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Analysis of Renewable Energy Potentials in Nigeria for National Development

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Abstract: **Various sources and types of renewable energy used in developed countries are stated, briefly discussed and their availability in Nigeria considered. Most of world developed economies survive mainly on the consumption of biomass, hydroelectric power, natural gas, crude oil, geothermal heat and other renewable energies. Hence this work explores the energy potentials Nigeria possesses as a country which are readily available for solving her perennial national power problems. Attention is also paid to the impedances associated with effective use of renewable energy in boosting the Nigerian economy and ways of ameliorating such bottlenecks. A mixed research methodology was adopted in gathering and analysing data obtained from government parastatals and questionnaires given out to Nigerians in the six geopolitical zones to sample their opinions about national power situation. Graphs, tables and charts were employed in analysis and results discussed. A conclusion is finally presented which shows that Nigeria has the potentials to solve her energy problems as one of the ways of encouraging national development.**

Keywords: **Renewable, Energy, Production, Consumption, Potentials, Power, Analysis, Mixed methodology, Questionnaires, Graphs, Tables, Charts.**

1. INTRODUCTION

Renewable energies are derivable from natural sources and their availability depend mainly on the prevalent climatic conditions that control their formation. The principal source of all renewable energies is the sun which provides terrestrial and aquatic lives with ultraviolet radiation necessary to sustain green vegetation. There are various types of renewable energy and the nature of each depend on the mode of formation and the materials involved. The types of renewable energy considered in this work as potential sources from which power problems can be solved effectively in Nigeria are solar, wind, hydro, biomass, fossil and geothermal heat energies.

Solar energy is derived from the ultraviolet radiation given out by the sun from the outer space. It is the pivot of green plants sustenance is it energizes the process of photosynthesis through which green plants manufacture their food. However its importance to mankind has for so long gone beyond mere sustenance of green life. Solar energy was used extensively by early men for the purposes of agriculture and several domestic activities and it is believed that human civilization started with the exploration of possible ways of harnessing it. Its importance today has transcended beyond agriculture but now extensively applied in technological developments. One of such developments relevant to this work is the application of solar energy in power production using the solar panels. A publication termed '*A Review of The Nigerian Energy Industry'* of 3rd October, 2011 claimed that Nigeria is capable of generating up to 600,000 MW of electricity from solar energy from only 1% of her land area. Solar water heaters have been developed at the National Centre for Energy Research and Development (NCERD) situated at the University of Nigeria Nsukka (P. Ilenikhena & L. Ezemonye, 2010). Despite the expensive nature of solar power projects, the payback period is said to be not less than 5 years and the panel can last for as long as 25 years. Daily solar radiation is around 3.5kwh per m^2 in southern Nigeria and up to 7.0kwh per m^2 in northern Nigeria (S. Goudarzi, 2011).

Wind energy was one of the mostly used energy resources at about 3,200 BC. The first recorded use of the wind energy is the Egyptians sailing exploits. The windmills flourished so much on wind power and still do in developing countries. Immense technological advancements over the years have made wind power an indispensable energy resource as wind speed as low 3m/s is detected and converted into work by modern hypersensitive turbines. A wind turbine in Portugal for instance is able generate as much as 2,130 MW of electrical power which serves a population of about 1,119,900 people

in northern Lisbon. Nigeria recorded a significant increase in the use of wind power between years 2002 and 2011. Maximum wind speed of 8m/s has been recorded up north in Nigeria and 6m/s down south. The average wind speed across Nigeria is estimated at 3m/s after adjustments made to wind speed measurements at different heights (M. Adaramola & O. Oyewola, 2011). According to reports gathered from various meteoroligal stations across Nigeria, wind speed rise to as high as 7.5m/s at the Sokoto area around June hence bringing annual average to 3.92m/s.

Nigeria is segmented by two major rivers namely river Niger and river Benue that form a confluence at Lokoja; a town in Kogi State of Nigeria. The confluence formed yield several distributaries southwards and this explains why the southern land areas of Nigeria adjoining the Atlantic Ocean are made up of a delta. Hydro power is one of the oldest sources of renewable energy in Nigeria as hydroelectricity for instance mainly came from hydropower through the use of dams and before the discovery of fossil fuels. It is the second largest type of renewable energy available in Nigeria as it accounts for about 29% of the total national electric power supply (S. Nadabo, 2010). There are about 31 large and small scale hydroelectric power stations in Nigeria (I. Zarma, 2006). Nigeria is able to generate as much as 14,750MW of electricity from hydropower. It is also a very useful asset in agricultural practices in Nigeria as dams make it possible for irrigation of farmlands to take place especially in times of drought. A high dependence on biomass in recent years has caused the use of hydropower to plunge downwards progressively as the highest recorded megawatts supply of electricity occurred in year 2002.

