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# Alternative Energy to the Rural Communities of Nigeria: Solution to Energy Shortage.

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## Introduction

The survival of human society is dependent on the continuous supply of energy. Modern man utilities energy for almost everything, from normal body metabolism to industrial processes (Agbanigo & Oladipo, 2009). Its availability and proper use in a country, according to Ayodele et al (2006), can improve the economic life of the citizens. It is a "universal impute to economic growth. Nigeria with a population of about 140 million would require an estimated power demand of 13,160.33MW signifying that all hands must be on deck to generate not less than 15,000 MW for constant power supply to the consumer (Adeoye & Ekejiuba, 2014). The present power generation is 4439.5 MW and there is high transmission loss which means the time to achieve constant power supply seems to be far away from us and the developmental progression of the country would be extremely slow (The Nation, 2012). Petirin & Mojibola, (2007) observed that the nation has been suffering from chronic power outages that results in low voltages, voltages fluctuations, power offs and load shedding. Some of the major problems for this chronic power as identified by (Owolabi, 2008) includes: vandalization of gas pipelines, old and decay infrastructures and high level of inefficiency that have engulfed the system.

Hence, the rural communities in Nigeria suffer the most having no test of electricity at all; to this end, an alternative means of energy supply is proffered.

## Background

Nigeria is located in the western part of Africa, between latitudes $4^{o}$ 16'N and $13^{o}$52'N; and between longitudes $2^{o}$49'E and $14^{o}$37'E and occupies a total land area 923,768$km^2$ with a population of 147 million people as at 2006 and spans different climatic and ecological zones, mean annual rainfall rainfall ranges from about 450-750 mm in the northeast to about 3,500-4,300 mm in the coastal south-east, with rains falling within 90 to 290 days respectively, mean annual temperature ranges from $21^{o}$C in the south to $30^{o}$C in the north with extremes of $14^{o}$C and $45^{o}$C and an altitude range of 0-100 m above sea level(Katsina state, 2010, Kankara, 2013, Sambo, 2009). Being so located has blessed the country with different forms of energy; renewable and non renewable but alas the country has found it hard to meet the energy demand of her populace(Ozore, 2003, Adebayo,2013).

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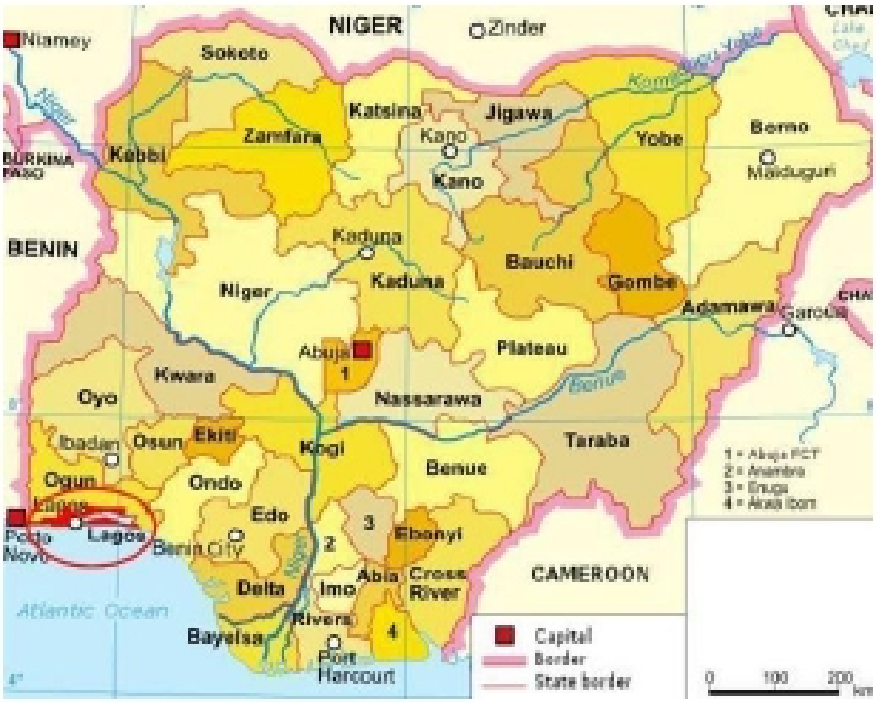


