Presented at *Short Course VIII on Exploration for Geothermal Resources*,
organized by UNU-GTP, GDC and KenGen, at Lake Bogoria and Lake Naivasha, Kenya, Oct. 31 – Nov. 22, 2013.

GEOTHERMAL EXPLORATION AND DEVELOPMENT IN RWANDA

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ABSTRACT

Rwanda needs a safe and clean source of energy for its people. At present the Government of Rwanda is looking at future strategy for solving the country's needs for electricity. When looking at available options, the concept of geothermal appears one of the best options, given that the resource is there and the development cost is acceptable. Rwanda is believed to have a geothermal potential which is estimated to be in excess of 300 MW. The development of geothermal resources is in its early stages and it has reached a point where exploration drilling is carried out to prove the existence of a geothermal potential. Exploration drilling is under way in the Karisimbi area in the Northern part of the country, and the first well has just been completed. This paper outlines the background and current status in geothermal development in Rwanda, the initiatives undertaken and strategy for exploration and development of geothermal resources for the four prospects identified.

1. INTRODUCTION

Rwanda is currently confronted with energy supply problem due to rapid growth of population and limited energy resources. Most of the population use wood as their basic energy need leading to an increasingly scares of fuel wood and thus creating deforestation. Biomass dominates as the principal source of primary energy for 85% of the population followed by imported petroleum fuels for 11% dominating the local industries energy supply. In the third level is electricity which account for 4% and is used by 16% of the population. The electrical energy in Rwanda is currently predominantly on diesel generation followed by hydropower as consequence of low rainfall and an increasing demand for electricity. The high prices of oil are putting a strain on the national budget and constitute presently a serious hurdle to the economic growth for a landlocked developing country such as Rwanda.

Overall, the country vision is to ensure universal access to electricity from both grid and off-grid solutions, over the EDPRS II period (Economic Development and Poverty Reduction Strategy). Detailed plans have been developed to spread the electricity network across the country. In tandem with the relocation driven by urbanisation and resettlement policy, this should bring the grid within reach of around 48-50% of the population (Energy Sector Strategic Plan, 2013).

The present total generation capacity available in Rwanda is 109.4 MWe, with hydro-generation accounting for 52% (56.7 MWe) and 44% (48.3 MWe) from fuel fired plants. The current average cost of electricity is of about 0.26 US$ per kilowatt hour. Therefore, to minimize the dependency on

energy imports, save foreign currency and create conditions for the provision of safe, reliable, efficient, cost-effective and environmentally appropriate source of energy, geothermal development seems to be the long term solution that could end the current energy crisis.

The development of geothermal energy resources in Rwanda is at early stages compared to some East African countries such as Kenya and Ethiopia. The exploration of this resource really boomed in 2006 with a view of diversifying energy sources in the generation of electricity and meets the electricity demand in the country. The volcanoes area, the geological context and the hydrothermal manifestations of Rwanda are an indication of the existence of potential geothermal systems. Early geothermal investigations pointed out the north-west area as a potential for large, high temperature geothermal systems, while the rift in the south-west part of the country along the Lake Kivu is believed to present an environment for low to moderate temperature resources (Demange et al., 1983; Newell et al., 2006).

The current strategy of the Government of Rwanda (GoR) is to know how much geothermal potential is available for the country to meet its energy demand. This step is being implementing by the drilling of the first exploration well in the Karisimbi area to prove the resource.

2. BACKGROUND ON GEOTHERMAL EXPLORATION

Geothermal investigations in Rwanda started in the 1980's but the existence of geothermal resources in identified geothermal prospects still needs to be confirmed through drilling. Several reports exist, indicating two areas as prospective zones for geothermal energy; the first zone (Gisenyi, Karisimbi, and Kinigi) in the north-western region, which is associated with volcanoes and the second zone (Bugarama) in the southern region associated with faults in the East African Rift (Figure 1). Among the four prospects, the development activities for Karisimbi are the most advanced followed by Kinigi and Gisenyi. Bugarama on the other side is at the reconnaissance stage to be followed by geo-scientific survey to estimate the potential of this area.

