International Journal of Academic and Applied Research (IJAAR)
ISSN: 2643-9603
Vol. 6 Issue 7, July - 2022, Pages: 100-109

OVERVIEW OF RENEWABLE ENERGY RESOURCES IN BENUE STATE: IMPLICATIONS, CHALLENGES AND THE WAY FORWARD

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ABSTRACT: *Energy crisis in Nigeria and indeed the states have reached an alarming rate owing to the fact that the country cannot meet up with the increasing demand for electricity by the ever increasing population of over 200 million people. Benue State is not an exception since there is obviously little supply of electricity to over 4,253,641 people in the states demanding to be hooked up to electricity. Again, the people of Benue are mostly rural dwellers who are either far off the grid or do not have access to electricity. This paper provides the* renewable electricity answers *available in the state for the government to explore so as to alleviate the sufferings of the people in the way of electricity. Since over 80% of human existence and life revolves round power…*
Keywords: Renewable Energy, Resources, Implication, Challenges, Benue State

INTRODUCTION

Access to affordable, clean and stable electricity supply is paramount to attaining and sustaining socio-economic and technological development by any country. Conversely, dearth of electricity retards economic growth and impacts negatively on the citizens' quality of life (Akhator, *et. al.*, 2019). Nigerians in particular the agricultural dwellers, suffer a number of the worst varieties of energy deprivation within the world (Eleri, et. al., 2012). Presently, approximately ninety five million Nigerians and about fifty five% of the population are without access to grid energy, at the same time as the ones having experience epileptic delivery over 60% of the time (Aliyu, *et. al.*, 2013; NPBR, 2015).

Nigeria is richly blessed with reasonably high qualities of various energy resources such as crude oil, tar sands, natural gas and coal. About 90% of the country's economy is dependent on crude oil (Okoro, et. al., 2007). In 2006, Nigeria was ranked the 10th largest crude oil producer internationally with a reserve envisioned to be about 36 million barrels amounting to 4.9 billion tons of oil equivalent (toe) (Okoro, et.al, 2007). Despite the abundance of energy resources available, Nigeria is only able to general 1600MW effectively out of 6000MW of installed generating capacity (less than 30%) (Mohamed, et. al. 2014). Presently, the precise amount of electricity generation in the country is drastically under the demand for electrical power. Majority of the countrys'citizens are rural dwellers where there are hard terrains, no smooth access to fossil fuel and electricity grids because of bad roads (Mohamed, et. al. 2014).

Benue State, Nigeria, a non-oil and gas producing state and a typical representation of rural communities in Nigeria (Ifeanyi, et. al.2017) shares the same fate with its father Nigeria in terms of poor electricity generation and consumption.

Benue State is one of the north-central states in Nigeria. It lies within the lower river Benue Trough in the Middle Belt region with longitude 7^{0}47' and 10^{0}0'E. Latitudes 6^{0}25' and 8^{0}8' North and shares boundaries with five other states of Nasarawa in the north, Taraba in the east, Cross River to the south, Enugu to the South-west and Kogi to the West. Benue State also shares common boundary with the Republic of Cameroon on the South-east region. Benue State has a population of about 4,253,641 in the 2006 Census, with an average population density of 99 persons per Km^2. This makes Benue the 9th populous state in Nigeria. Benue occupies a landmass of 34,059 square kilometres. The state was created on the 3rd of February 1976 from the former Benue-Plateau State with its capital as Makurdi.

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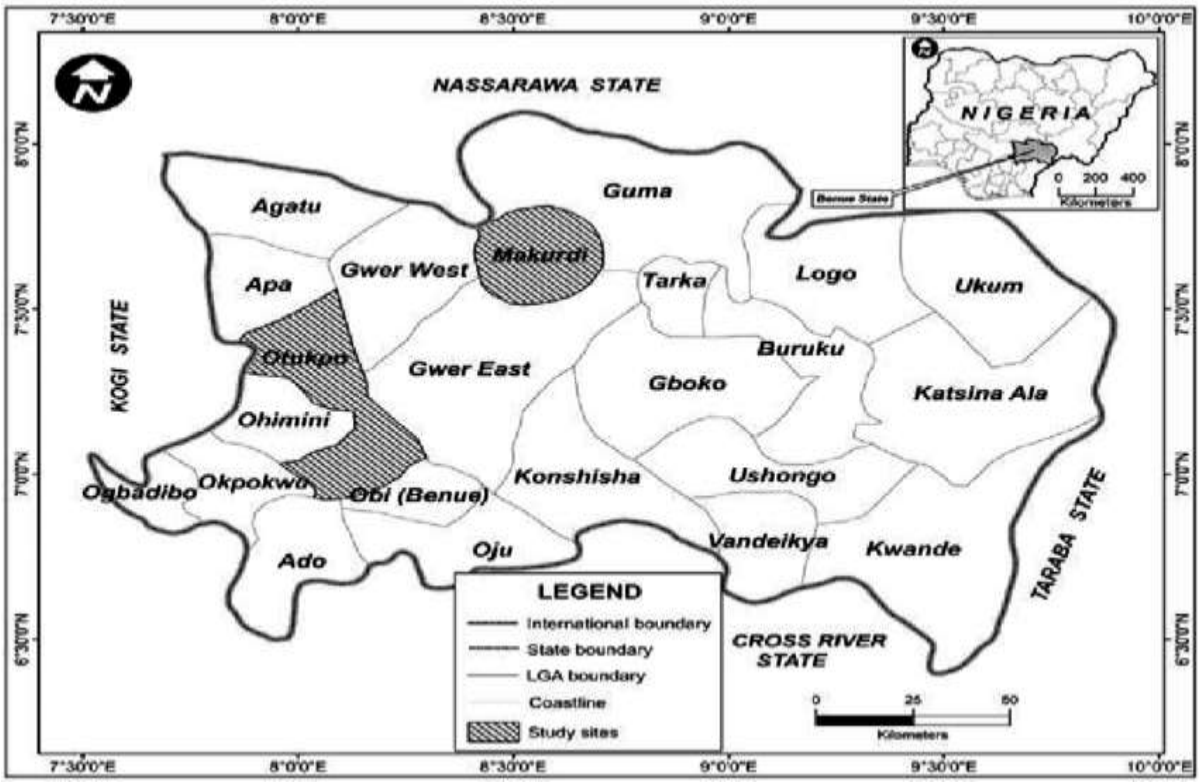

