Sub-Sahara African Academic Research Publications
March, 2023, Editions

JASOR
Journal of Advanced Science and Optimization Research
Vol. 27, No.9, ISSN 2418-9325

POTENTIAL OF GEOTHERMAL ENERGY APPLICATION IN NIGERIA

MOHAMMED T. N.; SANI M.; MAFE A.S; & OLANIYI K.O.
Department of Science Laboratory Technology, Federal Polytechnic Offa.

Abstract
Geothermal energy is the heat that is stored inside the earth, which when transferred to the surface can be used by humans. Uses for geothermal energy range from its direct use with no transformation, to the generation of electricity using geothermal power plants. This article overview the potential of geothermal energy application in Nigeria with a view to harnessing it for future application and usage. Geothermal energy is generally regarded as environmentally friendly, sustainable and reliable. This makes geothermal energy a no-brainer in some places, but heavy upfront costs stops us from realizing the full potential. The level of influence geothermal power will have on the energy system in the future will be dependent on technological advancements, energy prices and politics (subsidies).

Keywords: Geothermal, Electricity, power, Energy, Heat.

Introduction
In recent years increasingly greater attention is paid to the problems of utilizing clean alternative renewable energy sources to meet energy supply demands in different agricultural and industrial spheres. The relevance and perspective of the given trend are conditioned by the two key factors: catastrophic situation in the environment and necessity of searching for new kinds of energy(Magomedov, 1996). Due to slow and sure resource depletion of basic energy sources, first of all, oil and gas, as well as limits in development of hydro- and atomic power, many countries carry out the

research in extension of alternative energy sources use – peat, oil shale, bitumen, unconventional gases, energy of Earth heat, sun, wind, ocean, biosynthesis etc (Golitsyn, 2004 ; Konovalov et al., 2015). Energy can strongly act as a key role in socio-economical development of Nigeria. Nigeria's energy needs are always increasing because Nigeria has a rapidly growing economy and population.

Heat is a form of energy, and geothermal energy is the heat that is stored inside the earth, which when transferred to the surface can be used by humans. Uses of geothermal energy range from its direct use with no transformation, to the generation of electricity using geothermal power plants. Even though a huge amount of thermal energy is stored inside the earth, only a fraction of it is usable for mankind (Marzolf 2014; Dickson and Fanelli 2013). Given that geothermal energy is a renewable resource, it may be considered a solution for the environmental and energy shortage issues Nigeria currently faces (Muñoz et al. 2014 ; Samuel et al., 2017).

Geothermal energy is present almost all over the earth's surface but only difference is the method and cost of extraction. Earth geothermal energy has its origin from the original formation of the planet, from radioactive decay of minerals, from volcanic activity, and from solar energy absorbed at the earth's surface. The geothermal gradient which is the difference in temperature between the core of planet and its surface drives a continuous conduction of thermal energy in the form of heat from the core to the surface(Khyal and Rajender, 2014).

Geothermal energy, one of the most promising among renewable energy sources, has proven to be reliable, clean, and safe, and therefore, its use for power production, and heating and cooling is increasing. Geothermal energy is a power source that produces electricity with minimal environmental impact (Khyal and Rajender, 2014). Geothermal energy has been produced commercially for about 90 years and for four decades on the scale of hundreds of MW for both electricity generation and direct uses. Most of the world's geothermal power plants were built in the 1970s and 1980s following the 1973 oil crisis. Different authors have performed different estimations of the geothermal potential for both electricity generation and direct uses. The geothermal potential of the world to

produce electricity should be between 35 and 72 GW. With the improving technology such as permeability enhancement, drilling improvements, this range could reach up to 138 GW (Bertani, 2003).

The present paper is an attempt to highlight potential of geothermal energy in Nigeria. The main objective of this paper is to give an overview of geothermal energy and to assess geothermal potential present in Nigerian crust for heating purpose. As we all know that the energy demand is escalating with population growth and economic growth of our country. Presently the predictable energy shortage is 32% in Nigeria. To reduce this gap between demand and supply of energy we need to generate more power.

Extraction of Geothermal Energy

Extraction of geothermal energy from the underground, water is most times used as the heat carrier. As the crust is highly fractured and thus permeable to fluids, surface water, in most cases rainwater, penetrates at depth and exchanges heat with the rocks. Two main forms of heat transfer occur within the crust: conduction and convection. Where rocks are much fractured and circulating fluids are abundant, the resulting convective heat transfer is very efficient and can be easily exploited by drilling wells and discharge the hot fluids to the surface. In these convective systems, named hydrothermal resources, the aquifers represent the geothermal reservoir. Occasionally, in areas of very high heat flow, the fluid has high temperature (up to above 300^{o}C) and, depending on the pressure, can be vapor (steam) or water. Warm and hot fluids can be extracted from the underground in a wide range of temperature and discharge rate, and used directly for their heat content or to produce electric power. Even the modest temperatures found at shallower depths can be used to extract or store heat by means of ground source heat pumps, which are nowadays a widespread application for geothermal energy. Heat can be extracted at different rates. To guarantee a sustainable use of geothermal energy, the rate of consumption should not exceed the rate of generation, so that the heat removed from the resource is replaced on a similar time scale. Geothermal plants typically develop below a certain level of energy production. Geothermal typically

provides base-load generation, since it is generally immune from weather and seasonal variation, therefore producing almost constantly and distinguishing it from several other renewable technologies that produce variable power or heat with time (Manzella, 2017).

