JEES JOURNAL OF ENGINEERING AND EARTH SCIENCES

JEES ISSN: 1897-8680

JEES 2022

VOLUME 15 ISSUE NO 1

PAGE 110 - 118

RENEWABLE ENERGY: A SOLUTION TO THE POWER POVERTY IN ADO-EKITI, NIGERIA

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ABSTRACT

The pace of development and industrialization of any nation is dependent on the ability of its electricity supply industry to generate and ensure viable distribution of reliable, adequate and economically priced power to the end-users. In Nigeria, nonrenewable energy (coal, fossil fuel and hydro) accounts for more than 80% of total power generation. An energy source which is epileptic and have several risks associated with their use. They increase greenhouse gases, the global warming and climatic change associated with it. It represents one of the greatest environmental challenges of our time and the greatest social dangers in the future. Nonrenewable sources are gradually depleting and therefore, the need to harness a clean, reliable and environmentally friendly renewable energy sources that abound in Nigeria to generate electricity for socioeconomic development. This paper briefly looks at renewable energy that abounds in Ado-Ekiti and its potential for energy security. It also discusses the renewable energy projections and trends of Nigeria and some other countries.

KEYWORDS: Electricity; Renewable energy; Greenhouse gases; Development

INTRODUCTION

Ademiloye et al., (2020) defined the dimension of energy poverty of any nation as its in-ability to appropriate cheap, dependable, and high-quality access and environmentally friendly energy to aid economic and social development. Energy security is simply the affordable access to reliable power supply and sources of power (Okosun et al., 2021). The capacity of any nation to satisfactory deliver electric power and to ensure its viable distribution to the end-users (homes, industries, banks, media, health care, aviation, etc.) is critical to the pace of social-economic development and industrialization of that nation (Peter et al.,2019). More 645 million Africans are estimated to be without electricity. Sub-Saharan Africa has the lowest per capita power usage of any continent, with an estimated 181 kWh per year, compared to 6,500 kWh in Europe and 13,000 kWh in the United States (Lawal et al., 2020). Nigeria has vast oil, gas, hydro, and solar resources, and it already has the ability to produce 12,522 megawatts (MW) of electricity from existing facilities, out of these, 10,142 MW is from thermal plant and 2,380 MW is from hydro source, but it can only generate approximately 4,000 MW on most days, which is insufficient. and the supply is 60% most time unavailable for the over 200Million populace (Bamisile et al., 2020; USAID, 2019). This inadequacy in generation capacity, has Nigerian citizens forced to rely heavily on personal energy

generators over the years. As of 2009, more than six million Nigerians residents have personal power generating system and spend a staggering ₦1.56trillion ($13.35Million) to fuel them in a year (Lawal et al., 2020), which are inefficient and contribute to the pollution of the environment. It is commonly acknowledged that there is a significant relationship between socio-economic development, availability of electricity and poverty (Bamisile et al., 2020; Sambo et al, 2010). The hydropower and thermal generating stations in Nigeria are incapable to generate the required power to sufficiently feed the domestic, commercial and industrial demand of the country. While electricity from hydropower plant is widely acknowledged as environmentally friendly, those from fossil fuels and nuclear power have associated environmental limitations. This is because of the harmful effects of their by-products (Omole et al., 2014).

Adopting renewable energy resources for electricity production and other energy needs has become a notable objective globally. The available renewable resources dispersed in Ado-Ekiti can be harnessed to the maximum to generate enough electrical power for the teeming population and growing economy. Renewable energy (RE) exploration and usage will not only assist Ado Ekiti and Nigeria at large to meet her energy targets, but will also promotes energy security, likewise addressing issues such as global warming and climate change (Ademiloye et al., 2020).

This study takes a look at renewable energy that abounds in Ado Ekiti and its capacity to rescue Ado Ekiti from electrical power poverty.

REVIEW OF RENEWABLE ENERGY SOURCES

Renewable energy is the energy derived from natural sources which has the ability to be continually replaced. This comprises solar energy, geothermal energy, heat, wind, tides, and water. The most significant feature of renewable energy is its infinite supply. Renewable energy sources are hygienic sources with lesser negative environmental impact. The renewable Energy (RE) that has been identified in Ado Ekiti includes but not limited to biomass, biogas, hydrogen fuel cell, solar energy, small hydropower, and wind energy (Adewale & Koleola, 2012; CRET, 2015).