Source: Katsina State, 2010

Fig. 1: Map of Nigeria showing the 36 states and the FCT Abuja

Energy short societies constitute the majority of developing nations(Freling & Ramsour, 2010) and among the top priorities for the majority of the world's population is access to sufficient affordable energy. 80% of the world's population is the developing world but 30% of global commercial energy is consume by them (Martinot, et.al., 2002). WEC, 1993 said there is a very limited equity in the energy use in the different parts of the world. Whereas the per capita energy consumption level of 70% of the world's population when compared with W-Europe is less than one-quarter and one-sixth of that of the USA, per capita energy consumption in Nigeria is estimated at 0.03kW(Nwulu & Agboola, 2011, Okafor & Joel-Uzuegbu, 2010). Two billion people, a third of the world's population, have no access to modern energy services(Fridleifsson, 2010). It is estimated that just about 40% of Nigerians have access to electricity and out of this percentage 80% reside in the urban areas while only about 10% of the rural populace have access to electricity(Adaramola & Oyewola, 2011). Most of the rural regions in Nigeria are not electrified, they depend on traditional sources of energy for lighting and cooking(Sambo,2009, Nwulu & Agboola, 2011, FRN, 2006, Awosope & Okoye, 2003 & Makoju, 2003).

It has been found that the present dependence on fossil fuel is not enough to meet the energy demand needs of the country(Vincent-Akpu,2012), all efforts by the government to make energy available to her citizenry has led her to come up with different energy reform at one time or the other but still this has not come to fruition(Sambo, 2009), Omokaro (2008) discovered that over 90% businesses and companies have private generators leading to high production cost.

Table 1 Statistics of Electricity and Per Capita Consumption of some Countries.

| Continent | Country | Population(million) | Generation Capacity | Per-Capital Consumption (kW) |
|---|---|---|---|---|
| North America | USA | 200 | 813,000 | 3.2 |
| South America | Cuba | 10.54 | 4,000 | 0.38 |
| Europe Central | United Kingdom | 57.5 | 76,000 | 1.1 |
| Europe Eastern | Ukraine | 49 | 54,000 | 1.33 |
| Middle East | Iraq | 23.6 | 4,000 | 0.42 |
| Far East | South Korea | 47 | 1,800 | 1.1 |
| Africa | Nigeria | 140 | 4,000 | 0.03 |
| | Egypt | 67.9 | 1,800 | 0.27 |
| | South Africa | 44.3 | 45,000 | 1.03 |

Source: Okafor & Joel-Uzuegbu, 2010.

Nigeria in 2007 targets 7% renewable energy by 2025 and according to former United States' Secretary for Energy 'Nigeria can become the hub of renewable energy in Africa' (Tsokar, 2012).

**Non Renewable Energy Potentials in Nigeria**

As a result of the location of Nigeria, she is blessed with both non renewable energy and renewable energy sources. Until very recently, Nigeria has solely depended on non renewable energy which has been found to contribute to the environment being polutted and the supply of energy to the whole community not being adequate, mainly the economy has depended on fossil fuel which is found in abundance but which has not been able to meet all the energy demand. Table 2 shows the non renewable energy resources in Nigeria.

Table 2 Non Renewable Energy Resources in Nigeria and their Reserve Estimates

| Energy Type | Reserve Estimates |
|---|---|
| Crude oil | 33 billion barrels |
| Natural gas | 159 trillion cubic feet |
| Coal | 2.7 billion metric tonnes |
| Tar sands | 31 billion barrels of oil equivalent |

Source: Energy Commission of Nigeria, 2006.

Despite the abundance of the availability of non renewable energy, the generated power cannot be more than 6000 MW which is the installed capacity of the power generating stations that fed the national grid which because of age are not able to generate at their optimum and so most of the time are not to generate more than 3000 MW which is far below the needed energy by the populace(Ozore, 2003, Francis, 2004 & Adebayo & Yusuf,2013).

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Table 3 Total Installed Capacity of Existing Generating Stations in Nigeria.

| Site | Type | Capacity(MW) | Year Commissioned |
|---|---|---|---|
| Jebba | Hydro | 578.4 | 1984 |
| Kainji | Hydro | 320 | 1968 |
| Kainji | Hydro | 200 | 1976 |
| Kainji | Hydro | 240 | 1978 |
| Shiroro | Hydro | 600 | 1990 |
| Afam I | Gas | 20.6 | 1963 |
| Afam I | Gas | 35 | 1965 |
| Afam II | Gas | 95.6 | 1976 |
| Afam III | Gas | 110 | 1978 |
| Afam IV | Gas | 450 | 1982 |
| Ijora | Oil | 6.7 | 1966 |
| Ijora | Gas | 60 | 1978 |
| Delta I | Gas | 72 | 1966 |
| Delta II | Gas | 120 | 1975 |
| Delta III | Gas | 120 | 1978 |
| Delta IV | Gas | 600 | 1990 |
| Sapele GT | Gas | 300 | 1981 |
| Sapele ST | Gas | 720 | 1978 & 1980 |
| Oji | Coal | 300 | 1956 |
| Egbin AES | Gas | 1320 | 1985 |

Source:

**Renewable Energy Potentials in Nigeria**

The belief is that renewable energy is the energy source of the future for sustainable development(The willnigeria.com, 2012). Whereas the demand for energy worldwide has been high and ability to meet the demand has not been met renewable energy is the source of energy of the time that will assist in meeting this demand. Nigeria is blessed with various source of renewable energy that is available because of the location of the country.

