Renewable Energy as a Sure Solution to Nigeria's Perennial Energy Problems- an Overview

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Abstract: Energy is a basic necessity for human activities, economic and social development. However, in Nigeria, insufficient energy remains a strong barrier to technological and economical growth of the country. Incessant power outages have become order of the day. This has led to closure of many manufacturing outfits. The resultant effect of this is mass unemployment and under-employment. A larger population of Nigeria depends on fossil fuels for energy generation, which are not renewable and constitute hazards to both human and ecology. However, all hope is not lost as the country is blessed with a lot of natural resources, through which alternative forms of energy, which are renewable, could be generated. The renewable energy resources available in Nigeria and their capabilities are examined in this review. Also examined are various factors militating against effective utilization and harnessing of these vast and abundant energy resources. The study concluded that renewable energy resources were well abound in the country, but they were not effectively utilized and if properly harnessed will be a sure solution to perennial energy shortage in the country.
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1. Introduction

Energy is an essential and integral ingredient for socio-economic and technological development of a nation (Oladeji, 2012). Energy is needed in the provision of services, which are the desired and useful products and processes, such as for lighting, processing of engineering materials, and production of equipment and tools. Other areas are provision of air-conditioned indoor climate, refrigerated storage, transportation and appropriate temperatures for domestic cooking and industrial cottage applications.

According to an online publication by Energy Information Administration (2007), the Nigerian power sector operates well below its estimated installed capacity, with power outages being a frequent occurrence. Only 30 percent of Nigerians have access to electricity, the majority of which are concentrated in urban areas (Oladeji, 2009). The implication of this is that about 100 million people do not have access to electricity in Nigeria. To compensate for the power outages, the commercial and industrial sectors and majority of populace are increasingly using privately operated diesel and petrol generators to supply electricity. This is however dangerous to both human health and ecology. Many people have been reported dead for inhaling carbon monoxide, while using generators overnight, especially during the dry season (Oladeji, 2011). Despite endemic blackouts, customers are billed for services not rendered. There is also widespread vandalism and power theft, which complicate the activities and operation of Power Holding Company of Nigeria's (PHCN).

Global Energy Network Institute (2010) in her publication admitted that in Nigeria, as well as in many developing countries, providing energy to rural and urban areas has proved to be a great challenge. For example, in Nigeria, the Federal, State and Local Governments formulated policies towards increasing rural energy access have all along focused on grid extension and tanker distribution of petroleum products. With increasing population, the pressures on the infrastructure for the supply of conventional energy resources will continue to increase. Again, conventional energy is depletable with extinction risk. It is necessary to promote the policy of diversifying the energy supply so as to include alternative or renewable resources and technologies into the nation's energy supply mix in a bid to enhance the energy security of the country and establish a sustainable energy supply system.

Furthermore, as the cost of producing energy from fossil fuel and coal increases continually and with an urgent need to reduce the level of carbon emission, which arguably remains major cause of global warming (Hung, 2010). Hence, renewable energy becomes the only viable and sustainable alternative that can solve conveniently all the problems associated with this type of energy generation (Jekayinfa and Scholz, 2009). This has led to people, organizations and nations to look for ways to effectively develop or implement alternative

energy sources that would complement or completely replace existing sources of energy.

Nigeria is endowed with abundant renewable energy resources which have minimal or zero supply logistic problems (Jekayinfa and Omisakin, 2005). Sambo (2005), noted that the available sources of renewable energy in Nigeria are solar energy, biomass energy, wind energy, geothermal energy among others. Harnessing the renewable energy resources may lead to decentralized use and local implementation and management, thereby making sustainable rural socio-economic development possible through self-reliance and the use of local natural resources. Therefore, the main objective of this study was to identify various renewable energy sources and potentials available in Nigeria. Their capabilities were also highlighted.

2. Renewable Energy

Renewable energy sources include solar energy, some forms of biomass, tidal and hydropower and wind (Hung, 2010). Renewable energy sources are sources that can be replenished or produced quickly through natural processes. The rate at which they are used does not affect their availability in future and as such cannot be exhausted. All the regions of the world have reasonable access to one or more forms of renewable energy supply because the resources are generally well distributed all over the world, even at wide spatial and temporal variations (Osueke, and Ezugwu, 2011).

Many of the renewable resources can be depleted by human use, but may also be replenished thus maintaining a flow. Renewable energy sources are generally considered to be climate-friendly and allow countries with no fossil fuel reserves to gain energy security and independence (Asif and Muneer 2007). Critics of renewable energy, however, argue that the relatively low energy density of these energy supplies, or rather, of the low efficiency of the technologies used to convert the energy, renders a world using exclusively or even primarily renewable energy impracticable (Ausubel 2007). In some cases, they argue that renewable energies have poorer performance than the fossil fuel and nuclear energy sources used today.