Solar energy

Solar energy is an energy obtained from the sun. It is the world's most abundant and cheapest source of energy available from nature. It is free and automatically renewable every day (Ezugwu, 2015). Solar energy is available in two forms, namely Solar Thermal and Solar Photovoltaic.

Solar thermal collectors are used to heat air, water or other fluids, depending on the applications. High-temperature solar thermal collectors are also used to produce electricity indirectly via thermodynamic cycles. Some types of solar collectors can produce temperatures of about 100ºC or less, which is used for heating and cooling buildings, domestic hot water and industrial process heat. Parabolic troughs or parabolic dishes solar collector may be used to provide temperatures from about 100ºC to about 500ºC used for refrigeration to industrial process heat and electricity generation (WEC, 2013).

Solar PV is used to power small and medium-sized applications, from the calculator powered by a single solar cell to off-grid homes powered by a photovoltaic array. They are a vital and fairly priced source of electrical energy in areas where grid electricity is difficult, too costly to connect, or just absent (Fagbohun & Adebanji, 2014).

Hydropower (Large/Small Scale)

Flowing water like river or stream creates energy that can be captured and turned into electricity. This is called hydroelectric power or hydropower. It is an eco- friendly clean power generation method. This is achieved by constructing a dam across the flowing water which conserves the water in a reservoir. The potential energy of the high water head in the reservoir is converted into electrical energy for electric power generation (Ezugwu, 2015).

Hydro power can be classified based on generated power as follows:

Pico-Hydro<5KW

Micro-hydro>5<100KW

Mini-hydro>100KW <MW

Small hydro > 1MW < 10MW

Medium hydro > 10MW < 100MW

Large hydro > 100MW

Hydropower is a reliable and cost-effective renewable energy sources. One major shortcoming is the seasonal variation of water which could affect power generation (Fagbohun & Adebanji, 2014; Fagbohun, 2016).

Biomass

Biomass is a plant-based organic matter as well as animal wastes used for energy generation. It can be used as solid fuel and can also be converted to liquid or gaseous forms for electric power generation, heat or fuel using different technologies. The use of biomass for energy production is on the rise worldwide. In Nigeria, the biomass resources consist of wood, forage grasses and shrubs, animal wastes arising from forestry, agricultural, municipal and industrial activities as well as aquatic biomass (Ademiloye et al., 2020). Biomass is a renewable energy source because the energy it contains comes from the sun. Plant uses photosynthesis, to capture the sun's energy and when burn; it releases the suns energy therein. In short, biomass acts as storage media for solar energy (Ezugwu, 2015). Rotting rubbish, agricultural waste, and human waste all emit methane gas, known as "biogas". Crops, Corn and sugar cane, for example, can be processed to make ethanol, a transportation fuel like biodiesel which is made from vegetable oils and animal fats (Fagbohun & Adebanji, 2014).

Wind Energy

The wind energy stands out to be one of the most promising new sources of electrical power in the near term. Wind power is the transformation of wind energy into usable energy, such as utilizing wind turbines to generate electricity, windmills to provide mechanical energy, wind pumps to pump or drain water, or sails to drive ships (Fagbohun & Adebanji, 2014). Globally, the long-term technical potential of wind energy is believed to be five times total current global energy production, or 40 times current electricity demands. This could require wind turbines to be installed over large areas, particularly in areas of higher wind resources (Ezugwu, 2015). In Nigeria, wind energy is not in use for commercial electricity production, the passion to seek a lasting solution to the power situation in the country prompted some research into Nigeria's wind energy potential (Ademiloye et al., 2020) and its inclusion in the renewable energy target 2009 (Awogbemi et al., 2015).

Geothermal Energy

Geothermal energy is the thermal energy created and stored on the earth and it determines the temperature of matter. The geothermal energy of the Earth's crust is derived from the planet's initial creation (20%) as well as radioactivity of minerals (80%). The geothermal gradient brings about the continual transfer of thermal energy in the form of heat from the core to the surface

(Fagbohun & Adebanji, 2014). The temperature at the core-mantle interface can exceed 4000 °C (7,200 °F). The high temperature and pressure in Earth's interior cause some rock to melt and solid mantle to behave plastically, resulting in portions of mantle convecting upward since it is lighter than the surrounding rock. The crust heats up rock and water to temperatures of up to 370 °C (700 °F). Geothermal energy has been utilized for bathing since Prehistoric time and for space heating since ancient Roman times, although it is currently better recognized for electricity production (Fagbohun & Adebanji, 2014).