**Wind Energy**

Nigeria has not made appreciable use of wind energy as only a few local wind energy plants are installed or are been installed. Table 4 gives the available wind power plants.

Table 4 Available Wind Power Plants in Nigeria

| Location | Year of installation | Capacity | Current Situation |
|---|---|---|---|
| Sayya Gidan-Gada, Sokoto State | 1988 | 5kW/hr | Working |
| Dan-Jawa village, Sokoto | Not available | 0.75kW/h | Working |
| Katsina, Katsina | 2012 | 10kW/h | Under construction |

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| | | | |
|---|---|---|---|
| State | | | |
| Energy Research Center, Benin | Not available | 1kW/h | Working |

Source: Saddik, et al, 2012

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In Nigeria large difference may exist in the wind speed within the same locality because of the varying topography and roughness of the country. Wind energy is available in Nigeria at an annual average of 2.0m/s at the coastal area and an average of 4.0 m/s in the northern area of the country, the wind peak occur between April and August, while the actual exploitable wind reserve at 10m height may vary from 8MWh/yr in Yola to 51MWh/yr in Jos plateau and as high as 97MWh/yr in Sokoto(Adeyanju, 2011, Sambo, 2009 and ECN, 2004).

The initial cost of installation of wind power system has not made it attractive because it is estimated that the initial capital cost is about 90% of the project cost(Nelson & Shrimali, 2014, Ngala et al, 2007 & Kennedy-Darling et al, 2008). The cost projections of installed wind power capacity is between ₦144,000 to ₦999,000 per kW, energy costs per kWh by Wind Speed( 1 USD = ₦ 180) for high wind speeds from ₦64.00 to ₦80.00 and low wind speeds between ₦96.00 to ₦124.00 and energy costs per kWh over time with 1980 average energy cost as ₦140.80 and 2007 average energy cost as ₦65.60 (Ngala, et al, 2007).

**Solar Energy**

Solar energy is the cheapest source of energy and the most abundant because it is a free gift of nature. Opportunities abound to Nigeria through solar radiation because annual average of total solar radiation varies from about 12.6 MJ/$m^2$/day in the coastal regions to about 25.2 MJ/$m^2$/day in the north with average of about 19.8MJ/$m^2$/day and an average sunshine hours of 6 hours per day; which gives that an average of 6,372,613 PJ/year of solar energy falls on the entire land area of Nigeria. The minimum average is 3.55kWh/$m^2$/day in Katsina in January and 3.4kWh/$m^2$/day for Calabar in August and the maximum average of 8.0kWh/$m^2$/day for Nguru in May(Uzoma et al, 2011, ECN, 2005 & Sambo, 2009). The solar radiation map of Nigeria is shown in fig. 2

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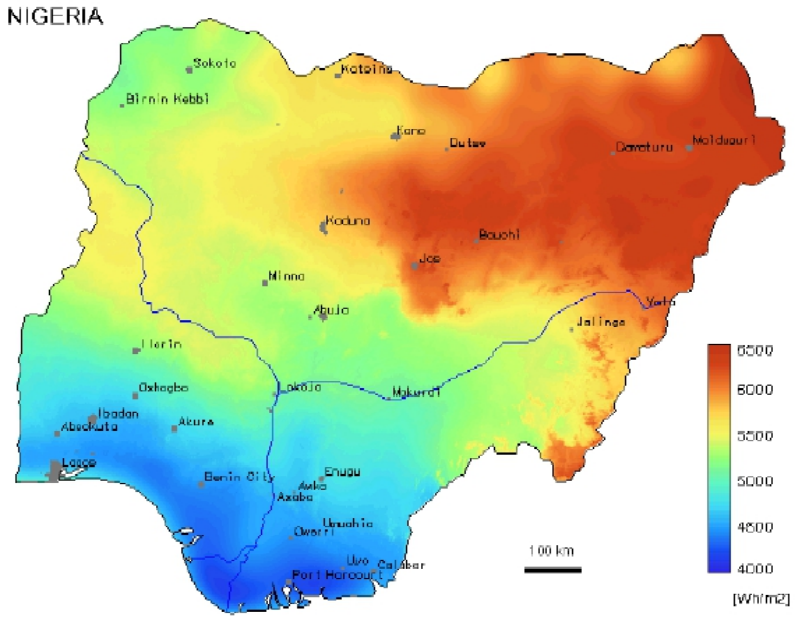


Fig. 2 Map of Nigeria showing the Solar Radiation(Sambo, 2010)

Notwithstanding the abundance of solar energy it has been found that the solar PV are better used in an off grid or better still by household because of the maintenance and repairs which becomes a burden and most of the time make the system to be abandon whenever there is need for repairs or maintenance because the community may not have people that may want to stand up to the challenge.

