Overview of Geothermal Resource Utilization and Potential in Eastern Africa, East African Rift System

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The Great East African Rift System (EARS) is one of the major tectonic structures of the earth which extends for about 6500 km from the Middle East (Dead Sea-Jordan Valley) in the North to Mozambique in the south. This system consists of three main arms: the Red Sea Rift; the Gulf of Aden Rift; and the East African Rift which develops through Eritrea, Ethiopia, Kenya, Tanzania, Zambia, Malawi and northern Mozambique floored by a thinned continental crust. The EARS is composed of two rift trends; the eastern and western branches. The western branch develops from Uganda throughout lake Tanganika, where it joins the Eastern branch, following the border between Rwanda and Zaire. The western branch is, however, much less active in terms of tectonics and volcanism although both branches are seismically and tectonically active today.

The East African Rift is one of the most important zones of the world where the heat energy of the interior of the Earth escapes to the surface in the form of volcanic eruptions, earthquakes and the upward transport of heat by hot springs and natural vapor emanations (fumaroles). As a consequence, the EARS appear to possess a remarkable geothermal potential.

The eastern branch, that forms the Ethiopian and Kenyan rifts, possesses by far the most extensive resource base in Africa and one of the most extensive in the world. Countries such as Djibouti, Uganda, Eritrea and other countries in southeastern Africa have lesser but still important resource bases. Using today's technologies, Eastern Africa has the potential to generate about 2,500 MW of energy from geothermal power.

Since about one hundred years now the technology had been available for exploiting this energy resource for generating electricity and for application in a wide range of agricultural and industrial undertakings. This takes place wherever favorable geological conditions could be found, by exploration and studies, to enable the economic exploitation of the resource.

GEOTHERMAL RESOURCE

The World: As of 2002, more than 8000 MWe of geothermal electrical generation was present in more than 21 countries led by the US, Phillipines, Italy, Mexico and Indonesia. This represents 0.25% of worldwide installed electrical generation capacity. Many more countries use the energy resource in agriculture, industry, especially in agro-industry, and in the health, recreation and tourism industries. Geothermal direct use applications provide about 15,000 thermal megawatts (MWt) of energy in about 35 countries.

The East African Rift Region

Kenya: In the East African Rift region, Kenya was the first African country to tap geothermal energy for electric power generation. This has partly also been due to the problems that it has in developing its limited hydro resources and the successes that it had in small scale development since 1982. Kenya's first electricity generating plant has been operating now for 22 years and has proven reliable and economic, running at 98% availability. This has encouraged Kenya to speed up its geothermal power development program and is now installed a total of about 100MWe generation capacity and another 64 MW being developed in stages by the private sector. This capacity has ben achieved over a period of 33 years. Todate, a total of 105 wells have been drilled for exploration, production, monitoring and re-injection with depths varying from between 180 and 2,600 meters below the earth's surface.

The long term least-cost power development program foresees a total generating capacity of 2350Mw by the year 2019 of which about 576 MW will be from geothermal power plants. It is notable that geothermal water and carbon dioxide are used in an extensive complex of green houses for growing roses. Rose exports from that farm total US$300 million per year.

Ethiopia: Ethiopia started a long-term geothermal exploration undertaking in 1969. Over the years a good inventory of the possible resource areas has been built up and a number of the more important sites have been explored in the whole part of the Ethiopian Rift Valley. Of these areas about sixteen are judged to have potential for high temperature steam suited to electricity generation. A much larger number are capable of being developed for non-electricity generation applications in agriculture, agro-industry etc.

Exploration work peaked during the early to mid-1980s when exploration drilling was carried out at Langano (Lakes District). Eight deep exploratory wells were drilled to a maximum depth of about 2500m, and four are found to potentially productive with a maximum geothermal reservoir temperature af about 350ºC. During the early 1990s exploration drilling was also carried out at Tendaho (Northern Afar), three deep (2100m) and three shallow wells (500m), proving the existence of high temperature (270ºC) and pressure fluid.

Resource utilization was delayed until 1998. The 7.2 MW net capacity pilot plant installed at Langano has faced operational difficulties that are essentially due to the lack of the appropriate field and plant management skills. With the rectification of these problems, the plant should run more reliably and provide experience that would be useful in the exploitation of the country's extensive resources, to augment power supply from hydro-resources and diversify the energy supply structure.

Djibouti : Much effort has been expended in Djibouti since the 1970s, in view of the country being deficient of indigenous energy resources. About six exploratory wells drilled in the Assal geothermal fields. While a very high temperature system has been successfully located, problems related to the high salinity of the discovered fluid, which is due to the close proximity of the Assal field to the Gulf of Aden, has delayed resource development and exploitation.

Uganda: Reconnaissance survey has been carried out on geothermal areas of Uganda since 1935 when the first documentation of hot springs was made. Uganda recognizes its need to develop its geothermal resources to diversify its electricity generation capacity, to support hydro and to improve electricity supply in the western part of the country. Recent geoscientific studies have focused on three geothermal systems of Buranga, Katwe and Kibiro , all located in the active volcanic belt in the western Rift valley all along the border of Uganda and Democratic Republic of Congo.

Eritrea: The Eastern lowlands of the country are of potential geothermal interest, and first priority was given to the Alid Volcanic center for exploration as it has numerous manifestations I the form of hot springs and fumaroles. Detailedgeoscientificinvestigations is underway in this geothermal prospect area indicating a reservoir temperature of about 250ºC. It is possible that there could be other sites suitable for the discovery of a high temperature resource.

Zambia: Reconnaissance survey has been carried out on geothermal areas of Zambia since 1950s Mini geothermal pilot power plant (200 KW) was installed on the basis of limited exploration work, and the plant never became operational.

Other countries such as Tanzania, Rwanda, Malawi and the Malagasy Republic have to date not gone beyond the resource potential inventory work hich is the starting point of geothermal work.

Except in Kenya, and in Ethiopia respecting the exploration phase, resources exploration and development is constrained mainly by the existence of very limited know-how.