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Geothermal Greenhouse Heating and Other Direct Use Opportunities in Kenya

Ong'ango Benard Omondi

bomondi@kengen.co.ke

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ABSTRACT

Geothermal development within the country is on a high growth rate with focus mainly on power generation, new developments include the recently commissioned 280Mw, a new plant Olkaria V to be commissioned later this year with a capacity of 165.4Mw in Olkaria field, an additional unit at the existing Olkaria 1 additional unit 6, and more wells being drilled in Menengai Nakuru by the Geothermal Development Company. Green house heating is where a geothermal well is channeled to heat fresh water which is circulated within the greenhouse with an intention of humid control, controlled humidity in turn leads to decrease in crop fungal infections. Heating also allows the greenhouse to be maintained at optimal crop growth conditions and shorten crop production cycles. This paper focuses on possibility of using some isolated low output wells which are seldomely used for power generation as they have a potential of less than $1Mw_e$, the wells can be channeled to several flower farms within Naivasha area which border Olkaria geothermal field. Greenhouse heating has been successfully implemented at Oserian flower farm in Kenya and the results are immense, it has greatly reduced cost used on fossil fuels for heating and helped in lowering cost of production and fasten rate of maturity in cut flowers, by implementing this technology the farms that boarder geothermal fields are able to increase their annual revenue benefitting from reduced infections and faster maturity and also give a chance for utilization of low temperature wells and exploitation of low temperature fields for several direct use opportunities in counties where there is potential like Mwannyamwala area in Kwale County. This will be of great help to Kenya in realization of food security in areas with potential.

1. INTRODUCTION

Greenhouse heating is one of the most common use of geothermal energy in agriculture around the world with the Oserian flower farm in Naivasha leading in Kenya, Oserian greenhouse heating uses an exploration well drilled by KenGen in 1983, the well is isolated and cyclic in nature with very low generation capacity and has a potential of less than$1mw_e$, the use of geothermal energy has the following benefits:

- Enables crops to grow at optimal crop growing conditions
- Decrease fungus due to humidity control
- Increased carbon dioxide level leading to faster crop maturity.

In many countries, geothermal heat is used to produce vegetables, fruits and flowers on a commercial scale all year round.

With several wells drilled within the olkaria field having outputs of less than $1Mw_e$ and with several flower farms overlying this field including Finlay's flowers,Sher Karuturi,Goldsmith,V.d Berg farms, the wells can be channeled into this farms to enable them be utilized for greenhouse heating within these farms.

2. GEOTHERMAL DISTRIBUTION IN KENYA

Research and exploration has been carried out in several parts of the country and immense potential noted with a capacity of about 10000Mw potential within the country, Figure 1 below shows geothermal distribution of the country in a map