Geothermal energy is inexpensive, dependable, sustainable, and ecologically beneficial, but it has traditionally been confined to places near tectonic plate borders.

MATERIALS AND METHOD

This paper discusses the renewable energy resources that abundant in Ado-Ekiti and their capacity to take us from energy poverty. Also, Journals and online materials were used to obtain information on installed capacities or global trend on renewables of some selected counties across the globe, the electricity consumption per capita and renewable energy master plans of some selected sub- Sahara African counties were also discussed to point to the fact that renewable are here to stay and are solution we seek in Ado-Ekiti and the nation at large.

Renewable Energy Global Trend

According to IRENA, (2021), Global renewable generating capacity was 3064 GW. With a capacity of 1360 GW, hydropower accounted for the lion's share of the global total.

Solar and wind energy provided an equal capability of 849 GW and 825 GW, respectively. Other renewables included 143 gigatons of bioenergy, 16 gigatons of geothermal energy, and 524 gigatons of marine energy.

Hydropower a global trend

Hydropower technology remains a corner stone of renewable energy nexus in some regions of the Earth. Hydropower is a clean renewable and environmentally friendly source of energy. Hydropower still accounts for over 80% of the world's renewable generation capacity, a proportion that rises to more than 80% in Latin America. Global hydro capacity is 1100GW in 2018 and is still the largest share in global statistic with a capacity of 1 360 GW at the end of 2021. Hydropower capacity increased by 19 GW (+2%) from previous year, 2020 (www.irena.org/publications).

Geothermal a global trend

The year 2018 comes to a conclusion with 14,600 MW of installed geothermal power producing capacity, and a positive outlook in key countries of the geothermal world as shown Table 2.

Biomass Global trend

Carbon dioxide emissions may be drastically reduced if the OECD (Organization for Economic Co-operation and Development) countries used biomass using agricultural and forest produce instead of coal to produce energy (AEBIOM, 2017). About three-quarters of the world's renewable energy use involves bioenergy, with more than half of that consisting of traditional biomass use. Bioenergy accounted for about 10% of total final energy consumption and 1.9% of global power generation in 2015. Biomass has significant potential and can be directly burned for heating or power generation, or it can be converted into oil or gas substitutes (IRENA, 2022).

RENEWABLE ENERGY TREND IN NIGERIA

Hydroelectric energy

Nigeria has around 20000MW of technically usable hydropower capacity out of a possible of 30,000MW (Awogbemi et al., 2015). The potential capacity of small hydropower (SHP) is 3500MW at about 277 sites, 12 states of Nigeria, and 4 river basin authorities countrywide, of which only 30MW is presently used (Awogbemi et al, 2015; Mohamed & Petinrin, 2014). Eight small hydro power Stations with aggregate capacity of 39.0 MW have been installed by private company and government. Small hydro power at Jos, Plateau has a capacity of 2MW, 8 MW Station at Kurra fall (Ademiloye et al., 2020).

Wind Energy

Wind speeds in far northern Nigeria range from 4.0m/s to 5.12m/s, whereas in southern Nigeria, wind speeds range from 1.4m/s to 3.0m/s. According to available data, yearly wind energy of 1680.50kWh is feasible at 25m height in 22 locations scattered over 17 Nigerian states. For example, in a site in Sokoto, a wind turbine can generate up to 197.68kWh/year while 93.91kWh/year,49.78kWh/year, 49.98kWh/year and 101.10kWh/year is estimated possible in Enugu, Ibadan, Port Harcourt and Maiduguri respectively at 25m height (Awogbemi et al., 2015; Mohamed & Petinrin, 2014).

Biomass

Nigeria's biomass resources (fuelwood, agro waste, saw dust, municipal solid waste) have been estimated at 8 x 10^2 MJ which can be used as fuel, fermented as biogas and as paper products. 80million $m^3$of fuelwood with energy content of 6 x 10^9 MJ is used annually for cooking and other domestic purposes in Nigeria (Awogbemi et al, 2015).

