Mwangi, 2003). It is further keen on sharing its expertise with other countries in the region. In this endeavour, the country, through the Kenya Electricity Generating Company (KenGen) and the Geothermal Development Company (GDC), since 2005, has invited the United Nations University Geothermal Training Programme (UNU-GTP) to jointly conduct annual short courses on exploration for geothermal resources for participants from Africa, coming to Naivasha, Kenya for the 3-4 week event. The three institutions have provided both the financial resources and the bulk of the facilitators for the program. Other instructors have been drawn from Iceland, Philippines, Uganda, Tanzania, Ethiopia, Djibouti, and Eritrea. Most of the African lecturers are former UNU Fellows. Over the years, the number of participating countries has increased from 5 to 19 in 2013. The number of trainees has correspondingly increased from 20 to 70; with the largest number of being Kenyans since the country has great plans for geothermal utilization in the immediate future and the need for capacity building is therefore significant. Table 1 is a summary of these short courses and the participating African countries. Yemen was included, though being on the other side of the Red Sea and thus in Asia, as it has common geological features with East Africa.

Table 1: Short Courses and the participating African countries

Year	Program Title	Total Number of Participants	Country / No. of Participants	Comments
2005	Workshop for Decision Makers on Geothermal Projects and their Management	20	Eritrea, Ethiopia, Kenya, Tanzania and Uganda	The objective of the workshop was to increase the cooperation between specialists in neighbouring countries and to enlighten top level decision makers on issues concerning geothermal utilization
2006	Short Course 1 - Surface Exploration for Geothermal Resources	23	Djibouti (2), Eritrea (3), Ethiopia (3), Kenya (10), Tanzania (2), Uganda (3)	The purpose of the Short Course was to give a state of the art overview of the possibilities and status of surface geothermal exploration in East Africa
2007	Short Course II - Surface Exploration for Geothermal Resources	30	Algeria (1), Comoros (2), Djibouti (1), Egypt (1), Eritrea (2), Ethiopia (1), Kenya (13), Rwanda (2), Tanzania (2), Uganda (3), Yemen (2)	The objective of the course was the same as in 2006, but with more lectures and lecturers.
2008	Short Course III - Exploration for Geothermal Resources	37	Burundi (2), DRC (1), Djibouti (2), Eritrea (2), Ethiopia (2), Kenya (18), Rwanda (2), Tanzania (2), Uganda (2), Yemen (2), Zambia (2)	Similar to the 2 previous years, the training consisted of field work and lectures on classical surface exploration environmental science, reservoir assessment and geothermal drilling. The last phase was 4 days of project work using data from Kenyan geothermal fields
2009	Short Course IV - Exploration for Geothermal Resources	45	Burundi (2), Comoros (2), Djibouti (2), Ethiopia (3), Eritrea (2), Kenya (21), Tanzania (3), Uganda (3), Rwanda (3), Yemen (2), Zambia (2)	The structure of the course was similar to 2008. Facilitators were from Iceland (UNU-GTP), KenGen, GDC and neighbouring countries, most of them former UNU Fellows in Iceland
2010	Short Course V - Exploration for Geothermal Resources	56	Burundi (2), Comoros (3), DRC (2), Ethiopia (1), Malawi (3), Morocco (1), Mozambique (1), Rwanda (3), Tanzania (3), Uganda (2), Yemen (2), Zambia (3)	The structure of the course was similar to 2009. A few more lectures were introduced, resulting in an extra day to the course.
2011	Short Course VI - Exploration for Geothermal Resources	58	Algeria (1), Burundi (1), Comoros (2), DRC (1), Djibouti (3), Eritrea (2), Ethiopia (3), Kenya (30), Malawi (3), Mozambique (1), Rwanda (4), Tanzania (2), Uganda (2), Yemen (1), Zambia (2)	The course was similar to that of previous years. Kenya continued to attract the greatest number of participants since the country has great plans for geothermal utilization in the immediate future and hence the significant need for capacity building
2012	Short Course VII - Exploration for Geothermal Resources	61	Burundi (2), Comoros (1), DRC (3), Djibouti (2), Ethiopia (3), Kenya (28), Malawi (2), Mozambique (2), Nigeria (2), Rwanda (6), Sudan (2), Tanzania (3), Uganda (3), Yemen (2)	This year's course was attended by participants from 14 countries with Kenya, one again contributing the largest number of participants and facilitators
2013	Short Course VIII - Exploration for Geothermal Resources	70	Burundi (2), Cameroon (1), Comoros (1), Djibouti (3), DRC (3), Eritrea (3), Ethiopia (2), Malawi (3), Kenya (32), Mozambique (1), Nigeria (2), Niger (1), Rwanda (3), Sudan (3), Tanzania (2), Tunisia (1), Uganda (2), Yemen (2), Zambia (3)	This year's course was attended by participants from 19 countries. This is the first time Cameroon and Niger have participated in the course