Figure 1: Map of Benue State

Benue State derives its name from the Benue River. It is made up of the major ethnic groups of Tiv, Idoma and Igede. The Tiv's are found in fourteen (14) local government areas with Etulo and Jukun, while Idoma, Igede, Nyifon and Akweya are found in the remaining nine (9). Benue is a wealthy Agricultural location; popularly grown vegetation includes; oranges, flax, yams, sesame, rice, groundnuts, and palm tree. Benue state is blessed with abundant mineral resources which are allotted in the various local government areas in the state. limestone at Tse-Kucha near Gboko and Kaolinite at Otukpo of all these minerals are the only ones being commercially exploited. Other minerals encompass Baryte, gypsum, feldspar, wolframite, kaolinite, mineral salts and gemstone etc. The State is the nation's acclaimed "Food Basket of the Nation" because of its wealthy agricultural produce which encompass yam, rice, beans, cassava, sweet potatoes, maize, soyabean, sorghum, millet, sesame, cocoyam etc. Benue cultivates more than 70% of Nigeria's soyabeans and farming is the main stay of the economy, attracting more than 75% of the state's farming populace. The kingdom additionally boasts of one of the longest stretches of river device inside the country with high-quality capability for a viable fishing enterprise, dry season farming via irrigation and for inland water highway. The plant life of the southern components of the nation is characterized by forests, which yields trees for wood and offer appropriate habitat for uncommon animal kinds and species. The state for this reason possesses capability for the development of feasible woodland and wildlife reserves. Benue has a total Gross Domestic Product (GDP) PPP per year of $6.86 billion according to the estimate in 2007 (Wikipedia, 2020). Agricultural bureaucracy forms the spine of the Benue state economy, this accounts for the low power supply experienced due to the inability of the government to harness the rich renewable energy in the form of Natural Sources such as Wind power, solar energy, hydro-power, biomass energy and geothermal energy etc. but rely on the national grid for electricity which is not even reliable.

The Nigerian power quarter is managed by way of state-owned electricity keeping business enterprise of Nigeria (percent), previously known as the national electric powered energy Authority (NEPA) (Sambo, et.al., 2010). President Olusegun Obansanjo, in March 2005 signed energy quarter reform invoice into regulation, permitting personal businesses to participate in power era, transmission, and distribution. In view of this, the national transmission grid has an installed capacity of 5,758MW, but its effective wheeling lies at about 4,500MW (PTFP, 2014). The transmission network has a total length of 12,300Km (330KVA5,650Km, 132KV6.687Km) (TCN, 2010) and connect 32 330KV and 105 132KV substations.