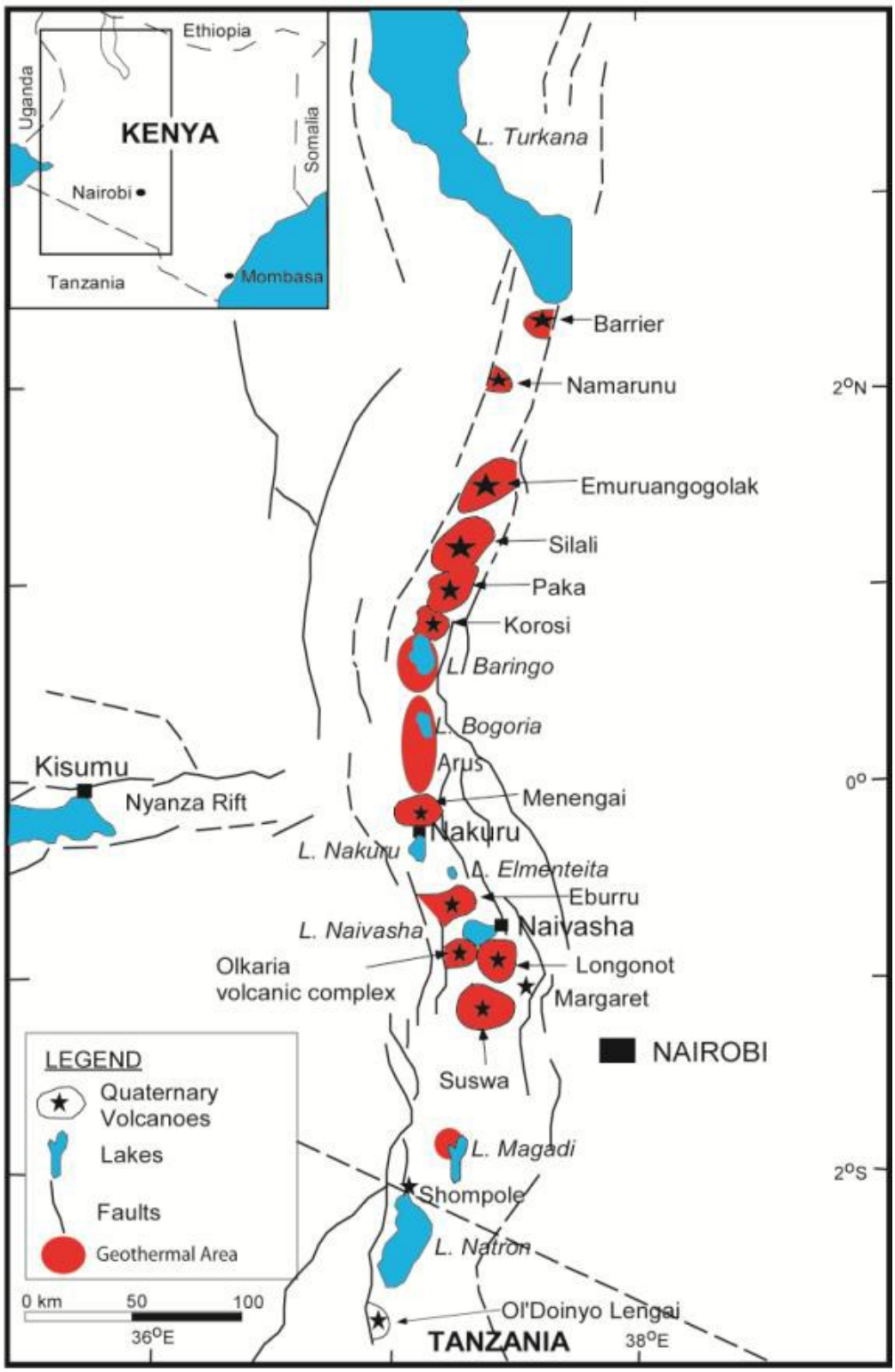


Figure 1.Map showing Kenya geothermal rift

3. HEATING SYSTEM OPERATION

3.01 PROCESS PRESSURE CONTROL

Due to the cyclic nature of the wells intended for use in the heating system, and coupled with the desire to achieve a constant pressure and temperature. A high performance ball valve is used to regulate downstream pressure.

3.02 SYSTEM VENT SYSTEM

A vent system whose main objective is to prevent well extinguishing at high pressures is provided for by means of a ball valve, the valve also helps in isolation of the system when no heating is required and also for venting in times of high pressures

3.03 HEAT EXCHANGE SYSTEM

Two identical heat exchangers can be provided to act as a redundant heat exchanger and only comes online during peak heating cycles, the exchanger provide a medium through which water to be circulated within the greenhouse is heated.

3.04 NCG SEPARATION

A knockout drum is provided after the heat exchangers to separate non condensable gases from the liquid phase, pressure in the knock out drum is controlled to a set value and CO_2 from the system is diverted to the greenhouse depending on greenhouse carbon dioxide demand

3.05 FLUID DISPOSAL

Fluid vented from the system vent line and NCG from knock out drum are discharged into a silencer, steam and gases are hence vented into the atmosphere and liquids to designated discharge areas

3.06 **SYSTEM CONTROL**

The system is controlled by a remote operation controller which provides a PID loop controls, this helps in monitoring alarms, logging of operation data. The system has mains and backup power system

