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Tapping into Geothermal Technology to Boost Electricity Supply in Nigeria

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***Abstract*- It is no more news that attention of humanity has shifted to the generation of energy through renewable energy sources. This paper is based on how Nigeria can tap into the use of geothermal technology other than other renewable energy sources to generate electricity using of the two available geothermal resources (hydrothermal and petrothermal) in available locations. Through hydrothermal plants the heat received from geothermal resources are converted to electricity. This is a technology that if efficiently utilized, can go a long way to make Nigeria electricity challenge a thing of the past.**

***Keywords*: - Rrenewable energy, geothermal, hydrothermal and petrothermal.**

I.INTRODUCTION

A lot of efforts have been made to improve generation of electricity using both non-renewable and renewable energy methods. Recently, the world is now turned in the direction of developing renewable energy sources and concentration greatly shifted to the possibilities of use of solar energy. There have also been plans to use wind and constructing wind power plants in developing nations, especially in Nigeria.

Geothermal energy has the following advantages over other renewable energy sources:

- High degree of availability.
- Low land use.
- Non dependence on environment conditions.

Basically, geothermal energy involves the tapping of thermodynamic quantities that can produce heat from beneath the earth crust and it gets to the earth's surface through convection and conduction. Heat generated in the earth crust is as a result of the decay of radioactive isotopes of uranium, thorium, potassium and earth crust core which has a temperature of 1000 – 4500^0C.The heat generated can be converted into other forms of energy such as electrical energy which is the major focus in this paper.Despite geothermal energy is the best potential energy sources according to World Energy Assessment (WEA), there has not been any serious investigation or research done in Nigeria to explore its potentials.

II. ENERGY INSIDE THE EARTH

There is generation of heat energy inside the earth's core much more than what is obtainable from the sun. the earth's core is about 4,000 miles below the surface. This temperature generated in the earth's core is a result of radioactive decay of particles which happens in all rocks. The earth has a number of layers as show in figure 2 below.

- **The core:** This has two layers namely, solid iron core and an outer melted rock called magma
- **The mantle:** This surrounds the core and it is about 1,800 miles thick. It comprises the magma and the rock.
- **The crust:** This is the outermost layer of the earth. If forms the land that forms the continent and the ocean floors. It is about 3 to 5 miles thick under the ocean and 15 to35 miles thick on the continents.

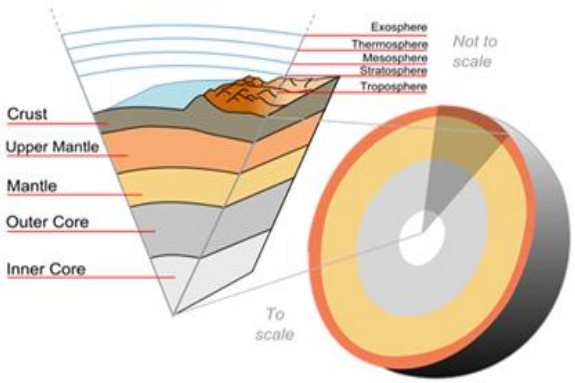


Fig 1. Different layers of the Earth.

The earth's crust is broken into pieces called plates. Magma finds its way to the earth's surface near the edges of the plates. Volcanoes occur here and the lava that erupts from volcano is partly magma. Water under the ground absorbs heat from magma. The heat absorbed by water increases down the ground. Geothermal energy finds its way to the earth's surface through any of the following ways.

- Volcano
- Hot springs
- Geysers

Geothermal resources are majorly found along plates boundaries where volcano and earthquake are concentrated. An area called **ring of fire** is where most geothermal activity in the world takes place. Ring of fire is around the Pacific Ocean.

The heated water from porous rock or fractured rock surface and faults as a result of its contact with magma is called hydrothermal resource with two major ingredients which are water and heat. There are basically two types of geothermal resources: hydrothermal and petrothermal. Naturally, areas with large geothermal resources is called geothermal reservoir.