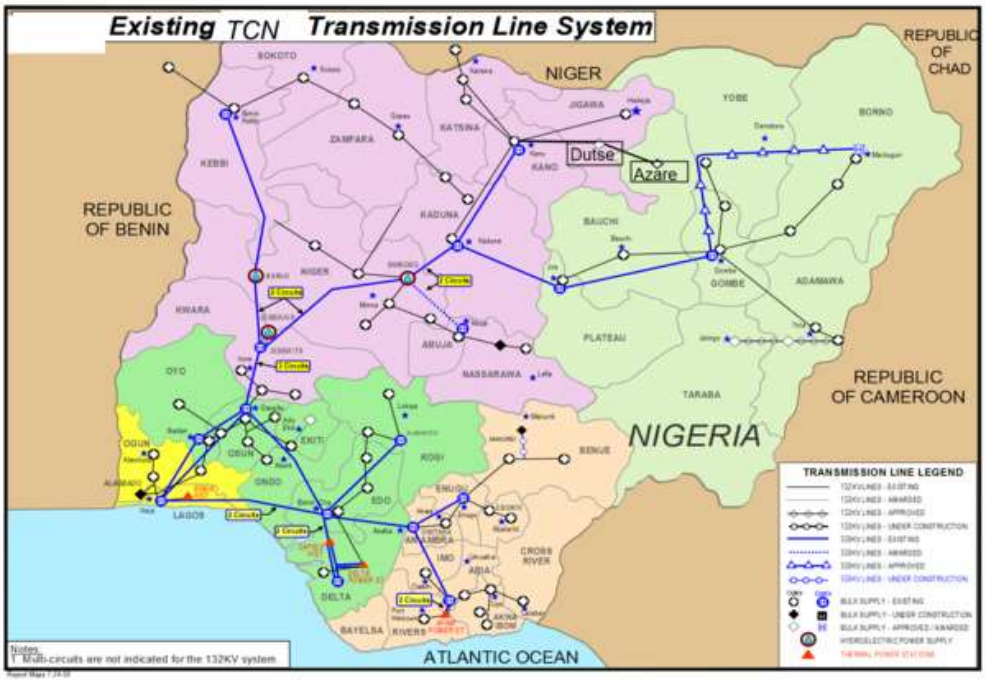

Fig. 2: The Existing Transmission Company of Nigeria (TCN) Line (Adapted from engerypedia, 2020).

The distribution network spans up to 224,838 Km (having the 33Kv, 11Kv and LV lines overhead and cables). Part of the power sector reform, recommended the spliting into 11 distribution zones, each of them owned and managed by a different Electricity Distribution Company (DISCO), with the exception of the Kaduna Electricity Distribution Company whose privatisation process is still on-going (Energypedia, 2020).
Table 1 includes information on the distribution network per Electricity Distribution Company (DISCO).

Name of company	Owner*	Purchase Value ($ Million)	Coverage	Length of lines							Distribution losses (%)	Capacity (MW)	Peak Load Demand (MW)	Customer based (as at 2008)
				Overhead			Cables			Total				
				33KV	11KV	LV	33KV	11KV	LV					
Abuja	Kann Consortium Utility Company Plc	164	FCT, Niger, Kogi and Nasarawa	3,312	3,804	3,520	0	355	262	11,253	35	515	835	469,306
Benin	Vigeo Power Consortium	129	Edo, Delta, Ondo and Ekiti	4,133	5,168	12,576	11,146	132	150	33,305	21	392	100	529,341
Eko	West Power & Gas	135	Lagos South	545	2,347	3,980	317	462	262	7,913	18	796	1105	266,075
Enugu	Interstate Electrics Limited	126	Enugu, Abia, Imo, Anambra and Ebonyi	4,092	3,210	20,558	4	178	213	28,255	6	612	1017	545,103
Ibadan	Integrated Energy Distribution and Marketing Company	169	Oyo, Ogun, Osun and Kwara	8,088	4,594	11,401	0	462	407	24,952	8	878	1193	812,000
Ikeja	NEDC/KEPCO	131	Lagos North	7,711	2,730	25,742	12	110	262	36,567	18	854	1335	535,692
Jos	Aura Energy Ltd	82	Plateau, Bauchi, Benue and Gombe	3,930	1,395	12,152	0	20	56	17,553	22	378	507	277,826
Kaduna	Sahelian Power SPV Ltd (Not fully privatized yet)	58	Kebbi, Doka, Gusau, Mak	1,533	1,614	6,535	5	145	93	9,743	25	344	520	285,736
Kano	Sahelian Power SPV Ltd	137	Kano, Jigawa and Katsina	3,583	1,253	2,351	4	156	17	7,364	40	365	596	489,655
Port Harcourt	4 Power Consortium	124	Rivers, Cross River, Bayelsa and Akwa Ibom	6,109	9,747	n.a.	n.a.	n.a.	n.a.	15,856	n.a.	486	773	347,789
Yola	Integrated Energy Distribution and Marketing Company	59	Yola, Adamawa, Borno, Taraba and Yobe	8,761	1,407	21,485	0	2	25	31,680	22	138	176	189,347

*State governments are shareholders in the DISCO that operates in their territory. Ikeja also counts with a private stakeholder: Sahara Energy
**Table created only for indicative purposes. The information included might not be complete or up to date

Table 1: Electricity Distribution Company and the state of their Network (Wale, 2014).

From the Table 1 above, it is clear that Benue State takes it electricity from Jos usually known as Jos Electricity Distribution Company (JEDCO), the company is owned by Aura Energy Ltd with a purchase value of $82 Million. JEDCO has coverage of four states namely: Plateau, Bauchi , Benue and Gombe. Benue, therefore, shares with the other three states a consumption capacity of 378MW with a peak load demand of 507MW, the distribution loss is 22% which makes the electricity supply in the state very low. This company also has a customer base of 277,826 people as of 2008. The biggest challenge is access rates of states in Nigeria to the national grid that varies notably. As an example, in keeping with the projections of the Japanese international Cooperation enterprise (JICA), Taraba had the least electrification rate in 2010 with 21% and Lagos the very best with 96% (Energypedia, 2020). Out of the 13 states that registered the bottom electrification rates, 10 have been placed within the North-West and North-East. The eight (8) that registered the very best electrification rates were positioned inside the South-West or South-South region. The table underneath provides an overview of the state of electrification consistent with kingdom.