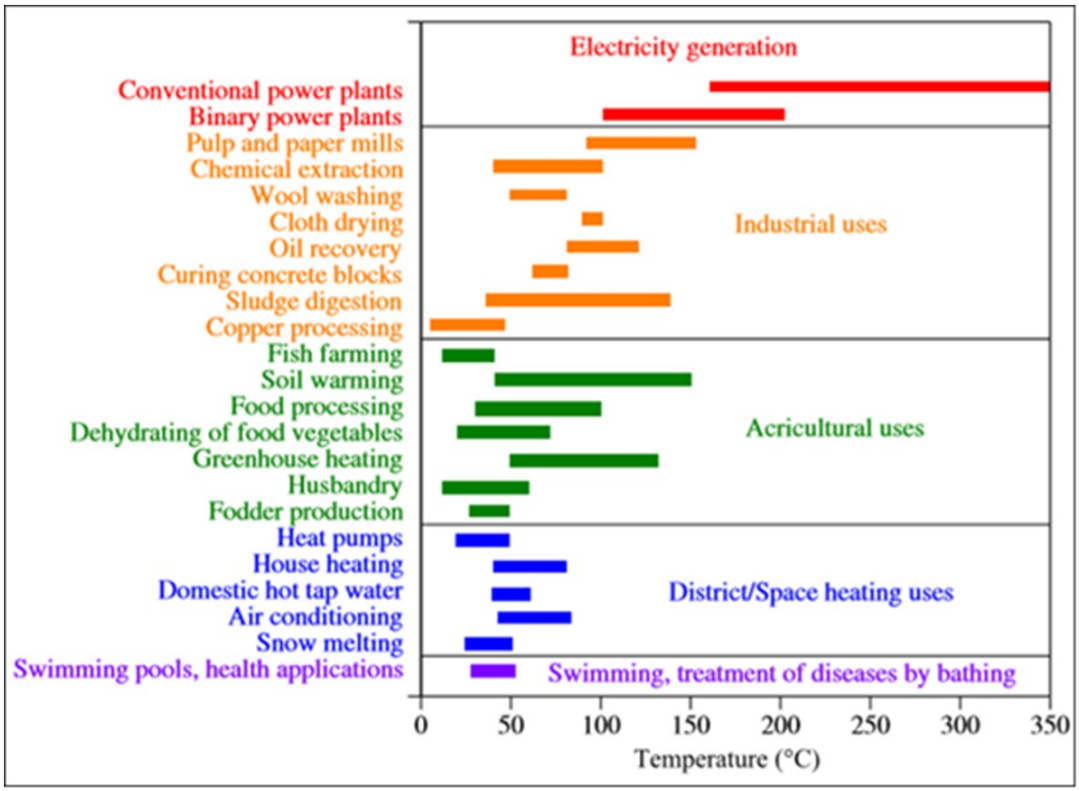
Images of oserian heating system

Figure 2.Oserian geothermal heated greenhouse

Figure 3 Oserian geothermal heat exchanger

4.0 OTHER DIRECT USE OPPORTUNITIES IN KENYA

Direct utilization opportunities are as indicated in the lindal diagram below



Lindal diagram-thermal level for various direct use applications

Application of direct use helps greatly as low temperature wells that are always considered as white elephant projects would be put to use, it also gives life to wells that are drilled in isolation and not connected to power plants. With the proposed industrial park to

be constructed in Naivasha Olkaria, opportunities for heating will be provided, this would in turn help industries to lower their cost of production and save on cost of fossil fuels

4.01 Geothermal spas and swimming pools

Geothermal spa and swimming pools have been I existence and used by Romans, Chinese, Japanese and central Europeans for centuries. The Kenyan Rift Valley host several tourist attraction centers including Hells gate national reseve,Lake Nakuru national park,Oserian animal sanctuary and Mount Longonot among many others, hence development of hot spring areas for medicinal, recreational and tourism purposes (spas, swimming pools and saunas).These uses are particularly developed in the Asia and in European countries, The launch of Olkaria Geothermal spa in Kenya figure 5 has since shown a great increase in number of visitors visiting hells gate national park,P.Mangi (2018),there are also local uses of hot springs, without proper facilities in Kenya, Martin M, (2000). A tourist hotel near Lake Bogoria is utilizing hot water from a nearby Loboi spring at 38ºC to heat a spa pool. These uses are feasible in Lake Bogoria (Plate 1) where a total of 437 MWt are lost in the area surrounding the Lake. Other feasible areas include Lake Baringo where there was the famous Chepkoiyo blowout well (Plate 2) and at Kapedo (Plate 3). The expansive area between Lake Bogoria (Plate 4) to the north and Nakuru to the south where anomalous borehole for domestic water have been encountered are also promising areas J lagat (2015). At Eburru these developments can also be realized utilizing the heat available as a by-product of geothermal power generation for spa development These developments if realized will enhance local and foreign tourism hence boosting the economies of the local population and the country at large.

Figure 4.Bogoria hot springs

Figure 5 Olkaria geothermal spa

4.02 Aquaculture

The use of geothermal energy for raising catfish, tilapia, and tropical fish has produced crops faster than by conventional methods. In Kenya GDC Uses geothermal heat that allows better control of pond temperature, Geothermal heated water flows into aquatic ponds to maintain a pond temperature of 29°C in a flow through water system. These ponds are housed in tunnels to conserve heat lost through evaporation. An aeration system is provided pushing compressed air through diffuser tubing placed along the bottom of each fish pond. This temperature is optimal for metabolism of the tilapia species of fish, leading to enhanced growth Fish are fed using high quality fish food . an improved maturity period of six and a half months on average compared to the conventional eight month maturity age for the tilapia species of fish was achieved. Fish breeding has been successful in Japan, China and the U.S, Freestone, D. H., (1995). The most important factors to consider are the quality of the water and disease.

