KENGEN GEOTHERMAL DEVELOPMENT STATUS AND FUTURE EXPANSION PLANTS

Abel K. Rotich
Kenya Electricity Generating Company Ltd
P.O Box 785 – 20117 Naivasha,
KENYA
arotich@kengen.co.ke

ABSTRACT

Key words: Geothermal Development, Olkaria, Kenya

Kenya has significant geothermal power potentials that is estimated at approximately 10,000 MWe as envisaged from its rich geothermal prospect in the Kenya Rift region. Geothermal energy is regarded as reliable, indigenous, clean, green, renewable and base load source of energy. Kenya Electricity Generating Company Limited (KenGen) has developed geothermal energy from Olkaria and Eburru with an installed capacity 533 MWe. This has put the country as the leading country globally in geothermal developments. KenGen is the leading power generating company in Kenya with an installed capacity of 1,617 MWe equivalent to about 80% of the national installed interconnected capacity of about 2350 MWe. KenGen utilizes various primary sources of energy to generate electricity ranging from hydro, wind, thermal and geothermal. KenGen plans to increase its installed capacity by 2,500 MWe by 2025 with most of the capacity expansion targeted from geothermal. Accelerated geothermal expansion in the company and in the country has been guided by Vision 2030 and current Government of Kenya (GoK) initiative to develop up to 5,000+ MWe by 2016. In the 5,000+MWe program, geothermal power is expected to be about 1,646MWe. Under this program, KenGen is expected to implement 700MWe of Geothermal power by 2018.

1. INTRODUCTION

KenGen has over 50 years of experience in development, management and operation of power stations and utilizes state of the art technology in the management of plants. It has developed and operated the first geothermal steam plant in Africa, the Olkaria I power plant with an installed capacity of 45MWe (15x3)was commissioned between the years 1981 and 1985. Olkaria II power plant has an installed capacity of 105 Mwe (35x3) comprising of unit I and II with combined output of 70MWe, commissioned in the year 2003 whereas the third unit with an installed capacity of 35MWe was commissioned in the year 2010.

Geothermal power has a prominent place in Kenya's overarching development plans. These include the Vision 2030 and the current GOK initiative to develop up to 5,000+ MWe by October 2016. In the 5,000+MWe program, geothermal power is expected to be about 1,646MWe. Under this program, KenGen is expected to implement 700MWe of Geothermal power by 2018, of which 580MW has already been commissioned

In 2014, KenGen commissioned two (2) power plants (Olkaria IV, and Olkaria I Unit 3&4) with an installed capacity of 150MWe each and a combined net output of 280MWe. This is one of the largest single geothermal power plant development implemented over a period of 36 months. The Company is in the process of developing two (2) power plants, namely, 140MWe Olkaria V and 70MWe Olkaria I Unit 6 through the traditional public procurement model and Olkaria VI-140MWe through a Public Private Partnership (PPP) Model. In total KenGen is generating 533MWe of geothermal energy and on global ranking its place at position 7 (Figure1).

Production drilling is still ongoing in Olkaria geothermal field for the upcoming projects such as Olkaria VII (140MWe), Olkaria VIII (140MWe) and Olkaria IX (140MWe). Besides Olkaria, KenGen is also licensed to develop geothermal resource from Eburru geothermal prospect which currently producing 2.5MWe from the well head generating pilot unit that was commissioned in 2011. The company is planning to undertake more geoscientific study in the area and to carry out production drilling for generation of 25MWe.

As a way to deliver on its key mandate of geothermal expansion, KenGen geothermal division was formed and it has structured its operations through various support departments and sections that includes key department of resource development and infrastructure, drilling and logistics, reservoir and Steamfield and Plant Operations department.