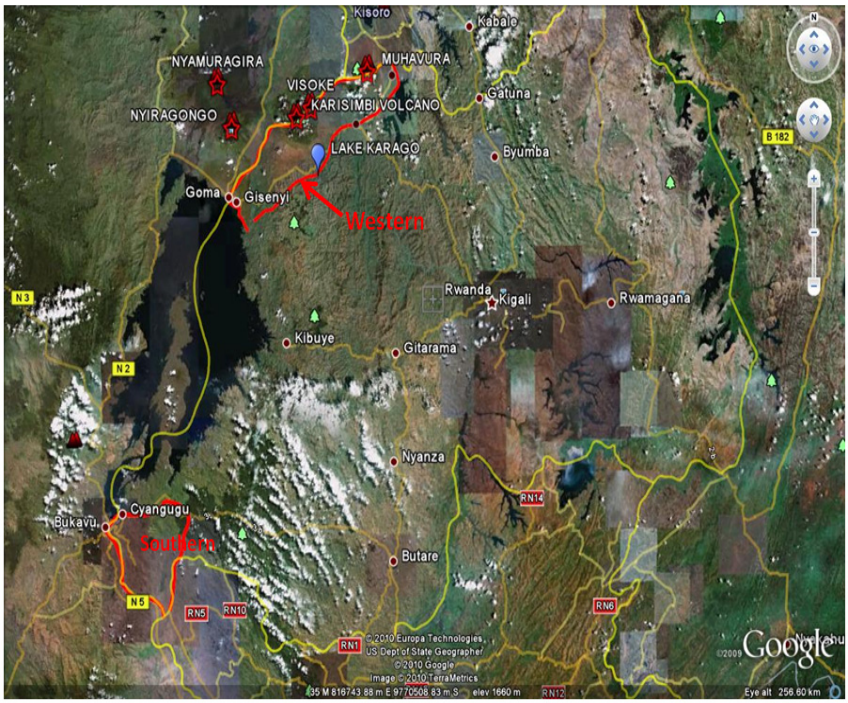

FIGURE 1: Location of the two geothermal prospective zones (Onacha et al, 2010)

Serious investigations on Rwanda geothermal resources started in 2006 with a view of diversifying energy sources for electricity generation and meet the electricity demand in the country. Surface exploration studies to prove the resource have been carried out in several phases:

In 1983, the French Bureau of Geology and Mines (BRGM) identified Gisenyi and Bugarama as potential sites for geothermal energy with estimated reservoir temperatures of over 100°C.

In 2006, Chevron carried out geochemistry studies in the Bugarama and Gisenyi geothermal prospects and estimated the geothermal reservoir temperatures to be more than 150°C.

In 2008, the Germany Institute for Geosciences and Natural Resources (BGR), in collaboration with the Kenya Electricity Generating Company (KenGen), the Icelandic Geo Survey (ISOR) and the Spanish Institute for Technology and Renewable Energies (ITER) carried out surface studies in the Gisenyi, Karisimbi and Kinigi areas. The results from this study concluded that a high temperature geothermal system (>200°C) may exist on the southern slopes of Karisimbi volcano and that a medium temperature geothermal system may exist around Lake Karago (150-200°C).

In 2009, KenGen acquired additional surface studies (geochemistry and geophysics) and carried out baseline environmental impact assessment (EIA) on the southern slopes of the Karisimbi Volcano. Findings recommended drilling three exploration wells in the Karisimbi prospects.

In 2011, an additional geothermal survey was done by the Institute of Earth Science and Engineering (IESE) through Auckland UniServices, New Zealand aiming at developing a conceptual model for the entire western region and locating sites for exploration drilling in the three prospects, Karisimbi, Kinigi and Gisenyi.

Workshops were organised in 2012 and 2013 with panel of experts aiming at merging all findings, to come up with one unified model for the Karisimbi area allowing for the definition of the location of sites for exploration drilling in Karisimbi.

Currently, the four geothermal prospects can be ranked as shown in Table 1.

TABLE 1: Exploration status for Rwanda prospect

Geothermal prospects	Reconnaissance study	Detailed survey	Wells sited	Infrastructure works	Wells drilled
Karisimbi	yes	yes	yes	yes	on-going
Kinigi	yes	yes	yes	no	no
Gisenyi	yes	yes	no	no	no
Bugarama	on-going	no	no	no	no

3. CURRENT EXPLORATION AND DEVELOPMENT

3.1 Karisimbi prospect

The Karisimbi area is located near the Karisimbi volcano within the National volcano park in Nyabihu district. Detailed surface geo-scientific studies and Environmental and Social Impact Assessment (ESIA) have been completed. Drilling of three deep exploratory wells (Figure 2) has been planned and currently drilling of the first well is completed.