Solar technology has been well perfected and is being applied in diverse areas for residential, commercial, industrial, agricultural and transportation sectors. The magnitude of power available from solar cell could be as high as a few million watts needed for calculators to as high as tens of kilowatt for an electrical equipment or for household power supply, for lighting, cooking, washing, drying and so on (Ekejiuba et al, 2012). At present panels typically convert about 15% of incident sunlight into electricity (Owolabi, 2008).

**Hydro Energy**

Nigeria is blessed with very high percipitation and the rivers are characterized by high water discharges during the rainy season and very low discharges during the dry season with the exception of the river Niger which has a reliable and stable flow throughout the year. Hydropower of Nigeria is put at 30690 GWh/yr in 1980 and 5250 GWh was generated from the hydro power stations in 1997(Nigerian Muse, 2007).

Adebayo &Yusuf, (2013) discovered that only 4% of the total energy that can be harnessed from small hydropower is being harnessed by just 3 states of the country which study showed that has about 278 small hydropower sites that can generate about 734.3 MW and these potential small hydropower sites are scattered throughout the country. A major drawback for the small hydropower potential sites is cost of installation which is on the high side and the rural communities where these potential sites exists can not afford except they are assisted but a plus for it is that once installed they can function reliably for a very long time(Manohar & Adeyanju, 2009). Work is presently on going in the six geopolitical zones of Nigeria sponsored by UNIDO to develop some small hydropower.

Table 5 Selected Sites in the Geopolitical Zones and FCT for Small Hydropower

| **Site/Community** | **State/Geopolitical Zone** | **Capacity** |
|---|---|---|
| Ketti | AMAC/FCT | 0kW |
| Kwaita | Kwali/FCT | 10kW |
| Kurmu Daudu | Bwari/FCT | 10kW |
| Eboji | Abaji/FCT | 10kW |
| Obudu Cattle Resort | Cross River/South-South | 30kW |
| Ta Hossi Community | Plateau/North Central | 100kW |
| Ikeji-Ile Ijesha | Osun/South West | 15kW |
| Iguoriakhi Farm Settlement | Edo/South-South | 75kW |
| Sabke-Mai dua | Katsina/North West | About 150kW |
| Kiri-Numan | Adamawa/North East | About 300kW |

Source NASENI, 2011

**Biomass Energy**

Water lettuce, water hyacinth, dung, cassava leaves, processing waste, urban refuse, solid waste, agricultural residues and sewage have been identified as very good substrates for biogas production(Jupe et al, 2007) while sorghum, maize and sugarcane have also been identified as very good substrates for biofuel production(Nnaji et al, 2010), all these are found in abundance in Nigeria because of the location of the country.

The biomass resources availability follows the same pattern as the nation's vegetation. Municipal wastes are generated in the high-density urban areas, crop residues are in abundance in the guinea savannah vegetation of the north central region, sudan and sahel savannah zones and woody biomass in the rain forest of the south(Sambo, 2009).

Currently, biomass utilization as energy resources is limited to thermal application as fuel for cooking, crop drying, tobacco curing and some other application. Nigeria at presnt does not have an existing power plant fired by biomass(Sambo, 2009).

Table 6 Biomass Resources and the Estimated Quantities in Nigeria

| **Resource** | **Reserve** | **Utilization Level** |
|---|---|---|
| Fuelwood | 11 million hectares of forest and woodlands | 43.4 million tonnes of fuel wood/yr |
| Energy crops and agric waste | 28.2 million hectares of Arable land | 8.5% cultivated |
| Animal waste | 243 million assorted animals | - |

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| | | |
|---|---|---|
| | in 2001 | |
| Municipal waste | 18.3 million tonnes in 2005 | - |

Source: Sambo, 2011

## Conclusion

Nigeria as a country is blessed with different sources of alternative energy which is found to abound at every geographical location which if properly harnessed will serve the dispersed rural communities that are not yet connected to the national grid and serve other areas which are connected to the national grid which hardly enjoys supply because of the inability of the existing supply to effectively cover them.it is also found that if this is done there will be abundance of food and great security to the populace.

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