No.	State	No. of Households as of 1997 (*1)	% of Household with Electricity as of 1997 (*2)	No. of Households with Electricity as of 1997	Annual growth rate of consumers (%)	% of Household with Electricity			No. of Household with Electricity		
						2006	2010	2020	2006	2010	2020
1	Taraba	432,880	12	50,301	7.80	17	21	34	98,888	133,542	283,012
2	Jigawa	823,164	12	99,685	7.77	18	22	35	195,520	263,766	557,554
3	Zamfara	593,479	13	77,924	7.71	20	23	37	152,101	204,752	430,492
4	Sokoto	686,178	13	90,095	7.71	20	23	37	175,859	236,734	497,734
5	Kebbi	592,137	13	77,807	7.71	20	23	37	151,866	204,431	429,794
6	Katsina	1,074,392	14	145,902	7.69	20	24	38	284,184	382,194	801,663
7	Gombe	426,284	17	72,553	7.49	25	30	46	139,031	185,628	382,367
8	Bauchi	819,259	17	139,438	7.49	25	30	46	267,198	356,753	734,857
9	Benue	788,111	17	135,003	7.49	25	30	46	258,565	345,146	710,537
10	Yobe	400,682	19	75,729	7.39	27	32	50	143,826	191,270	390,098
11	Ebonyi	416,196	25	102,759	7.06	39	46	69	189,857	249,413	493,343
12	Enugu	608,334	25	150,198	7.06	39	46	69	277,505	364,554	721,096
13	Cross River	547,224	29	159,954	6.80	40	47	68	289,196	376,273	726,572
14	Nassarawa	345,773	31	108,607	6.68	43	49	71	194,326	251,669	480,372
15	Plateau	602,456	31	189,231	6.68	43	49	71	338,583	438,495	836,973
16	Kano	1,663,337	32	538,256	6.62	44	51	72	958,709	1,239,106	2,353,218
17	Borno	725,970	34	248,935	6.51	46	53	75	439,310	565,469	1,062,926
18	Adamawa	601,745	35	210,069	6.48	47	54	76	369,621	475,140	890,189
19	Akwa-Ibom	689,703	36	246,638	6.43	47	55	77	432,200	554,578	1,034,327
20	Niger	693,215	42	288,932	6.10	54	61	83	492,124	623,542	1,126,789
21	Kaduna	1,126,632	43	479,607	6.05	55	62	84	813,402	1,028,655	1,850,037
22	Kogi	614,828	50	309,996	5.60	62	70	90	506,218	629,499	1,085,526
23	Bayelsa	321,102	52	167,069	5.51	64	71	91	270,706	335,469	573,511
24	Rivers	912,575	52	474,813	5.51	64	71	91	769,348	953,408	1,629,926
25	Abia	547,888	52	287,587	5.48	53	58	75	464,946	575,611	981,623
26	Imo	711,551	61	433,833	5.00	72	78	96	673,132	818,258	1,333,107
27	Delta	741,568	62	462,294	4.92	73	79	96	712,530	863,590	1,396,589
28	Edo	621,770	63	388,855	4.91	73	79	96	598,757	725,382	1,171,814
29	Kwara	443,257	68	299,509	4.63	77	83	98	450,021	539,288	847,795
30	Osun	617,802	71	436,539	4.45	80	85	99	646,094	769,082	1,188,952
31	Abuja	106,397	71	75,436	4.44	80	85	99	111,517	132,676	204,841
32	Ogun	668,065	72	483,813	4.35	81	86	99	709,928	841,842	1,289,056
33	Ekiti	439,644	72	318,698	4.35	81	86	99	467,484	554,265	848,386
34	Ondo	643,968	72	466,812	4.35	81	86	99	684,748	811,860	1,242,673
35	Anambra	800,534	78	621,295	4.06	85	88	99	888,786	1,042,097	1,551,263
36	Oyo	988,395	78	771,541	4.03	85	89	100	1,101,286	1,289,986	1,915,566
37	Lagos	1,638,903	96	1,577,936	3.00	96	96	97	2,058,848	2,317,252	3,114,193
	Total Nigeria	25,475,400	44	11,263,648	6.04	53	58	75	17,776,220	21,870,672	37,168,770

(Remarks)
(*1) No. of Households as of 1997 was extraporated based on the result of 1991 Census.
(*2) % of Household with Electricity as of 1997 was quoted from the result of General Household Survey 1997/98.