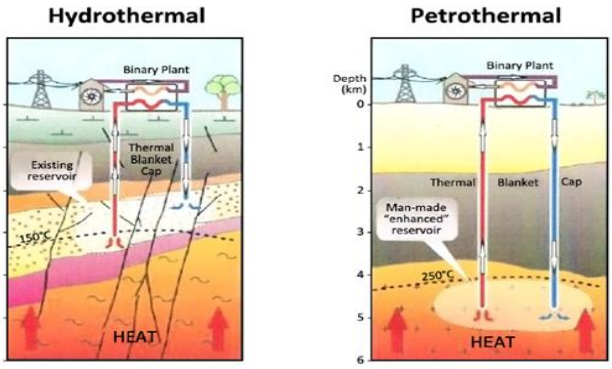
III. USES OF GEOTHERMAL ENERGY

Geothermal energy has some applications which are mentioned below:

1. **Direct use and heating systems:** This is the use of heat from springs or reservoirs directly.
2. **Geothermal heat pumps:** This is the use of stable ground or water temperature near the earth to control the temperature of buildings.Temperature above ground change from time to time and season while temperature in the upper 10 feet of the earth's surface is nearly constant between 50 to 60 degree Fahrenheit meaning soil temperatures are usually warmer than the air in winter and cooler than the air in summer.Geothermal heat pumps use natural temperature constant condition to heat and cool the buildings.
3. **Electricity generation:** This is the use of steam or water with high temperature about 300 to 700 Fahrenheits to turn geothermal power plants. Geothermal power plants are located near geothermal reservoirs.

4. **There are three types of geothermal power plants:**
   - **Dry steam plant:** It uses steam piped directly from geothermal reservoir to turn power generating turbines.
   - **Flash steam plant:** This uses high temperature water from deep inside the ground and converts it to steam to drive the generator turbine. When the steam is cold it is re-injected back into the system and turned back to steam.
   - **Binary power plant:** This transfers the heat from water from inside the earth to another liquids which turns to steams at lower temperature. The steam from another liquid now turns the generator turbine.

5. **There are two types of geothermal resources, they are-** Hydrothermal and petrothermal resources capable of generating electric power. The two figures (fig 2 and fig 3) below show the two types of geothermal resources.



(a) (b)

Fig 2: (a) Heat carrier (i.e steam/ Hot water) at locally present Depth-very rare (Energies, 2014)
(b) Heat carrier at a depth where it is artificially circulated – ubiquitous (Energies, 2014)

IV. GEOTHERMAL AS ALTERNATIVE SOURCE OF ENERGY IN NIGERIA

It is very surprising that despite results of researches that Geothermal gives highest capacity of energy compared to other types of renewable energy, Nigeria in not doing anything serious to tap into such much available opportunity.

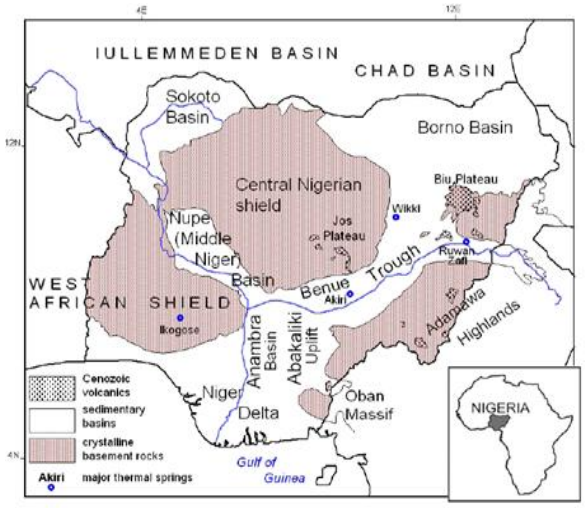


Fig 3. Geological setting and location of the major structural units in Nigeria. [4]

The only investigation done so far in Nigeria were those of subsurface temperature of rock mass in some wells due to exploration of oil and gas within sedimentary basins in some chosen locations such as: Niger Delta [4]; Benue Trough (which comprises Anambra pot as well as Abakaliki Anticlinorium-Uplift, North Centre as well as Upper Benue Trough-together having Yola, Gongola as well as Kerri basins) (1). Borno pot (6). Sokoto pot (5) amongst others. Figure3 below shows the units/locations in Nigeria where geothermal values were taken.