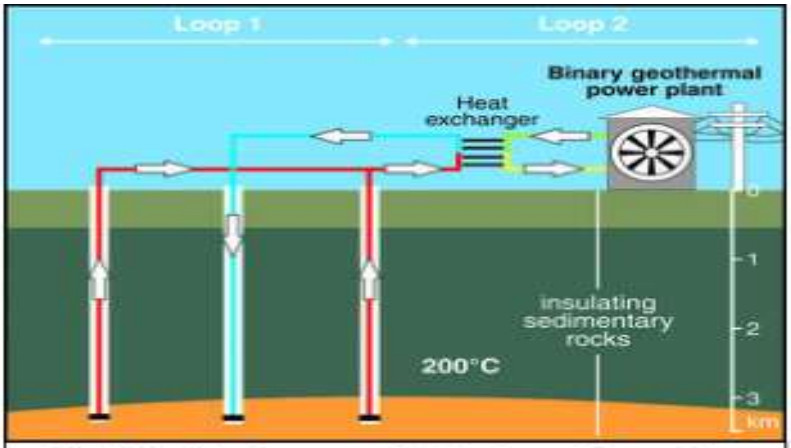

Fig 1: Working Processes of A Geothermal Power Plant

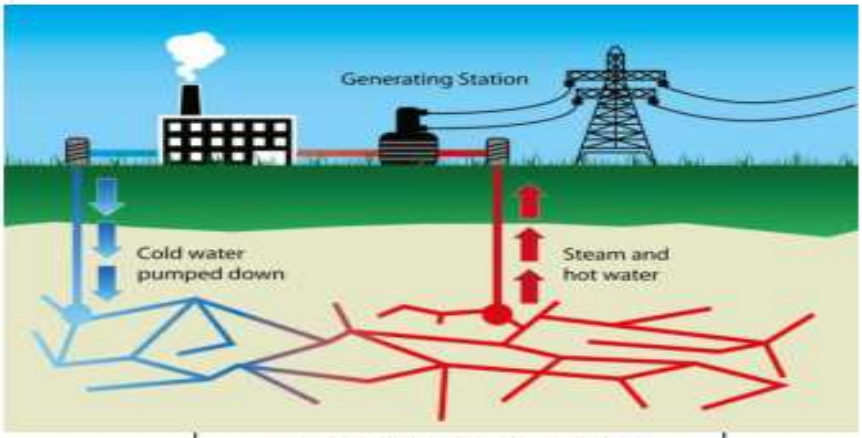

Fig 2: Geothermal Power Plant

Merits of Geothermal Energy

- Environmentally Friendly: Geothermal energy is generally considered environmentally friendly. There are a few polluting aspects of harnessing geothermal energy, but they are minor compared to the pollution associated with conventional fuel sources.
- Renewable: Geothermal reservoirs come from natural resources and are naturally replenished.Geothermal energy is therefore a renewable energy source. Sustainable is another label used for

renewable sources of energy. In other words, geothermal energy is a resource that can sustain its own consumption rate, unlike conventional energy sources such as coal and fossil fuels. According to scientists, the energy in our geothermal reservoirs will literally last billions of years.

- Massive Potential: Worldwide energy consumption – about 15 terawatts (TW) – is not anywhere near the amount of energy stored in earth. However, most geothermal reservoirs are not profitable and we can only utilize a small portion of the total potential. Realistic estimates for the potential of geothermal power plants vary between 0.035 to 2 TW.
- Stable: Geothermal energy is a reliable source of energy. We can predict the power output of a geothermal power plant with remarkable accuracy. This is not the case with solar and wind, where weather plays a huge part in power production. Geothermal power plants are therefore excellent for meeting the base load energy demand.
- Great for Heating and Cooling: Water temperature of more than 150^{o}C or greater is needed in order to effectively turn turbines and generate electricity with geothermal energy. Another approach is to use the (relatively small) temperature difference between the surface and ground source.