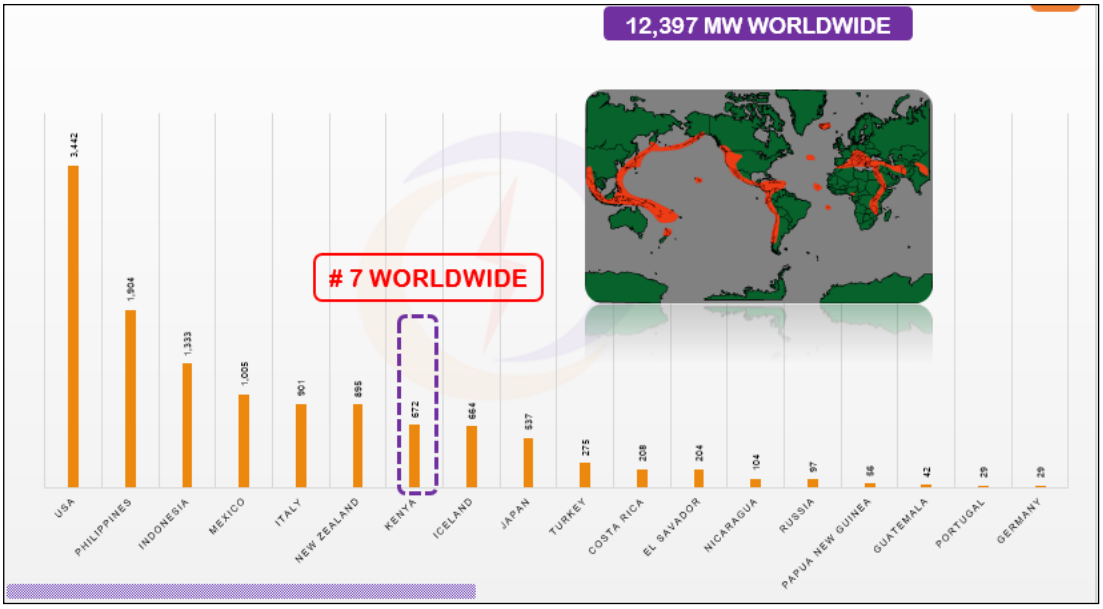

Figure 1: Worldwide Geothermal Development-Bertani 2015

1.1 THE PROJECTED ENERGY DEMAND GROWTH

The current growth momentum is expected to be sustained with an estimated annual demand growth of about 150MWe (equivalent to 9% of the current effective capacity), which may stretch gradually with the enhanced rural electrification program and the increased economic activities. Further, The Vision 2030 forecast the demand to grow by between 8-10%, whereas the system requires a reserve margin of between 20-30%. The growth in energy demand is projected from 1,231MWe in 2012 to 16, 905 MWe by 2031. Figure 2 below depicts the projected demand growth of 3,751MWe to the year 2018.

Figure 2: Projected Energy Demand Growth of 3,751MWe to the Year 2018

1.2 GEOTHERMAL POWER SUPPLY POTENTIAL

Geothermal resource is located within the Kenya Rift sector of the larger East Africa Rift System. There are 18 geothermal prospects (figure 3) . Initial investigations indicate that Kenya's Rift Valley has a potential of between 7,000 MWe – 10,000 MWe that can be exploited for generation of electricity using conventional methods for at least 20 years. Olkaria field may sustain an additional 1,200 MWe on top of what is being currently generated in the long term. Eburru field on the other hand has a potential of about 60MWe. It is against this background that KenGen has developed the geothermal capacity expansion programme. Due to the upstream risks of geothermal development, the Government of Kenya has been responsible for financing geothermal exploration, resource assessment and drilling up to the point where a clear and sustainable availability of steam is identified.