Effect of temperature on animal and fish growth (after Lund, 2000).

The improved maturity period and production per unit area, make this resource critical in achieving food security. These high protein algae grow naturally in many of the Kenyan lakes (Turkana, Baringo, Bogoria, Nakuru, and Naivasha) and offer ideal feed for herbivorous fish, as well as directly providing for human consumption. Use of geothermal to raise fish will help alleviate lake dependency for fish, and with great potential within the Kenya rift, these is an area requiring adequate exploitation.

4.03 Drying of agricultural products

Drying and dehydration are important moderate temperature uses of geothermal energy. Various vegetable and fruit products are feasible with continuous belt conveyors or batch (truck) dryers with air temperatures from 40 to 100°C. Geothermally drying onions, pears, apples and are examples of this type of direct use. Using geothermal energy increases the efficiency of the process and extends the production into the wet months.

Pyrethrum flowers are mainly dried right on the farms using naturally ventilated driers, or less frequently, firewood and waste fuels burning driers, or solar heated chambers.

Efficient drying is an essential part of pyrethrum production. Improper drying can cause serious reductions in the pyrethrins content, and consequently, affect the commercial value of the final product. Temperature control is an important aspect of the drying process, since overheating can cause a marked decline in the pyrethrins content. To eliminate moisture efficiently, drying must be a gradual process. The temperature of the airflow can be regulated before it reaches the flowers, and should never exceed 85°C. Use of geothermal to dry pyrethrum in the dull, misty conditions that are prevalent during rainy seasons, when natural drying is not feasible should be considered. In the Eburru area, farmers have for decades utilized natural steam at a temperature of 98ºC, emitted by

fumaroles to dry their flowers. The dryers have been very useful especially during the wet season when there is no sunlight. More modern type dryers need to be constructed in most of the pyrethrum growing areas.

4.04 Dairy farming

Another area that will help to improve food stability is the direct use of geothermal heat for milk pasteurization, milk production is on a high increase in the country but suffers a major hindrance due to perishability of the produce, Most dairy farmers who live around the geothermal rift valley stand a chance to benefit if this field is well exploited.
In Kenya, GDC is championing this by installation of milk processing unit with a 150 litre capacity for milk pasteurization. It takes about four hours to pasteurize one batch; hence this plant can effectively be used to pasteurize bigger quantities of milk if the raw milk is available.

Fig 6; Milk pasteurization unit at GDC Kenya

4. CONCLUSION

Kenya being a country that largely depends on agriculture will greatly benefit with increased investment and use of greenhouse heating to improve agricultural production, Oserian flower farm has managed to be on top of the rest for over a decade now due to fast maturity of cut flowers and reduced cost of production due to elimination of fossil fuels to heat the greenhouses, a pilot project by GDC also shows very good results on geothermal greenhouse heating. Advancement of this direct use system will also open areas considered to be very remote to agricultural activities and hence provide employment to residents of these areas and improve food sustainability of the areas.

The successful pilot projects on direct use by GDC on fish farming, greenhouse heating and milk pasteurization, and Kengen's geothermal spa and Oserian green house heating is a testimony of an untapped potential waiting to be fully exploited.

REFERENCES

Omenda P.A., Opondo K., Lagat J., Mungania J., Mariita N., Onacha S., Simiyu S., Wetang'ula G., Ouma P., 2000: Ranking of geothermal prospects in the Kenya rift. Kenya Electricity Generating Company Limited, internal report. pp 121.

Oserian geothermal heating system operation manuals.

FAO 2015. Uses of geothermal energy in food and agriculture, Opportunities for developing countries, United Nations, Rome.

Lund J.W., 2015. Direct Utilization of Geothermal Energy. Geo-Heat Centre, Oregon Institute of Technology

Popovski, K. & Vasilevska, S.P. 2003. Heating greenhouses with geothermal energy. In proceedings of the International Geothermal Workshop, 6–10 October 2003, Sochi, Russian Federation. Paper No. W00037, 17 pp.

Mangi, P. 2013: Direct Utilization in Kenya: A case of a Geothermal Spa and Demonstration Centre at Olkaria, pp 6.