Average number of persons per household	4.13
Annual growth rate of consumers (Highest)	7.80 %
Annual growth rate of consumers (Lowest)	3.00 %

Table 2: Tendencies in electrification rates per state (Adapted from Energypedia, 2020)

Table 2 above shows the tendencies in the electrification rates of all the states in Nigeria and the Federal Capital Territory (FCT), from 1997 data, available with projections up to 2020. Benue as at 1997 had 788,111 households; out of which only 17% were hooked to the national grid or better sill had access to electricity. Therefore, households with electricity were 135,003 households. The figures for annual growth rate for Benue consumers of electricity were 7.49%. This means, the households that will need electricity in Benue will grow by 7.49% which is high compared to the other states. If attempts are not made to increase power supply, then more households in the State will go without electricity from now on. This will be a big challenge to the economy of the state. Also from the table, projections made for 2006, 2010 and 2020 of the number of household with electricity was 258,653; 345,146 and 710,537 respectively translating to 25%, 30% and 46% respectively for the proportions of families that are expected to have access to electricity in Benue on or before 2020. This is in view of the fact that electricity plays a major part in the socio-economic development of a country and by extension, the states. Access to contemporary power services is closely related to improvements in other facet of human development such as healthcare, water supply, education, environmental cleanliness, job creation, food security etc. (Kanagawa, et. al., 2007; Sokona, et. al. 2012 in Akkhator, 2016). At the opposite, bad delivery of energy hinders economic growth and negatively influences the cost of living of human beings (Akhator, 2016). The electricity sector is of

particular importance as a source of power due to the variety of its end-use in comparison to different kinds of energy. Despite having an abundance of both renewable energy resources of hydro, biomass and some little deposits of non-renewable resources like coal and fossil fuel, Benue State is still being plagued with electricity crisis, a crisis that seems will not end. The electricity crisis has hampered the socio-economic and technological development in the State, which has mandated lots of companies, like Olam Rice, Benue Breweries, Taraku Mills, Otukpo Burnt Bricks, etc. to either shut down or relocate to neighbouring states thereby reducing job availability and the IGR of the state government. The National Peak electricity demand forecast for 2016 was put at 17,520MW, but Nigeria has a deteriorating installed capacity of about 11,165MW (Nnodium, 2016), while that of Benue State, the government was only making plans to construct a 10MW Power Plant in the state with an estimated loss of 25% (NERC, Online Media Retrieved 21/05/2020). The same situation as applied to the nation runs through the state or is even worse. According to the Transmission Company of Nigeria (TCN), the maximum electrical power generation ever recorded in the history of Nigeria is 5074.70MWh. This amount falls quick of the national requirement consequently it's far inadequate to light up every residence and avenue inside the country as it is obvious from the incessant blackouts and brownouts witnessed by her citizens (Akhator, 2016). A direct impact of this poor electricity supply is felt across the state owning to the households figures that have resulted to alternative source of electricity such as generators and renewables such as solar panels and inverters for both residential and commercial purposes.

The low electrical power generation and distribution within the country can be linked to several problems such as non-availability of operational power plants, inadequate, inefficient and obsolete power generation equipment in the regional and power distribution offices, high incidence of equipment breakdowns etc. Also, majority of the residents in Nigeria live in rural areas where there are difficult terrains and they do not have access to fossil fuels as such are not connected to electricity grids because of bad roads. Very many of the communities are located at a fairly long distance from the nearest common connection point of a utility grid system. Some of the rural areas are characterised by very low population density, low level of education, and low load density which is evident from very short periods of peak load. Consequent from the attendant problems, the rural dwellers resort to using diesel generators (Shaaban, 2014). But the use of alternative power supply by rural dwellers come with challenges like high cost of fuel and maintenance, other constraints that are attributed to it are: non-availability of access/good roads most especially during the rainy season, when the roads are flooded for several days hindering delivery of the necessary fuel and other materials needed for the running of generators (Stephen, 2012). More so, it's impractical to keep the generator working for 24 hours daily. Consequently, kerosene lamps, candles and the likes, are opted for, thus spending so much time collecting fire wood for cooking of food and heating purposes (Shaaban, 2014). A Typical Benue scenario presented above that is predominantly characterised by rural communities. These rural communities have no proven deposits of crude oil, natural gas or large body of water (Shaaban, 2014). Nevertheless, Benue is blessed with considerable Renewable Energy sources such as solar radiation, biomass, wind speed and river Benue with its tributaries in the state for small hydro-power (SHP) production. In view of these attendant problems of power supply to the state that a possible solution could come in the form of renewable energy for rural electrification of various communities in the state.

1.2 Biomass Potentials in Benue State

Studies have been conducted in respect of sustainable power provision to rural areas in developing countries using decentralised renewable energy technologies (RETs). Typically, Dasappa (2011) reported that biomass makes up the optional alternative energy sources for sustainable power provision in Sub-Saharan Africa (SSA) given the fact that it is universally available from all the resources. Demirbas (2009) argued that biomass energy technologies (BETs) can compete with fossil fuel sources in terms of the costs. Mahapatra and Dasappa (2012) reported that from the whole life costing (WLC) of biomass, solar PV and grid extension systems, biomass is the most the most budget friendly approach of providing sustainable power to Indian's rural areas. In addition, they argued that of all the BETs (gasification) has the most significant advantage over solar PV system which requires only additional fuel as operational hours increases, but increasing the load demand will not require increasing the gasifier rating since the gasifier turndown ratio is quite high. While in the case of solar PV, increasing the operational hours leads to the increases of the system size and consequently, its capital cost". Also Garba and Kishk (2014), evaluated six (6) major Renewable Energy Technologies (Solar PV, Wind, Small hydropower, biomass, geothermal and ocean energy systems) using systematic review method, and a SWOT analysis for each RET which was carried out in order to assess their sustainability indicators. Their findings by order of priority revealed that biomass, solar PV, small-hydropower and wind were the best means for providing sustainable power in Nigerian rural areas. However, Evans, et. al. (2010) argued that BETs are cheaper than solar PV but more expensive than grid extension system. Hence, from the above, it is fair to conclude that BETs are the best means of electricity provision in rural areas (Garba, et. al., 2016). This informed the choice of Biomass Renewable form of energy to be used in Benue State.