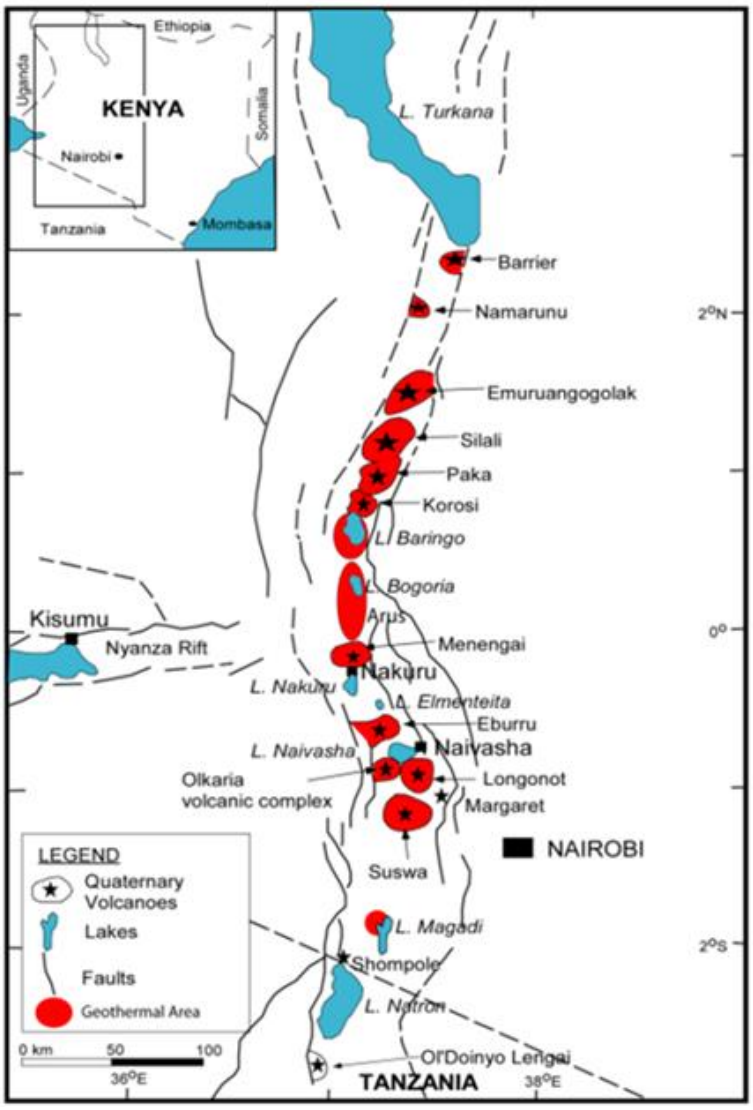

Figure 3: Geothermal Prospects located within Kenyan Rift (Omenda, 2007).

1.3 KENGEN INSTALLED AND EFFECTIVE CAPACITY

The total KenGen installed capacity is 1,230.7 MWe with a total effective capacity of 1,135.9 MWe. Hydropower and geothermal performance is high with weighted availability factors averaging 89% and 79% respectively as at June 2012.

2.0 KENGEN STRATEGIC DIRECTION

Power demand is forecast to grow at between 8-10% p.a. as the country gears up towards realization of the Vision 2030 goals which requires Kenya to have at least 30-35% electricity penetration by 2018. KenGen as the leading provider of electric power will through a "Geothermal led strategy" lead the required capacity expansion in Kenya and beyond. The "burning platform" for KenGen today is to stabilize the power situation in the country by the end of year 2014 by delivering ongoing projects/optimizations and initiating energy efficiency and conservation programmes. The Least Cost Power Development Plan (LCPDP) 2011-2031 forecasts a demand of 4,755MWe by the year 2020. Sustainably growing power provision for Kenya will require KenGen through its geothermal led strategy to increase its installed geothermal capacity by 1,110MWe by 2020. This will be achieved by refurbishing the existing old power plant (Olkaria I power station) and constructing conventional

geothermal power plants, well heads and binary power plants. The company also plans to promote direct use of geothermal energy.

2.1 OBJECTIVES OF THE GEOTHERMAL ENERGY EXPANSION PROGRAMME

The objective of the geothermal energy expansion programme is to adequately harness steam that will be used for the generation of an additional 1,110MWe of geothermal energy in line with Kenya's vision 2030. Specific objectives of the programme are to: diversify sources of energy in order to minimize the over reliance on hydro and thermal sources of energy, mitigate against climate change by harnessing power from geothermal sources that emit less green gas emissions than other sources like coal and thermal, reduce the countries import bill in the long term by saving on money used to import the expensive fossil fuels, earn revenue for the company and the government , create employment for the local communities and Kenyan's at large, Promote direct uses of geothermal heat and generate least cost power that will make our economy competitive.

2.2 EXISTING AND PROPOSED PROJECTS UNDER THE GEOTHERMAL EXPANSION PROGRAMME

Existing Conventional Power Plants

KenGen currently owns and operates two Geothermal Power Stations at Olkaria namely Olkaria I and Olkaria II, located about 120 km Northwest of Nairobi. Olkaria I Power Station has three units namely Unit 1, 2 and 3 which were commissioned in 1981, 1982 and 1985 respectively. Each of these three units produces 15 MWe making a total of 45MWe. Olkaria II Power Station has three units each generating 35 MWe hence making a total of 105MWe. Unit 1 and Unit 2 of Olkaria II were commissioned in September 2003 whereas Unit 3 was commissioned in June 2010. Olkaria I units 4 & 5, Olkaria IV with a combined net output of 280MWe commissioned in2014. The existing power plants use single flash steam cycle technology, which is recommended for the high enthalpy resources at Olkaria.

Proposed Conventional Power Plants

The geothermal expansion programme 2012-2020 comprises of conventional power plants namely, Olkaria I unit 6, Olkaria V, Olkaria VI, Olkaria VII, Olkaria VIII, Olkaria IX and Eburru as detailed in table 1.