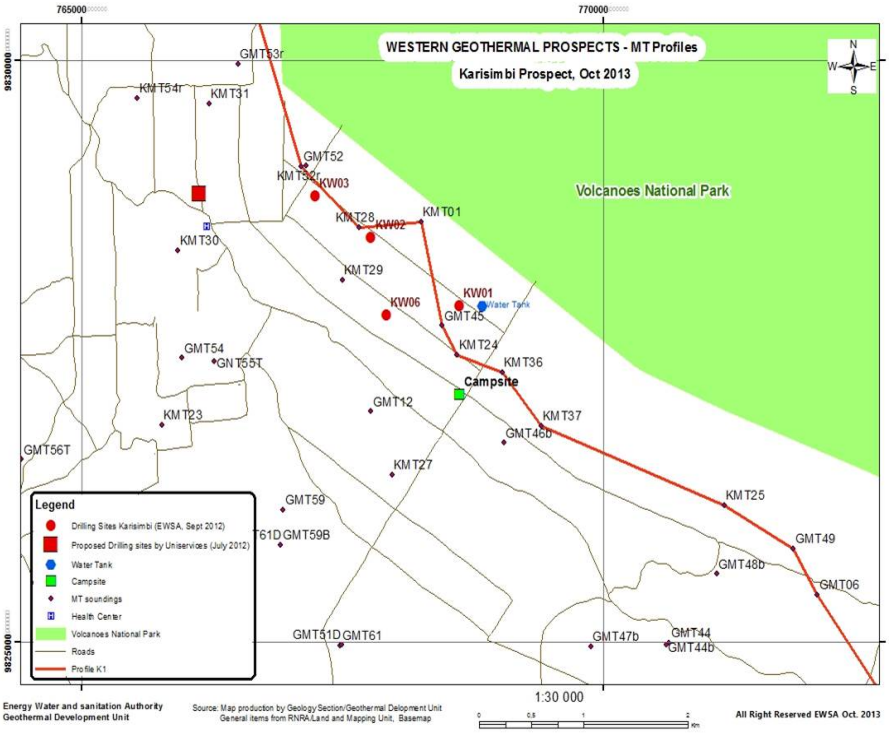

FIGURE 2: Location of wells in Karisimbi prospect (GDU, 2013)

Several contracts have been awarded for the preparation of drilling. Contracts for the supply of drilling materials and drilling services have been awarded early 2012 to the China Petroleum Development and Technology Corporation (CPTDC) and Great Wall Drilling Company (GWDC), respectively. The contract for the rehabilitation of the road to the drilling site was awarded to a local company ERGECO and works are completed. The water supply to the site and civil works contract was awarded to a Kenyan Company, YASHINOYA limited.

Well testing services is provided by the Geothermal Development Company (GDC) from Kenya. Technical assistance prior to drilling was provided to the Geothermal Development Unit by the Japanese Agency (JICA). On job training is provided by the Icelandic Geological Survey (ISOR) through funding from the Icelandic Development Agency (ICEIDA). The drilling supervision for the first well was carried out by Reykjavik Geothermal Company (RG) and funded by the Nordic Fund through NEFCO (Nordic Environment Finance Corporation).

The exploration drilling in Karisimbi of the first well KW01 started in July 18 and was completed on November 7. Well testing of KW01 indicates low temperature and poor permeability at depth. The immediate plan for the Karisimbi prospect is to continue the assessment by carrying out in fill measurement in the area, drilling two additional wells KW02 and KW03 and well testing.

3.2 Kinigi prospect

The Kinigi geothermal area is located in Musanze district, east of Karisimbi. Detailed surface studies Environmental and Social Impact Assessment have been completed. Additional studies for updating of the conceptual model of Kinigi geothermal prospect is proposed and submitted to UNEP for funding. The drilling of three exploratory wells in Kinigi is to be financed by the Government of Belgium through Belgium Technical Corporation (BTC) for an amount contribution up to 27 million Euros. This contribution should cover the infrastructure works and the drilling of three exploration wells. In addition to GoR and BTC commitment to finance the drilling project, Expression of Interest for GRMF funding has been submitted.

3.3 Gisenyi prospect

The Gisenyi geothermal prospect is located in Rubavu district, south of Karisimbi and is defined by a NW trending resistivity anomaly aligned with Nyiragongo and Nyamuragira active volcanoes in the Democratic Republic of Congo. Detailed surface studies have been completed. Additional studies to complement existing geophysical, geological and structural data in the Gisenyi area and to quantify geothermal potential and locate sites for drilling 3 exploration wells have been proposed and submitted to EU for funding.