Biomass is a term used to describe agricultural and municipal wastes that are capable of producing renewable energy when subjected to thermal or chemical decomposition. They are both plant and animal based in nature and hence are made up mainly of organic materials. They are mostly found as a mixture of carbon and other inorganic molecules of elements such as Oxygen, Nitrogen and small amounts of metallic compounds. Biomass differ from fossils because the latter are remains of biological materials that have absorbed carbon dioxide over long period of time while the former is made of bonded plant and animal remains of recent origins. Nigeria has a total land mass of about 79.4 million hectares out of which 77.8% is used for agricultural activities hence the vast availability of biomass resources.

Fossils are the remains of prehistoric organisms found in the earth crust which have been subjected to intense heat and pressure over long period of time. The renewable energy derivable from fossils are in some cases found in the form of coal, crude oil and natural gas. The exploration of crude oil in Nigeria started in the beginning of the twentieth century in small quantities and first commercial production took place in 1958 at Oloibiri; a town located in the present day Bayelsa State. The civil war in Nigeria which took place between 1967 and 1970 highlighted the importance of crude oil in the Nigerian economy as the global oil price was on the rise at that time. Enormous returns were realized from crude oil sales as these injected large income deposits into the Nigerian economy and also became the major source of foreign exchange earnings. Nigerian gas reserve was rated 7^{th} largest in the world and 1^{st} in Africa.

Geothermal heat comprises of hot water, hot rock and molten rock situated some distance into the earth crust. It is sustained by shallow grounds capable of maintaining a temperature range of 50^0C to 60^0C. It is a harmless and clean source of renewable energy and do not pose any known environmental pollution. There are two known potential geothermal resource stations in Nigeria: Ikogosi warm springs in Ondo State and Wikki warm springs in Bauchi State (O. Babalola, 1984).

The instances stated above are clear indications that there are enormous renewable energy potentials in Nigeria. Despite these, Nigeria still face serious perennial problems in energy production and distribution.

2. METHOD

A mixed methodology was applied in analysing the energy situation in Nigeria. The first step taken was to consult some relevant government parastatals in possession of useful items of information as regards the trends in energy production, distribution and consumption over several years. In addition to that, questionnaires were circulated around the six geopolitical zones in Nigeria to sample opinions about the availability and pricing of renewable energy. Relevant internet sources were also consulted for some information concerning energy problems in Nigeria. The government parastatals consulted are the Federal Ministry of Power (FMP), Presidential Task Force on Power, Energy Commission of Nigeria (ECN), Federal Ministry of Environment (FMENV), National Power Training Institute of Nigeria (NAPTIN), Standards Organisation of Nigeria (SON), Nigerian National Petroleum Corporation (NNPC), Rural Electrification Agency of Nigeria (REA) and the National Bureau of Statistics (NBS). A scale of 1-5 was adopted on the questionnaires to indicate level of satisfaction where 5 stood for "highly satisfied' and 1 indicated 'highly dissatisfied'. 2.5 meant the respondent was undecided on whether renewable energy resources are adequately utilised and uniformly distributed in Nigeria. Electric power project, which is one of the greatest applications of renewable energy in Nigeria, was considered by

tabulating household rural electrification by state according to information gathered from the National Bureau of Statistics. The availability and pricing of petroleum products and gas across the country was investigated through one-on-one interaction with people. The responses obtained from the six geopolitical zones were first tabulated and evaluated by selecting at random 10 questionnaires from each zone, finding an average response for each zone and then plotting them against the measurement scale. Analytical tools like graphs and charts were employed to fully analyse the trend in production and distribution of renewable energy resources in Nigeria.

3. RESULTS AND DISCUSSION

An investigation into the rural electrification projects in Nigeria 36 states' households and the Federal Capital Territory yielded the results tabulated below.