Biomass refers to the numerous materials received from vegetations and animals, which can be used as raw substances for the introduction of useful energy in diverse forms and for diverse purposes (Sambo, 2005). Biomass is available in kind of forms, however may be labeled extensively in terms of end-use as; fuel biomass, feed biomass, fibre biomass, organic fertilizer biomass and chemical biomass. Furthermore, the method of biomass production depends on the type of biomaser (Jemirna, et. al., 2012). Also, biomass is an indirect form of solar energy because it arises due to photosynthesis. Fuelwood is the most common form of biomass energy (Shahaan, et. al., 2014). Biomass therefore, is a general term for all organic material that stems from plants (including

algae, trees and crops). Biomass is produced via inexperienced vegetation converting sunlight into plant fabric through photosynthesis and includes all land-and-water based floras, in addition to all natural wastes. Biomass is available on a renewable foundation, both through herbal methods, or it is able to be made to be had as a derivative of human activities i.e Organic wastes. The ability of biomass electricity derived from woodland and agricultural residues global-extensive, is estimated at approximately 30 EJ/year, as compared to an annual global-huge strength call for of over 400EJ (McKendry, 2002). Most of biomass assets are located near rural regions and consist of agricultural vegetation and their residues, animal dung, forestry residues, different energy crops, and municipal solid waste (IRENA, 2012). Biomass is normally plant derived materials, able of being transformed to one or more kinds of energy (electricity, heat and gas) and can be speedily be regenerated in different environments (Evans, et. al., 2010). In view of the assertion above, Benue State is endowed with plentiful renewable resources scattered around the 23 local government areas of the state. Little wonder, Benue State is acclaimed "Food Basket of the Nation", due to its wealthy agricultural produce which accounts for 75% of the population and include rice, cassava, maize, soybean, sorghum, millet, sesame, etc. which can be harnessed by the state in the form of biomass for power generation. The state also boasts of one of the longest stretches of the river structure in the country with great potential for small-hydro-electricity generation station in the state for energy production. Tributaries such as river Konshisha in Konshisha Local Government Area, Katsina-Ala river in Katsina-Ala LGA, River Guma in Guma LGA, River Logo in Logo LGA, River Okpokwu in Okpokwu LGA, river Obi in Obi LGA. Other tributaries of the Benue river include Mkomon, Amile, Kpa, Duru, ombi mu, Be, Aya and Oyongo, which are scattered all over, and have great potentials if properly harnessed to provide small-hydropower electricity to the ever increasing demand for electricity in State.

Solar energy is another promising renewable energy in Benue State as a result of its apparent limitless potentials. The State has its monthly average solar radiation ranging from 14MJ/M^2 day (Abur & Ayubaduruma, 2014). These radiation values are enough for the availability of electricity through photovoltaic systems. The study carried out by Abur and AyubaDuruna, 2014 worked on Estimation and Mapping of solar energy potentials of Renewable Energy resources in Benue State-Nigeria: looked at the solar radiation of the 23 local government areas in the State with a view to ascertaining the viability to be used as renewable energy. Data was obtained and the recommendation made was for the government of Benue State to adapt proper application of solar power technologies to harness the solar power potential of the state for economic growth development, sustenance and reduction of over dependence on fossil fuels to save the environment.

Yearly Average Solar Radiations for the Selected Stations L.G.A	**Towns/Stations**	**Latitude °N**	**Longitude °E**	**Radiation(MJ/m2day)**
Ado	Igumale Utonkon	6.7918 6.9452	7.9850 8.0330	17.90 17.89
Agatu	Obagaji Usha	7.8776 7.9290	7.9203 7.8124	17.85 17.85
Apa	IgaOkpaya Ojantele	7.5540 7.7247	7.8626 7.8592	17.91 17.88
Buruku	Buruku Ugbema	7.4693 7.1915	9.1981 9.2702	17.91 17.97
Gboko	Gboko Ikpa	7.3179 7.5090	8.9951 8.7617	17.95 17.92
Guma	Gbajimba Udei	7.8155 8.0666	8.8604 8.5166	17.86 17.82
Gwer	Aliade Igbor	7.2964 7.4527	8.4870 8.6098	17.78 17.93
Gwer West	Naka Adudu	7.5834 7.7429	8.2055 8.2688	17.92 17.88
Katsina-Ala	Katsina-Ala Harga	7.1666 7.2570	9.2833 9.8110	17.88 17.79
Konshisha	Kornya Ikumbur	6.7149 7.2893	8.9224 8.6682	18.03 17.90
Kwande	Adikpo Waya	6.8878 6.8734	9.2354 9.6062	18.02 18.07
Logo	Ugba Abeda	7.5000 7.6024	9.3333 9.2881	17.92 17.90
Makurdi	Makurdi Apir	7.7411 7.6305	8.5121 8.5817	17.86 17.91