3.4 Bugarama prospect

The Bugarama geothermal prospect is located in the southern province of Rwanda. The geothermal manifestations in this area are hot and warm springs and travertine deposits, which is being mined as feedstock for a nearby cement factory. This prospect probably extends into Burundi and the Democratic Republic of Congo. No detailed geo-scientific work has been carried out in this area. A regional geothermal exploration study funded by EU has started in November 2013 for the three countries, Democratic Republic of Congo, Burundi and Rwanda. The exploration study will conclude with location of targets for deep exploratory wells drilling. The project is financed by the European Union and the consultancy firm hired for this project is Reykjavik Geothermal (RG). Great Lakes Energy Agency (EGL) is mandated for the implementation of this regional project.

4. OTHER INITIATIVES

A detailed Geothermal Strategy and Geothermal Act have been developed which will both be formally approved. The short term strategy is to take geothermal exploration to a next level by drilling multiple exploration wells to map the geothermal resources in different prospects in the country. In the mid-term, proving the presence and feasibility of geothermal resources is a necessary step in attracting private investors who could scale up the geothermal energy production. In the long term, the plan is to develop over 300MWe of least cost, base load and environmentally friendly geothermal energy through public and private sector partnerships. To achieve this, funds are required immediately for detailed surface exploration, exploration drilling, production drilling, feasibility studies and power plant construction. This will be achieved by strengthening the institutional, technical, legal and regulatory and policy framework.

A clear policy of giving out concessions and payment of royalties will be established through the Geothermal Resources Exploration, Development and Management Law and regulations which are currently being discussed by all stakeholders. The Law will also ensure sustainable utilization of geothermal resources with a negotiate cost reflective tariff structure.

Technical assistance and capacity building are provided and financed by several institutions; the Japanese International Cooperation Agency (JICA), The Icelandic International Development Agency (ICEIDA), the United Nations University Geothermal Training Programme, the African Rift Geothermal Development Facility, the European Union Energy Initiative (EUEI) and others. The Geothermal master plan is to be developed by JICA.

A new institutional framework for the Geothermal Development Unit in EWSA is being discussed with development partners to fast track the geothermal programme in the country.

5. ISSUES AFFECTING THE DEVELOPMENT OF GEOTHERMAL ENERGY IN RWANDA

Theoretically, the estimates of geothermal energy potential can supply all the national power needs for Rwanda for the next 10 years. However, the pace and level of development of geothermal resources has not been effective. This is mainly due to lack of funds and the perceived risk in developing the geothermal resources. Financing from multilateral institutions or international lenders is difficult without adequate data. The Geothermal Risk Mitigation Facility for East Africa (GRMF) is one of the alternatives to be utilized. Based on the request from the African Union Commission AUC to submit expression of interest for GRMF, Rwanda has submitted Kinigi and Gisenyi prospect sites for exploration drilling.

Geothermal energy development generally has very high project development costs. Unlike diesel plants, where you can purchase the fuel when required, in geothermal you have to prove the availability of fuel (steam) in advance before power construction.

Other issues affecting the development of geothermal energy are marketing, institutional, and policy impediments. The role of geothermal development in the energy mix needs to be clearly defined with set and funded targets to prove the viability of a geothermal resource. There is need to share and disseminate information among all stakeholders and potential investors. The fear of developing geothermal energy has to be overcome among policy makers and opinion leaders. There is need to build adequate human resource capacity while at the same time encouraging local education institutions to provide training relevant to geothermal development. Clear guidelines on the level of participation of local community and other stake holders in geothermal development and utilization are required.

6. CONCLUSIONS AND RECOMMENDATIONS

Rwanda has very positive indicators of geothermal prospects, which can be exploited commercially for electricity generation and industrial uses. Four potential geothermal areas, Karisimbi, Gisenyi, Kinigi and Bugarama have been identified and exploration drilling is underway in Karisimbi area. There is however need to carry out a thorough assessment of the data to minimise the risks of sinking unproductive wells. A criterion for sitting wells needs to be established. A cautious approach will be utilised in the exploration program to increase the success rates. Enabling environment should be created for the private sector to undertake development of geothermal resources in the country. The establishment of a legal and regulatory framework is urgently required. Furthermore, to implement effectively the geothermal development plan of the country, additional staff should be hired and trained, and institutional provisions must be developed for the Geothermal Development Unit (GDU).

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