Table 1

Household Electrification Rate by State in %				
Geopolitical Zones & States of Residence	**Have Electricity**	**No Electricity**	**Missing**	**Number of Households Surveyed**
North Central	**48.7**	**51.2**	**0.1**	**5,942**
FCT-Abuja	77.7	22.0	0.3	361
Benue	22.1	77.9	0.0	1,365
Kogi	62.9	37.1	0.0	876
Kwara	90.6	9.1	0.3	617
Nasarawa	33.2	66.5	0.3	550
Niger	51.7	48.2	0.1	1,504
Plateau	36.3	63.7	0.0	669
North East	**29.3**	**70.4**	**0.3**	**5,115**
Adamawa	37.6	62.2	0.2	726
Bauchi	29.3	70.3	0.4	932
Borno	33.0	66.5	0.5	1,560
Gombe	48.1	51.8	0.1	464
Taraba	10.9	88.8	0.3	634
Yobe	18.1	81.7	0.2	799
North West	**42.2**	**57.7**	**0.1**	**9,992**
Jigawa	26.0	74.0	0.0	1,152
Kaduna	53.5	46.2	0.3	1,915
Kano	52.1	47.9	0.0	2,606
Katsina	31.3	68.5	0.2	1,257
Kebbi	44.4	55.6	0.0	1,069
Sokoto	38.9	60.9	0.2	898
Zamfara	29.1	70.6	0.3	1,096
South East	**66.4**	**33.6**	**0.0**	**4,687**
Abia	81.7	18.3	0.0	644
Anambra	88.1	11.8	0.1	1,050
Ebonyi	39.2	60.7	0.1	978
Enugu	55.4	44.6	0.0	920
Imo	69.9	30.1	0.0	1,096
South South	**68.3**	**31.3**	**0.4**	**5,239**
Akwa Ibom	68.0	31.8	0.2	892
Bayelsa	52.5	47.3	0.2	322
Cross River	57.4	41.4	1.2	848
Delta	78.3	21.6	0.1	946
Edo	82.4	17.5	0.1	702
Rivers	65.1	34.5	0.4	1,529
South West	**81.1**	**18.8**	**0.1**	**7,546**
Ekiti	92.7	7.3	0.0	376
Lagos	99.3	0.5	0.2	2,240
Ogun	72.0	27.9	0.1	1,355
Ondo	66.3	33.7	0.0	920
Osun	89.4	10.6	0.0	853
Oyo	66.6	33.3	0.1	1,802
Total	**55.6**	**44.2**	**0.2**	**38,523**

Source: National Bureau of Statistics, 2013

The information tabulated above shows the percentage of households from each of the six geopolitical zones that contains the 36 states and federal capital territory who have access to electrical power supply and who do not. The information above includes off-grid renewable energy. Evidently about 44.2% of the households do not have access to electric power supply as clearly illustrated in the pie chart below.

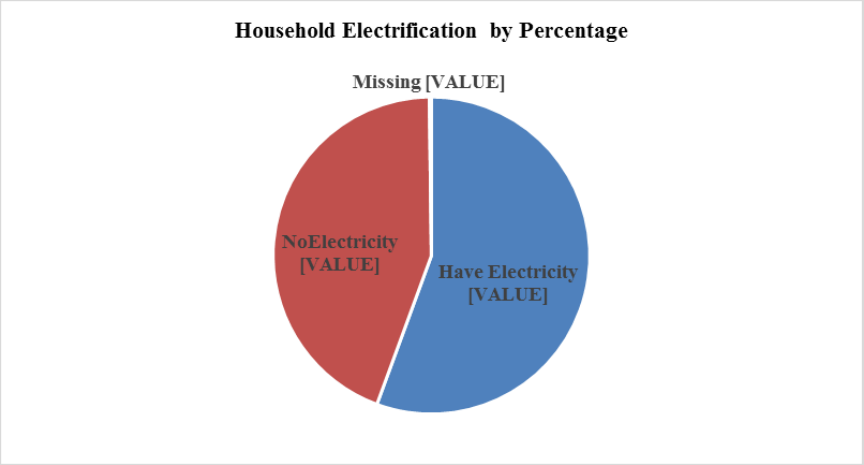

Figure 1

Data collected with questionnaires and evaluated are as tabulated below:

Table 2 Zonal Responses on the Availability and Pricing of Petroleum Products and Gas

(A) Geopolitical Zones	(B) Number of Questionnaires Distributed	(C) Number of Questionnaires Evaluated	(D) Averages of Responses (Scale of 1-5)
North Central	30	10	2.5
North East	35	10	2.1
North West	30	10	2.3
South East	25	10	2.7
South South	20	10	3
South West	25	10	3.5
Total	**165**	**60**	**16.1**

*Note that (D) is directly dependent on (C) and indirectly dependent on (B)

A mean value of the responses gives: 16.1/6 = 2.68

This mean value indicates that a little above half of the entire Nigerian population have access to on-grid renewable energy. This assertion is justified by Table 1 which shows a similar trend in the availability of electrical energy resources to the people. This is also illustrated below.