Obi	Obarike-lto Ameko	7.0260 7.0907	8.3268 8.2927	18.01 17.99
Ogbadibo	Otukpa Orakam	7.0892 6.9884	7.6498 7.5840	17.99 18.00
Ohimini	Ochobi Ijemi	7.1830 7.1857	7.9769 8.0437	17.97 17.95
Oju	Oju Adum	6.8454 6.8593	8.4173 8.5960	18.06 18.02
Okpokwu	Ingele Ajide	7.0740 7.1261	7.8700 7.9059	17.98 18.00
Otukpo	Otukpo Adoka	7.1914 7.4511	8.1333 7.9679	17.97 16.60
Tarka	Wannune Gwache	7.5618 7.6090	8.8887 8.9057	17.90 17.88
Ukum	Sankera Kasimbila	7.5333 7.8718	9.6500 9.6728	17.91 17.85
Ushongo	Lessel Amire U Kiriki	7.2299 6.9871	9.0315 9.3182	17.96 18.00
Vandeikya	Vandeikya Mbara	6.7838 6.9049	9.0626 9.0756	18.03 18.02

Table 3 Yearly Average Solar Radiations for selected stations (adopted from Abur & Ayubadavuna, 2014)

This is also the opinion of Shaaban and Petinrin, 2014 that solar energy can provide cheap and abundant energy for communities whose connection to the public supply of electricity may not be economical due to their remote physical location from the nearest grid connection point. And that solar energy is another source of energy in rural and remote climes in Nigeria. This suits Benue state since it is mostly made up of rural communities.

Wind energy generation is the fastest growing renewable energy market world-wide. The global cumulative installed capacity of wind power gradually increased from 6100MW in 1996 to 158,505MW in 2009. It is further speculated that on or before 2014, wind energy will have over 238GW of installed capacity and is predicted to play a crucial role in mitigating future Green House Gases (GHG) emissions (World wind Energy Report, 2009). Agbetuyi, et. al. estimates wind energy density at 25m height for some 22 selected sites across the country. Table provides detailed potentials and wind energy densities of the sites.

SN	Station	Mean wind speed at 25m level m/s	Monthly mean wind Energy kWh	Annual Wind Energy kWh	Annual Wind Energy from a Wind Turbine (kWh)	
					10m Blade Diameter	25m Blade Diameter
1.	Benin City	2.135	2.32	27.86		
2.	Enugu	3.372	7.83	93.91	7,375.75	46,097.96
3.	Ibadan	2.62	4.15	49.78	3,909.79	24,436.19
4.	Ilorin	2.078	1.23	14.73	1,157.06	7,230.57
5.	Jos	4.43	16.05	192.64	15,129.60	94,559.98
6.	Kaduna	3.605	9.91	188.88	936.81	58,355.08
7.	Kano	3.516	8.57	102.86	8,078.61	50,491.28
8.	Lagos(Ikeja)	2.671	4.36	52.32	4,099.78	25,682.52
9.	Maiduguri	3.486	8.42	101.01	7,933.61	49,583.17
10.	Minna	1.589	1.05	12.6	989.60	6,185.01
11.	Makurdi	2.689	4.44	53.27	4,183.51	26,148.85
12.	Nguru	4.259	14.48	173.74	13,645.19	85,284.42
13.	Oshogba	1.625	1.07	12.81	1,006.60	6,288.09
14.	PH	2.64	4.17	49.98	3,925.48	24,533.88
15.	Potiskum	3.636	9.44	113.25	8,894.35	55,591.46
16.	Sokoto	4.476	16.47	197.68	15,525.75	97,035.94

17.	Warri	2.027	2.02	24.2	1,900.66	11,879.15
18.	Yelwa	3.36	7.76	93.13	7,314.88	45,714.59
19.	Yola	1.824	1.45	17.34	1,361.88	8,511.75
20.	Zaria	2.891	5.32	63.88	5,017.26	31,357.02
	Total		**134.23**	**1680.5**	**120,078.90**	**790,548.39**

Source: Wind energy Potential in Nigeria: (Agbetuyi et al, 2012)

Table 4. Wind Energy Density Estimates at 25m height (Adopted from idris et. al., 2012).

From the Table 4, it is clear that Makurdi, the state capital has mean wind speed at 25m level of 2.689m/s and an annual wind energy from a wind turbine 1st at 10m blade diameter of 4,183.51kWh and 2nd at 25m Blade Diameter of 26,148.85kWh. These values are very high and puts Benue State at very good position both national and international collaboration so as to establish Wind Power Stations solely for providing electricity for its populace. This is asserted by Sambo (2012), who giving assessment of some renewable energy resources said about 2 to 4m/s at a height of 10m wind speed is used for wind energy construction. Benue is among the states with such a value that the government of the day can cash-in and collaborate with agencies towards establishing turbines in the state.