Biogas

Nigeria is believed to create 227,500 tons of fresh animal waste each day, with each capital producing 20 kg of municipal solid trash per year. From 1kg of fresh animal manure, around 0.03m^3 of biogas may be created, allowing Nigeria to produce 6.8 million m^3 of biogas every day. It has also been discovered that a 6.0m^3 family-sized biogas digester can generate 2.7m^3 of biogas/day to satisfy the cooking need of a family of 9 persons (Ademiloye et al., 2020).

Solar Energy

The amount of energy radiated by the sun is around 3.8 x 1023 KW/s, which is equivalent to 1.082 million ton of oil equivalent (mtoe) every day (Awogbemi et al., 2015). Based on a geographical area of 924 x 103km2, Nigeria receives a yearly average of 1.8044.851 x 1012 kWh of incident solar energy. Because of Nigeria's geographical position, solar radiation is widely spread throughout the country, as seen in Figure 1. The yearly solar energy value is around 27 times the country's entire fossil energy resources in energy units and exceeds 115,000 times the amount of electricity generated. This indicates that just roughly 3.7 percent of Nigeria's geographical area is needed to capture enough solar energy to equal the country's conventional energy sources (Awogbemi et al., 2015). A year in Nigeria offers roughly 290 days of sunshine. The average solar insolation in Nigeria is expected to range between 4.0 kWh/m^2/day on the country's southern beaches and 7.0 kWh/m^2/day on the country's northern coasts. The daily average is estimated at 5.5 kWh /m^2/day which shows that availability of abundant sunshine is a positive indicator that Nigeria is an ideal candidate for investment in solar energy resource development (Ademiloye et al., 2020).

RENEWABLE ENERGY MASTER PLANS IN NIGERIA

Renewable Energy Master Plan (REMP) of 2009 provides a roadmap for the effective implementation of the RE and articulates Nigeria's vision for achieving sustainable development in energy. Through this roadmap, government set up the Nigeria's Renewable Energy targets as in (Awogbemi et al., 2015).

By 2025, renewable energy will account for 18% of total power generated.

i. By 2030, renewable energy will account for 20% of total power generated.
ii. Small hydro capacity of 760 MW by 2025
iii. 400 MW solar PV capacity by 2025
iv. 40 MW wind capacity by 2025
v. 30 MW biomass fired capacity by 2025.

These targets are too low when compared with other Africa countries as shown in Table 3.

CONCLUSIONS AND RECOMMENDATIONS

Renewable energy has come to stay as an integral part of global energy nexus. The choice of renewable energy sources is to reduce the pessimistic environmental effects associated with the usage of non-renewable energy sources such as coal, oil and natural gas and to arrest the inadequate and epileptic power that had bedeviled Ado Ekiti. Choosing a renewable energy source will not only result in long-term potential savings, but will also help prevent climate change from the threats of fossil fuel pollution. By harnessing the RE that abound will invariably add more power into Ado-Ekiti for economic growth and development. This paper presented a cursory look into renewable energy that abounds in Ado-Ekiti, and how other regions of the country and world over are embracing it for sustainable energy future. This paper also seeks to advice the government to take a decisive measure to arrest the situation by harnessing and increasing the share of renewable energy in her energy-mix plan for prosperous future.

REFERENCES

Ademiloye, I.B., Olofinjana, A., Yusuf, B. M., & Adeoye, O.S. (2020). Renewable energy resources in Nigeria as Panacea to Electricity Inadequacy: A review. International *Journal for Research in Electronics & Electrical Engineering*, 6(6), 1-12.

Awogbemi, O., Oluwaleye, I. O., & Komolafe, C. A. (2015). A survey of solar energy utilization for sustainable development in Nigeria. *Journal of Multidisciplinary Engineering Science and Technolog*,*2*(7), 1717-1724.

Awogbemi, O., & Ojo, A.O. (2012). Small hydropower for rural electrification in Nigeria. *American Journal of Science and Engineering*, *1*(2), 27 - 32.

Centre for Renewable Energy Technology (CRET), 2015. Renewable energy in Nigeria retrieved on the 20th of August, 2022 from www. overseas.mofa.go.kr/ng-ko/brd/m_9890.

Ezugwu, C. N. (2015). Renewable energy resources in Nigeria: Sources, problems and prospects. *Journal of Clean Energy Technologies*,3(1), 68-71.

Fagbohun, O. O., & Adebanji, B. A. (2014). Integrated renewable energy sources for decentralized systems in developing countries. *Journal of Electrical and Electronic Engineering*, 9(5), 26-35.