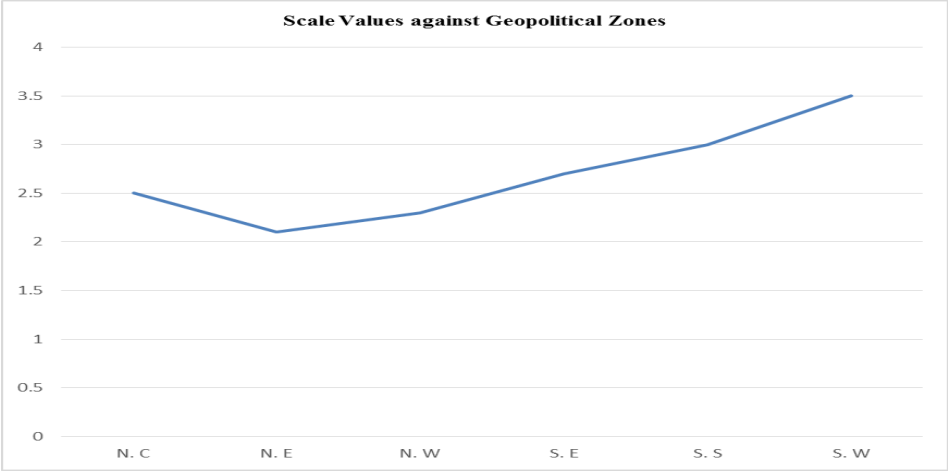

Figure 2

Additional information visible from figure 2 reveals that the southern areas of Nigeria seem to have more access to the on-grid renewable as people from the southern regions showed greater positivity in their responses. This is reasonably in agreement with the data provided by the National Bureau of Statistics. According to the data, only 48.7% of households from the North Central zone have access to a combination of on-grid and off-grid electricity while 51.2% have not. This explains why the questionnaires circulated in this region brought back an overall average scale response of 2.5; just around the half mark. Apparently greater number of people from this zone would respond with more dissatisfaction if additional households are included in this study. Similarly, 29.3% of the households within the North East zone have access electrical power while 70.4% have not. This is comparable to an overall response of 2.1; much greater number of households live without on-grid renewable energy supply. There seem to be a greater accessibility of the on-grid renewable energy at the southern regions looking at the shape of the graph. However an overall mean value of 2.68 simply shows that more than 44.2% of the Nigerian population are still suffering from lack of renewable energy supply. One-on-one interaction carried out revealed that a greater part of the Nigerian population, especially the rural dwellers, depend mainly on biomass for renewable energy.

4. CONCLUSION

The problems associated with uniform renewable energy distribution in Nigeria are not without mismanagement of resources, vandalism, poor maintenance culture, sabotage and corruption. These vices have over the years badly hindered possible increments in the national grid. However the federal government have taken bold steps towards revamping the battered power production and distribution. Studies have shown that Nigeria has the potential of producing enough renewable energy for the entire households though this is only achievable if necessary steps are further taken. The transmission company of Nigeria (TCN) on November 2015 announced that Nigeria currently has up to 4883MW and 106,288MWH maximum daily energy delivery; a remarkable improvement that is unfortunately still insufficient to satisfy the remaining 44.2% of the households as presented by National Bureau of Statistics (NBS). Though there has been marked positive changes in the reliability and supply of electrical power within the past few months, the level of reliability is still not enough to effectively sustain foreign investors and the national economy as a whole. Studies reveal that Nigeria is capable of generating 600,000MW of solar power from only 1% of her land mass, has an average wind speed of 3m/s, is able to produce 14,750MW of electrical power from hydroelectricity, has 77.8% of her total land mass available for biomass energy, possess extensive crude oil and gas reserves as 1st in Africa and 7th in the world and has warm spring locations available for geothermal heat. A combination of these potentials are more than enough to solve the perennial energy problems in Nigeria. In addition to these, the government should monitor pipelines more closely as a check for vandalism, consider professionalism and competency in awarding energy projects, mete out severe punishments for resource misappropriation through the judiciary, ensure there is no over pricing of energy supplied and sustain sound maintenance culture on power distribution equipment. Half of Nigeria's flared gas can generate up to 5000MW of power. This practise should be discouraged and alternatives sought.

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