Geothermal energy is heat energy produced and stored in the earth-crust. It is created from the radioactivity decay and continual heat loss from the earth's formation. Geothermal energy involves the tapping of thermodynamic quantities that are equivalent to the quantity a physical system produces work and heat (Otobong & Onovughe, 2016). Geothermal energy can also be refered to as thermal energy produced and stored in the earth. Heat energy is that which determines the temperature of matter (Abdullahi, et. al., 2014). The geothermal energy of the earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%) (Turcotte & Suhubert, 2002). Utilisation of geothermal fluid depends heavily on its thermodynamics characteristics and chemistry (Eyinla, et. al., 2016). Under appropriate conditions, high, intermediate and low temperature geothermal fields can be utilised for both power generation and the direct use of heat (Tester, et. al., 2005). The perfect geology of the geothermal power is that heat from the earth's own molten center is carried out to the adjacent rocks and sooner or later is transferred to underground water reservoirs through convection (Eyinla, et. al., 2016). The resulting steam and hot water produced by the geothermal heat can be tapped using extraordinary technologies and channelled for various uses. Electricity generation is therefore the most important form of utilisation of geothermal resources.

Geothermal power is a renewable, environmentally friendly energy-source primarily built on the internal heat of the earth. It could be related to volcanic activity, hot crust at depth in tectonically active areas or permeable sedimentary layers at great depth (Lund, 2004). Thermal springs have been used for bathing; washing and cooking for thousands of years, while geothermal electricity production and large-scale direct use, started during the first half of the twentieth century. Geothermal power is now being utilised in more than 50 countries worldwide (Abdullahi, et. al. 2014).

The renewable power sources available in Nigeria are diverse and enormous. At present, these are no installed geothermal plants by Nigeria. However, the renewable energy master plan (REMP) second draft as prepared by the Energy Commission of Nigeria (ECN) in November 2012, sought to increase the supply of renewable electricity from 13% of total electricity generation in 2015 to 23% in 2025 and 36% by 2030. Therefore, the available information extracted from the geology and mineral maps of Nigeria, three major potential geothermal sources are available viz; the Biu, Plateau and Pindiga formations of the Benue Trough and the Gombe sandstones (containing the Wikki springs). Benue State is lucky to be blessed with this large expense of geothermal assets which the government could tap from. Benue trough is large and the government could liaise with other states belonging to the extended trough so as to harness the resources into electricity that could very well serve the region and also inject into the national grid. The prevailing power crisis within the country at large and Benue State in particular geothermal power can function as a future source of energy if exploited. This could put much less pressure on fossil fuels and hence deal with the imminent terrible consequences of worldwide warming (Eyinla, et. al., 2016). Although, geothermal power is not widely known in Nigeria, but public outreach and acceptance associated with the sector will be a key factor for its exploration and exploitation. Government should put in place a project that with a time frames that will come out with a strategic geothermal power assessment. The Authorities' of Benue state have to set up a geothermal power research within the Federal University of Agriculture, Makurdi and the Benue State University with a vision for the centre to provide urgent, forward looking research, improvement and aid for establishment of geothermal energy as a clean electricity alternative via application of research.

CONCLUSION

A significant proportion of Nigerians and Benue population live in rural communities since Benue can be said to be housing largely rural communities that are located quite far off from the nearest connection to the public power supply. These rural groups haven't

any confirmed deposits of natural gas, crude oil or massive rivers, but are but, blessed with abundant renewable energy (RE) assets (Shaahan, et. al., 2014). It is very true of Benue State that it is blessed with numerous renewable energy resources; but the government has not given any meaningful consideration of taping into it. In spite of the fact that Benue has these huge renewable energy reserves, the demand for electricity in the state far exceeds the amount of power generated in the State. Because of the careless inefficiencies that are associated with electric energy provision in the state, it is becoming more difficult for the rural population to have access to electricity services. Unfortunately, even the urban populace that have little access to electricity it is usually epileptic. This paper is advocating the usage of renewable energy resources by the Benue State government to bridge the gap between the demand and supply of energy in the state so as improve the standard of living of rural communities. The potentials of various renewable energy sources, including Biomass, solar, wind, and geothermal energies were discussed. The government of Benue State should take a bold step into looking at renewing most of its energy policies which might be obsolete that allows you room to addressing any flaw in them so as to enable the state move quickly into the implementation of the reviewed policies for the good of the generality of the people in the state. Also using new and emerging technologies will lead to a better provision of energy resources amongst Benue people, which would in turn alleviate the misfortune of rural communities currently groaning under acute shortage of electricity. Finally, the government should look inward to their tertiary institutions of learning so as to utilise their works in the form of research and development leading to finding lasting solutions to renewable sources exploration and exploitation as this will eventually ameliorate the energy outlook of Benue State and by extension, Nigeria.

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