Table 1: Proposed Conventional Power Plants

PLANT	CAPACITY	DUE DATE	MODE OF FINANCING	COST MUSD ($)
280MWe Project –Under Construction				
Olkaria I (units 4 & 5)	140	2014	Debt & equity	*375
Olkaria IV (units 1 & 2)	140	2014	Debt & equity	*375
210MW (CP1)				
Olkaria I unit 6	70	2016	Debt & equity	189
Olkaria V	140	2017	DFI or / Private Public Partnerships	378
585MW (CP2)				
Olkaria VI	140	2017	PPP / Joint Venture	378
Olkaria VII	140	2019	Private Public Partnerships	378
Olkaria VIII	140	2020	Private Public Partnerships	378
Olkaria IX	140	2020	Private Public Partnerships	378
Eburru	60	2017	Equity / Private Public Partnerships	180
TOTAL	**1,110**	**2020**		**3,009**

* The cost is inclusive of all components but exclusive of drilling

2.3 DIRECT USES OF GEOTHERMAL

Once a geothermal power plant is operational, it can also be used in multiple ways to enhance the project's overall economic result i.e. multiple or cascaded use of geothermal resource. Besides power generation, geothermal resources can also be used for space heating, fish farming, heating green houses, drying of agricultural produce and for swimming as shown in figure 4.

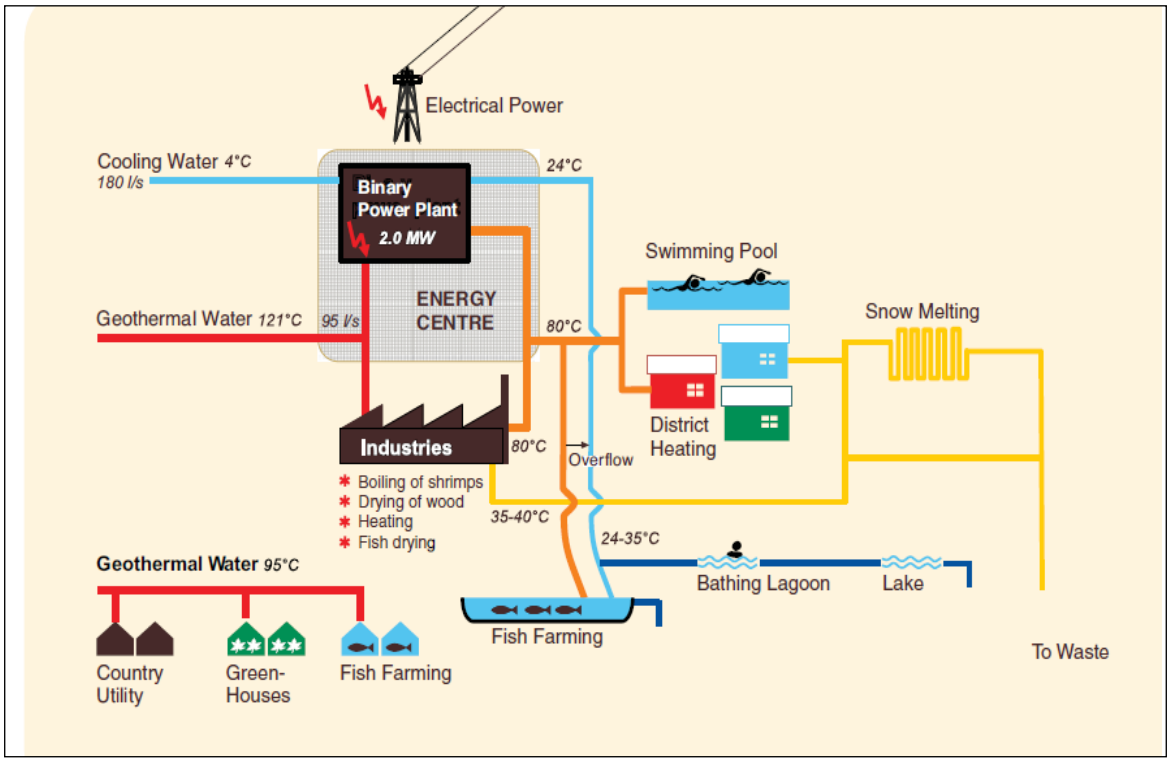

Figure 4: Typical Diagram Showing Multiple Uses of Geothermal Resource

KenGen has constructed a geothermal spa at Olkaria to show case direct uses of geothermal energy. The spa has three pools supplied with brine from Olkaria II power station. The company is also supplying Oserian Development Company with steam for heating their green houses. With the establishment of the proposed industrial parks within the Greater Olkaria Geothermal Area, in line with economic vision and strategy of Kenya Vision 2030, there exists a great opportunity of enhancing direct uses of geothermal resource hence various projects will be implemented to achieve this objective as illustrated in Lindal diagram, figure 5.