3. Renewable Energy Resources in Nigeria

As earlier noted, Nigeria is blessed with abundant renewable energy resources and they abound in various forms. Notable among them are biomass, wind and solar energy. Hydro and geo-thermal are also included in the cluster. Some of the renewable energy resources available in Nigeria are discussed in sub-sections below:-

3.1 Biomass Energy Potentials

Biomass can be classified as plant biomass (woody, non-woody, processed waste, or processed and processed wastes are products or by-products of agro-industrial activities. Animal manure can be used as cooking fuel or as feedstock for biogas generation. Municipal solid waste is also considered a biomass resource.

fuel or animal biomass. In Nigeria, most woody biomass is supplied by forestry plantations, natural forests, and natural wood lands. Non-woody biomass

Biomass energy refers to the energy derived from biological sources such as wood and wastes. Biomass energy is an indirect form of solar energy because it arises due to photosynthesis. Biomass is the most commonly used resources of rural energy in Nigeria, because fuel wood is the cheapest and most accessible source of fuel even in the urban household. Fuel-wood is the traditional fuel source, which in spite of the availability of conventional domestic fuels, remains in high demand at the expense of Nigeria forest.

The biomass resources of Nigeria include sources such as wood, forage grasses and shrubs, residues and wastes as well as aquatic biomass (Fapetu, 2000a). Wood, apart from being a major source of energy in the form of fuel wood, is also used for commercial purposes in various forms as plywood, sawn wood, paper products and electric poles (Oladeji, 2013a). Sambo (2005) observed that for energy purposes, Nigeria is using 80 million cubic meters (43.4 x 109 kg) of fuel wood annually for cooking and other domestic purposes.

The energy content of fuel wood that is being used is 6.0 x 109 MJ out of which only between 5 - 12% is the fraction that is gainfully utilized for cooking and other domestic uses. Although the biomass availability as at 1973 was put at 9.1 x 10^{12} MJ, it is expected that the overall biomass resource availability at present is lower than the 1973 figure (Fapetu, 2000b). This is largely due to the demand of wood for construction and furniture industries in addition to its use as an energy source. As for forage grasses and shrubs, estimates show that 200 million tons of dry biomass can be obtained from them and this comes up to 2.28 x 10^{6} MJ of energy. For crop residues and wastes, estimates of the 6.1 million tons of dry biomass that are produced annually leave residues, whose energy content approximates to 5.3 x 10^{11} MJ (Ikuponisi, 2004). Estimates made in 1985 give the number of cattle, sheep, goats, horses and pigs as well as poultry birds as 166 million. These produce 227,500 tons of animal wastes daily, which

come to 2.2 x 10^9 MJ taking the calorific value of animal dung to be 9,800 MJ/ton (Akinbami, 2001). Animal residue can be converted to biogas and estimates show that this is of the order of 5.36 x 10^9 m^3 which has an energy content amounting to 2.93 x 10^9 kWh (Jekayinfa and Scholz, 2009). Plant biomass can be utilized as fuel for small-scale industries. Methods of converting biomass to energy include: - burning, alcohol fermentation and anaerobic digestion. Briquetting and pyrolysis are also included in the cluster.

3.2 Solar Energy Potentials

Solar energy is one of the major options for a sustainable fuel source that will allow a switch to a carbon neutral energy economy (Oladeji, 2013b). Electricity generation from solar energy is rapidly spreading, but it needs transport and storage to balance production and demand. Nigeria, situated approximately between 4^0N and 13^0N and with landmass of 9.24 x 10^5 km^2 is endowed with an annual average daily sunshine of 6.25 hours, ranging between about 3.5 hours at the coastal areas and 9.0 hours at the far northern boundary and an annual average daily solar radiation of about 5.25 kW/m^2/day at the coastal area and 7.0 kW/m^2/day at the northern boundary. This is equivalent to about 1.082 million tons of oil equivalent per day, and is about 4 thousand times the current daily crude oil production, and about 13 thousand times that of natural gas daily production based on energy unit. This huge energy resource from the sun is available for about 26% only of the day (Bala, et al., 2000). Chendo (2002), added that based on the land area of 924 x 10^3 km^2 for the country and an average of 5.535 kWh/m^2/day, Nigeria has an average of 1.804 x 10^{15} kWh of incident solar energy annually. This annual solar energy isolation value is about 27 times the nation total conventional energy resources in energy units and is over 117,000 times the amount of electric power generated in the county in 1998. Invariably, about 3.7% only of the national land area will be utilized in a bid to annually collect from the sun an amount of energy equal to the nation's conventional energy reserve.

Solar energy has been utilized in Nigeria in various forms: namely, solar PV for rural electrification, solar cooker, solar crop dryer, solar manure dryer, solar water pump, solar water heaters, solar chick brooders etc. Notable solar projects in Nigeria include: street lighting in Ado Ekiti, Ekiti State, Ogbomoso in Oyo State, 7.2kW Kwalkwalawa Village Electrification, Sokoto State and 1.87 kW Iheakpu-Awka Village Electrification/TV Viewing, Enugu State among others (Awogbemi and Komolafe, 2011).