3. THE GEOTHERMAL ENERGY & RESEARCH INSTITUTE AT DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

In the last few years, the geothermal industry in East Africa, with support of the Global Environmental Facility (GEF), Africa Rift Geothermal (ARGeo) and the United Nations University (UNU) have deliberated on possibilities of establishing a geothermal training centre in the region. One of the proposals on the location of the Geothermal Training Centre was that it be hosted by a Kenyan university in partnership with the UNU-GTP, GDC and KenGen (Mariita, 2012). Such a university would be ideal as it would incorporate research and technology transfer, apart from students gaining a recognised certificate, diploma or degree. Collaboration with GDC and KenGen would facilitate industrial attachment to the students for hands-on experience. Such an arrangement would be in the best interest of both GDC and KenGen since when recruiting they will find a ready market of professionals with some experience. Further, the two companies would also have an opportunity in making recommendations to the host university on the type of courses to be offered. The proposed Geothermal Training Centre would focus on capacity building in promoting geothermal energy resource development and utilization in the African region; attracting trainees from those African countries with significant geothermal potential to enable them build up expertise in cover most aspects of geothermal exploration and development.

Dedan Kimathi University of Technology has taken the challenge in establishing a Geothermal Training and Research Institute (GeTRI) which will train a new generation of geo-science, engineering and business leaders in all aspects of geothermal energy production. GeTRI will contribute through the education of graduate students, partnerships with industry and other training colleges, 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.

It is envisaged that the KenGen and GDC staff who are currently being sent to training institutions abroad (e.g., Iceland and New Zealand) will take advantage to undergo these trainings locally, saving enormous amounts of money in foreign exchange. Currently, 10 staff of GDC and 10 of KenGen are attending the 2-year MSc geothermal energy technology training at GeTRI. It is further hoped that the training programs will in future attract students from the Kenyan general public and other East Africans.

The Geothermal Training and Research Institute is mandated to pursue the establishment of an organized skill training and skill-improvement system for the specialists in the field, within the context of the growth of use of geothermal energy. The Geothermal Energy Technology program is envisioned to provide an organized academic training in the field, within the context of the growth of use of geothermal energy. It will focus on capacity building for promoting geothermal energy resource development and utilization. In addition, it will create a 'knowledge & think-tank' of Geothermal Energy Technology for Kenya and the other countries in the region planning to develop their Geothermal Energy resources.

At the end of the geothermal training program, the graduate is expected to:

1. have a common foundation in multi-disciplinary Geothermal Energy Technology knowledge, that supports Geothermal Energy management.
2. apply the acquired knowledge and skills to identify problems and provide solutions through relevant data collection analysis and interpretation to the various challenges of Geothermal Energy exploration & exploitation.
3. effectively participate in Geothermal Energy decision making process and effectively communicate in Geothermal Energy matters.

4. COLLABORATION AND INDUSTRIAL LINKAGES

The Dedan Kimathi University of Technology's Post-Graduate Diploma & Master of Science degree in Geothermal Energy technology aims at training and producing highly skilled manpower to cater for the increasing need of Geothermal Energy Scientists and Engineers, as part of the Kenya Government's vision 2030. This is being achieved through collaborations with international partnerships and local collaborations with industry. For GeTRI to fulfil this training and research function, several activities have taken place. The institute has made wide and intensive consultations with stakeholders - the two geothermal companies of KenGen and GDC and the Ministry of Energy. Exchange programs have been established with international universities in Germany and Belgium. The curriculum has been developed in conjunction with GDC, KenGen and University of Leuven, (Katholieke Universiteit Leuven), a collaborating partner from Belgium. The collaborative agreement between GDC and KenGen stipulates that Dedan Kimathi University of Technology students can use the companies' equipment, laboratory facilities and data for academic purposes. A Joint Steering and Advisory Committee has been formed from DeKUT, GDC and KenGen, whose role is review the trainings from time to time to ascertain their relevance to industry and recommend any changes necessary. Recently, discussions on possible collaboration between DeKUT and the United Nations University – Geothermal Training Program (UNU-GTP) have been initiated.

5. CONCLUSIONS

In making geothermal energy available and affordable, there are three major obstacles: (i) pure economics, (ii) challenges of drilling wells in extreme temperature reservoirs, (iii) availability of adequate, knowledgeable and experienced human capacity. Nonetheless, because of government subsidies and guarantee long-term payouts (through PPAs) for geothermal energy, many investors with little geothermal experience are being attracted into the geothermal industry arena. Their lack of experience and inadequate trained and experienced people in the market poses a unique set of challenges for the industry. Consulting firms can

provide the geothermal industry with some of the best services and off-the shelf technologies available in the market. Unfortunately, consultancy does not come cheap, and may result in making power from geothermal resources not the least cost among other competing alternatives. There is therefore the need to have adequate local human capital which has the full geothermal project development and management capabilities.

Both the Kenya Electricity Generating Company and the Geothermal Development Company are now pursuing longer-range strategies through collaboration with universities and other external R&D resources. As a result, collaborative activities have multiplied and diversified enormously in recent years. The question is not whether increased geothermal industry – university collaboration can yield desirable outcomes for all concerned: clearly, it can and often does, as exemplified by the partnerships in training among the United Nations University-GTP, Dedan Kimathi University of Technology-GeTRI, Kenya Electricity Generating Company and the Geothermal Development Company.

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