Fagbohun, O., & Omotoso, T. (2018). Small hydropower viability assessment of Elemi River in Ekiti state of Nigeria. *Journal of Energy research and reviews, 1*(1), 1-12.

Ibitoye, F. I., & Adenikinju, A. (2007). Future demand for electricity in Nigeria. *Journal of Applied Energy, 84*, 492-504.

Lawal, O. A., Zubair, M. O., & Lateef, K. (2020). Analysis of environmental effects of the major stand-alone power generators used in Nigeria and Sub-Africa. *ATBU journal of Environmental Technology*, *13*(2), 14-27.

Mohamed, S., & Petinrin, J. O. (2014). Renewable energy potentials in Nigeria: Meeting rural energy needs. *Renewable and Sustainable Energy Reviews, 4*(4), 182-188.

Nwulu, N. I., & Agboola, O. P. (2011). Utilizing renewable energy resources to solve Nigeria's electricity generation problems. *International Journal of thermal and Environmental Engineering*,*3*(1), 15-20.

Omole, D. O., & Ndambuki, J. M. (2014). Sustainable living in Africa: Case of water, sanitation, air pollution & energy. *Sustainability*, *6*, 5187–5202.

Peter, O., Aezeden, M., Olufemi, A., & Elizabeth, O. (2019). Development and evaluation of fuel-less power generator. *International Journal of Innovation Technology and Exploring Engineering*,9(1),3559-3563. doi:10.35940/ijiteeL3122.119119

Sambo, A. S., Garba, B., Zarma, I, H., & Gaji, M. M. (2010). Electricity generation and the present challenges in the Nigerian power sector. *Energy Commission of Nigeria, Abuja-Nigeria*. https://www.researchgate.net/publication/228399732.

Uchegbulam, O., Opeh, R. N., & Atenaga, M. O. (2014). Assessment of power generation resources in Nigeria. *Journal of Applied Physics*,6(2), 44-50.

United State Agency for International Development (USAID). (2019). Power Africa in Nigeria Fact sheet. Retrieved September 1, 2021 from www.usaid.gov.ng.

International Renewable Energy Agency(IRENA). (2022). Renewable capacity Highlights. Retrieved July 14, 2022 from www.irena.org/publications.

The European Biomass Association (AEBIOM) (2017). Statistical – report. Retrieved July 10, 2022 from www.ibtc.bioenergyeurope.org/aebiom-2017-statistical-report

Table 1: Renewable Energy Resources and Estimated Reserves in Nigeria. **(**Source: Nwulu & Agboola, 2011)

S/N	Renewable Energy Sources	Estimated Power supply
1	Hydropower(Large/Small Scale)	14,750 MW
2	Solar Radiation	3.5 - 7.0 kWh/m^2/day
3	Wind	2 - 4 m/s at 10 m height
4	Biomass	144 million tons/year
5	Wave and Tidal Energy	150,000 TJ/year

Table 2: Geothermal installed capacity across the world in 2018

Countries	Installed capacity	Future projection
United state	3639MW	48MW
Indonesia	1948 MW	95 MW
Philippines	1,868 MW	_____
Turkey	1347 MW	_____
Mexico	951 MW	_____
Italy	944 MW	_____
Iceland	755 MW	45MW
Kenya	676 MW	_____
Japan	542 MW	_____
Other	925 MW	_____

Table 3: RE targets in Africa.

Country	RE targets	Target year
Cameroon	50% /80%	2015/2020
Cape Verde	50%	2020
Ghana	10%	2020
Madagascar	75%	2020
Mauritius	65%	2028
Niger	10%	2020
Nigeria	7%	2025
Rwanda	90%	2012

Source: (Awogbemi et al, 2015)

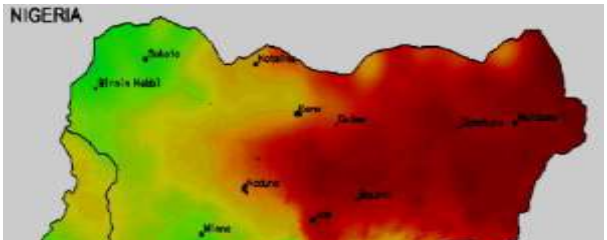

Figure 1. Solar radiation map of Nigeria (Awogbemi et al, 2015)