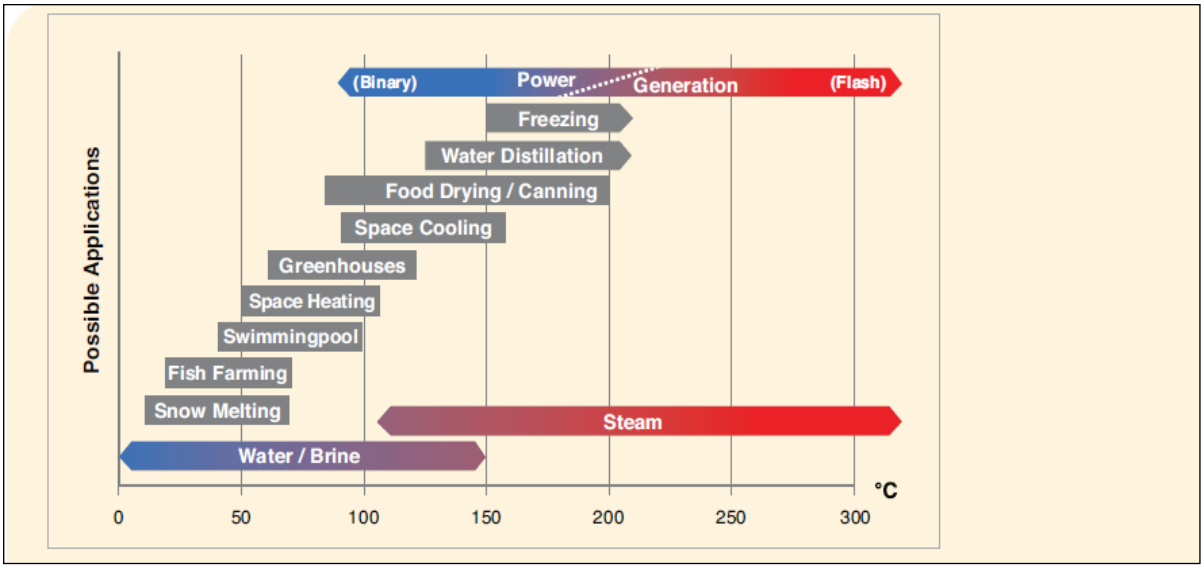

Figure 5: Modified Lindal Diagram Showing Direct Uses of Geothermal Fluids

2.4 Industrial Parks

Kenya aims to become the provider of choice for basic manufactured goods in Eastern & Central Africa according to the Economic Vision & Strategy of Kenya Vision 2030. Under this strategy, the government intends to establish at least 5 Small and Medium Enterprise (SME) Industrial Parks as flagship projects for manufacturing. The target is to construct these industries near the source of energy generation in order to cut on cost of transmission and power losses. Olkaria and Eburru geothermal fields have been proposed for setting up these industries. Establishment of these parks will be undertaken by private investors. This is envisaged to be accompanied by additional facilities like staff houses, waste treatment facilities and transport infrastructure.

2.5 Other Support Projects

KenGen is also considering construction of a geothermal training centre of excellence, a sports stadium and additional workers' accommodation facilities. Construction of a block of offices (geothermal plaza), modern laboratories and workshops is already underway. The proposed conventional power plants will also be registered as Clean Development Mechanism (CDM) projects. Once registered, appropriate community projects will be implemented through the Community Development Carbon Fund (CDCF) as provided for by the World Bank Guidelines. Registration of Olkaria II unit 3 power plant led to the implementation of 10 KM domestic water supply line and construction of classrooms at Nkaampani Primary School at Maiella location in Naivasha district and construction of a water pan for watering animals and classrooms at Enoosupukia location in Narok North sub-county in 2012.

3.0 CONCLUSION AND RECOMMENDATIONS

Development of geothermal resources with its challenges can be accelerated through elaborate strategies and support from government key participating stakeholders within the geothermal industry and the energy sector as a whole. Rapid expansion of geothermal resource development has been favoured by ever increasing energy demands in the country

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