Some of the geothermal values taken during the geothermal investigations in Nigeria are as given below:
a. 1.3 – 5.5^{0}C/100m(Across Niger Delta Region)
b. 2.0 – 4.9^{0}C/100m(South East Region)
c. 0.9 – 7.6^{0}C/100m(North East Region)
d. 2.0 – 2.5^{0}C/100m (South West Region)

The table below is from (World Energy Assessment - WEA)– a collaborative effort of United Nations Development Programme (UNDP), United Nations Development of Economic and Social Affairs (UN DESA) and the World Energy Council (WEC). Geothermal energy amongst all forms of renewable sources has the largest potential value.

Table 1. Potential of renewable energy sources in Exajoules per year (10^{18}J/Yr), from World Energy Assessment (WEA).

Energy source	Capacity(EJ/yr)
Geothermal	5000
Solar	1575
Wind	640
Biomass	276
Hydro	50
Total	7541

The growth of installed geothermal power (MWe) worldwide over the years 2000-2014 from Geothermal Energy Association (GEA) 2014 is as given in figure 3 below. [3]

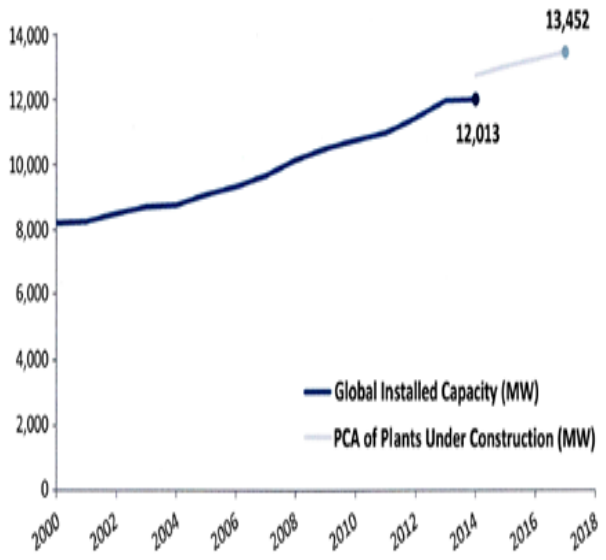


Fig 4. Growth rate of installed geothermal power from 2000-2014.

Table 2. Below shows installed geothermal electric capacity of countries that have adopted it.

Installed geothermal electric capacity

Country	Capacity (MW) 2007[7]	Capacity (MW) 2010[33]	Capacity (MW) 2013[34]	Capacity (MW) 2015[35]	Share of national generation (%)
USA	2687	3086	3389	3450	0.3
Philippines	1969.7	1904	1894	1870	27.0
Indonesia	992	1197	1333	1340	3.7
Mexico	953	958	980	1017	3.0
New Zealand	471.6	628	895	1005	14.5[36]
Italy	810.5	843	901	916	1.5
Iceland	421.2	575	664	665	30.0
Kenya	128.8	167	215	594	51.0[37]
Japan	535.2	536	537	519	0.1
Turkey	38	82	163	397	0.3
Costa Rica	162.5	166	208	207	14.0
El Salvador	204.4	204	204	204	25.0[38][39]
Nicaragua	87.4	88	104	159	10.0
Russia	79	82	97	82	
Papua New Guinea	56	56	56	50	
Guatemala	53	52	42	52	
Portugal	23	29	28	29	
China	27.8	24	27	27	
Germany	8.4	6.6	13	27	
France	14.7	16	15	16	
Ethiopia	7.3	7.3	8	7.3	
Austria	1.1	1.4	1	1.2	
Australia	0.2	1.1	1	1.1	
Thailand	0.3	0.3	0.3	0.3	
Total	**9,731.9**	**10,709.7**	**11,765**	**12,635.9**	–

V. CONCLUSION

It is no doubt that there has been over depended of humanity on no-renewable energy sources. Energy collapse will surely take place soon as it is expected in Europe by 2030 to 2040. The earlier efforts are made to completely exclude hydrocarbons as sources of energy the better. Different countries have been making advances to ensure complete transition to renewable sources of energy; Nigeria should not be an exception

RECOMMENDATION

Considering the severity in the need of electrical energy in Nigeria, Geothermal energy, because of its advantage over other renewable energy sources.Must be a good target for her not minding the initial cost.

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