Geothermal Energy Potential in Nigeria

The Nigerian Precambrian Basement complex covers 48% of the total land area in the country whereas the remaining 52% of the land is covered by cretaceous to recent sediments deposited within several basins. The geological setting in which geothermal reservoir is found can vary widely from rocks of limestone to shale, volcanic rock and granite. The most common rock type in which geothermal reservoir is found is volcanic rocks. The geothermal systems are associated with fracture and heat flow instead of specific lithology. The geological structure and history in Nigeria influences geothermal exploration within each geological province. The products of magmatic and volcanic activities, for instance, are numerous

within the Benue trough. Biu plateau has over 80 volcanoes and Jos plateau with extensive basaltic lava flows (Grant et al., 1972; Turner, 1978). The developed geothermal reservoir around the world also occur in convectional systems in which hot water rises from deep of the earth and is trapped in reservoirs whose caprock has been formed by silification precipitation of other mineral elements. Sedimentary basins in Nigeria have been explored for hydrocarbons for several decades, thus the oil companies possess large suite of subsurface temperature data. Data sets from the oil wells and water well have revealed that geothermal gradient in Niger Delta ranges from 1.3 to 4.7°C/100m. Another good source of information about subsurface temperatures is water boreholes. The temperature measured during pumping tests is close to the real temperature of water bearing rock formation. However, such wells are usually shallow; especially water wells drilled within crystalline areas in Nigeria usually are not deeper than 30 meters. In the sedimentary areas water boreholes are usually deeper, even down to 500 meters and many of them can be used as the source of geothermal data. With the availability of several warm/hot springs and seepages in Nigeria, most of which are located within sedimentary basin of Benue Trough, there may be potential geothermal resources within this part as these features are geological phenomena appearing as visible manifestation of geothermal energy within the subsurface (Dorcas, 2016).

Conclusion

Mostly, the biomass energy and hydraulic energy among renewable resources are used to meet a part of the energy need in Nigeria. Although geothermal energy comes after them, its usage has not been appreciated by relevant bodies and stakeholders in the power sector. In comparison to fossil fuels, geothermal energy has more advantages such as being renewable, reliable, clean, and a cheap domestic energy resource. Therefore, the development studies and investments in this sector should be supported. Taking into consideration the future energy need in Nigeria, it is clear that geothermal energy has an important role in meeting it, but it is not sufficient by itself.

It should be noted that Nigeria possesses great potential of alternative and renewable energy sources, particularly geothermal among which the most efficient is implementation of geothermal-generating power stations in order to save fuel consumed by diesel power. Alternative and renewable energy sources are most efficient in the areas of decentralized power supply where they are competitive with diesel power stations.

References

Bertani, R. (2010). Proceedings, World Geothermal Congress, Indonesia

Dickson M.H and Fanelli M. (2013). Geothermal energy: utilization and technology. United Kingdom: Routledge.

Dorcas S. E., Michael A. O., Thompson H.T., Ogunribido O. and Olumuyiwa A. O. (2016). An Overview of Geothermal Energy Resources in Nigeria. *Environtropica,* Vols. 12 & 13, 61-71 ISSN 1597-

Grant N. K., Rex D. C. and Freeth S. J. (1972). Potassium- Argon Ages and Strontium Isotope Ratio Measurements from Volcanic Rocks in Northern Nigeria. *Contr. Mineral and Petrol* 35, 277- 292.

Golitsyn M. V., Golitsyn A. M. and Pronina N. V. (2004) Alternative energy source (Moscow: Nauka) p 159.

Khyal C. and Rajender K. (2014). Geothermal Energy – An Alternative Source of Clean and sustainable Energy in India. https://www.researchgate.net/publication/30337012.

Konovalov O., Pogharnitskaya O., Rostovshchikova A. and Matveenko I. (2015). Potential of renewable and alternative energy sources PGON2015 IOP Publishing IOP *Conf. Series:Earth and Environmental Science* 012068 doi:10.1088/1755-1315/27/1/01206.

Magomedov A. M. (1996) Alternative renewable energy sources. Makhachkala and Yupiter. p 245.

Marzolf N. (2014). Emprendimiento de la energía geotérmica en Colombia, Banco Interamericano del Desarrollo. ISAGEN.

Manzella A. (2017). Geothermal Energy. Institute of Geosciences and Earth Resources - Pisa, Italy. EPJ Web of Conferences 148, 00012.

Muñoz Y., Guerrero J., Ospino A.(2014). Evaluation of a hybrid system of renewable electricity generation for a remote area of Colombia using homer software. *Tecciencia.* 9(17):45–54. https://doi.org/10.18180/tecciencia.2014.17.6.

Samuel S. S., Yecid M. and Adalberto O. (2017). Analysis of geothermal energy as an alternative source for electricity in Colombia. 5:27 DOI 10.1186/s40517-017-0084-

Turner D. C. (1978). Volcanoes of the Biu Basalt Plateau, Northeastern Nigeria. *J. Mining and Geology,* Vol. 15, No. 2, 49-63.