3.3 Wind Energy Potentials

Winds develop when solar radiation reaches the Earth's highly varied surface unevenly, creating temperature, density, and pressure differences. Nigeria is in a tropical region and has a net gain of heat due to solar radiation. Differences in atmospheric pressure due to difference in temperature are the main cause of wind. Wind is powered by the sun. The sun heats our planet to different temperature variation in different places and at different times. This unequal distribution of heat is what creates wind as warm air rises and cooler air descends to fill the void thereby producing wind, which is the ongoing movement of this air. As the sun warms the earth, it in turn, warms the air above it, making it less dense or lighter. As the light air rises, it creates a low pressure zone near the ground. Air from surrounding cooler areas rushes into balance the pressure (Osueke and Ezugwu, 2011). These are called local winds. Temperature difference between the polar caps and equator, as well as the rotation of the earth, produce similar result on a global scale called prevailing winds. Wind power system takes advantage of the power of wind. Lunge blades or rotor, catch the wind and spin. In hydroelectric system, the spinning movement is transformed into electrical energy by the generator.

Nigeria is one of the countries located within low to moderate wind energy zone globally. Ojosu and Salawu (1990) in their comprehensive nationwide study on wind energy availability and potential in Nigeria used data on wind speeds and directions for 22 meteorological stations from the Nigerian meteorological office, Lagos. The meteorological data are based on the 3-hourly records of wind for periods ranging from 12 to 33 years (1951 – 1983). Ojosu and Salawu (1990) estimated the maximum energy obtainable from a 25m diameter wind turbine with an efficiency of 30% at 25 m height to be about 97MWh $year^{-1}$ for Sokoto, a site in the high wind speed regions, 50MWh $year^{-1}$ for Kano, 25.7MWh $year^{-1}$ for Lagos and 24.5MWh $year^{-1}$ from Port Harcourt. Relatively a huge amount of energy could be accessed if this energy network available is amassed for national use. In regions with an adequate wind pressure, the amount of potential power is dictated by the size of the windmill. Windmills vary in sizes. Small windmills can be used to pump water or provide power for cooking and refrigeration. Medium windmills provide electricity for one or more homes. Large windmills or utility scale

windmill are capable of providing power for entire communities. Often these large windmills are connected to a mini-grid as to reduce the overall dependence on fossil fuels.

3.4 Hydro Energy

Water has kinetic energy when it flows from higher elevation to lower elevation and the energy generated from such is known as hydro energy. Hence, converting the flowing water into usable energy produces hydropower. Nigeria is blessed with many rivers and various dams were constructed all over the country and most of this water is released through turbine to produce energy. Hydro powered system also make use of turbines to generate electrical power, however, they do so by using the energy in moving water to spin the turbines. In Nigeria, there are six classifications of hydro schemes in Nigeria as illustrated in Table 1.

Table 1:- Classification of Hydro Schemes in Nigeria

Scale of hydro scheme	Capacity Range (MW)
Large	>100
Medium	50-100
Intermediate	10-50
Small	1-10
Mini	0.5-1
Micro	<0.5

(Source- Osueke and Ezugwu, 2011)

There are three major sources of hydro-energy power stations in Nigeria as depicted in Table 2

Table 2:- Three Major Sources of Hydro Energy Power Stations:

S/N	Name of Hydropower plant	Year established	Installed Capacity (MW)	Availability as of June 2010 (MW)
1	Kainji	1968	760	465
2	Jebba	1986	578	482
3	Shiroro	1990	600	450
		Total	1,938 MW	1,397 MW

(Source- Sambo, 2006)

3.6 Geothermal Energy Resources

Geothermal energy is generally defined as heat stored within the Earth. The Earth's temperature increases by about 3 degrees Celsius for every 100 meters in depth, though this value is highly variable. Heat originates from the Earth's molten interior and from the decay of radioactive materials. According to Björnsson (1998), four types of geothermal energy are usually distinguished. These are hydrothermal hot water or steam at moderate depths, geo-pressed hot water aquifers containing dissolved methane under high pressure, hot dry rock, abnormally hot geologic formations, with little or no water and magma and molten rock at temperatures of 700–1,200 degrees Celsius. Geothermal energy has enormous potential. However, in Nigeria, there is no technological ability and know how to use geothermal energy, despite the country geothermal potentials.

Conclusion

From this review study, the following conclusions among others can be drawn:-

i. There is gross energy inadequacy in Nigeria
ii. There abound a large amount of energy potentials in Nigeria, but they are grossly under-utilized and not well harnessed.

iii. Nigeria is technologically not advanced country and that explains why she cannot tap enormous natural resources at her disposal.
iv. Nigeria can surmount her energy problems, if she judiciously and effectively harnesses her renewable energy potentials, which are well-abound in the country.

SHORT PROFILE ON OLADEJI, J.T:

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