

## POTENTIALS OF RENEWABLE ENERGY IN EBONYI STATE, NIGERIA

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**ABSTRACT:** *Ebonyi State is one of the south east states in Nigeria and is highly endowed with enormous resources both renewable and non-renewable. It is currently known as the “Salt of the Nation” due to large salt deposits in the state. However the maximum solar irradiance in Ebonyi State is in the range 895.70 W/m<sup>2</sup> to 1043.83 W/m<sup>2</sup>. The generation rate of solid waste in the state capital is 9.580 x 10<sup>-3</sup>m<sup>3</sup>. These values indicate that the level of insolation and volume of biomass resources available in Ebonyi State can generate sufficient electricity for both her domestic and industrial use if properly harnessed in a sustainable manner. Despite these resources, Ebonyi State like other states in Nigeria still depends solely on fossil fuel for her electricity generation. The overdependence on fossil fuels has generated serious negative consequences on the environment, climate and on the health sector. Moreso, Ebonyi State has continued to suffer from epileptic power supply and this has almost crippled her economic, social and industrial activities. This study presents the current energy situation and the status of renewable energy technology and utilisation in Ebonyi State. It also highlights the potential benefits of renewable energy utilisation as a viable means of revitalising, restructuring and diversifying her energy source for sustainable growth and development in the State. The prospects and challenges of renewable energy technology are also discussed, and finally propose the way forward.*

**KEYWORDS:** Biomass Energy, Ebonyi State, Insolation, Renewable Energy.

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### INTRODUCTION

Ebonyi State is located at longitude 6°25'N and latitude 8°08'E ([www.distancefrom.com/ng/Ebonyi-State](http://www.distancefrom.com/ng/Ebonyi-State)). It has a population of 2,176,947 based on the 2006 census (National Population Commission, 2006, National Bureau of Statistics, 2010) and a land mass of 5533 km<sup>2</sup> (Wikipedia.org). Ebonyi State is popularly noted for rice production in Nigeria. The major minerals in the State includes large salt deposit (at Enyigba in Abakaliki local government area, Okposi and Uburu Salt lakes at Ohaozara local government areas), solid minerals such as lead, zinc ore, crude oil and natural gas amongst others. The potentials of solar energy

(Nwankwo et al, 2011) and the generation rate of solid wastes in Abakaliki metropolis (Nwofe, 2013) has been reported in the literature. Ebonyi state is known for agriculture especially in large scale production of rice, yam, cassava, potatoes and maize. Agricultural residues generates significant amount of wastes and is not currently utilised for energy generation but are rather disposed in a very crude and primitive methods. Other research groups has reported on this concept in Ebonyi State (Anikwe and Nwobodo, 2002; Etu at al, 2013; Nwakpu and Osakwe, 2007; Ogbodo, 2009, 2011; Okeh et al, 2014). Studies by Ngumah et. al., (2103) noted that Nigeria generates about 542.5 million tons of organic waste which has the potential of yielding about 25.53 billion m<sup>3</sup> of biogas (about 169 541.66 MWh) and 88.19 million tons of biofertilizer, with an estimated revenue generation of about N4.54 trillion (\$29.29 billion) from both ventures. Wind energy is relatively available especially in the harmattan periods (November – March) but currently, there are limited reports in the literature on the potentials of wind energy in Ebonyi State. Also the potentials of geothermal energy is yet to be established in the state either due to limited research centres in south-east Nigeria or to insensitivity of most State Governments in Nigeria to research and development (R&D). Research done by Kela et al (2012) indicates that Ebonyi State has 5 potential sites for small hydropower generation with a cumulative power estimates of 3000 MW per site. Ezemonye and Ezeribe (2013) also highlighted the potentials of small hydropower for energy generation in the State. Ubani et al (2013) investigated electricity consumption in all the five South East States of Nigeria: Abia, Anambra, Ebonyi, Enugu and Imo States and noted that electricity consumption in this region was strongly and significantly influenced by eleven socio-economic and physical features such as; internally generated revenue per state, urbanisation, population per state, total land area per state (km<sup>2</sup>), number of households, number of households with electricity, number of major commercial banks, population density per State, number of major markets, number of major manufacturing firms (industries) and the distance to nearest power stations. The irregular power supply in Ebonyi state has been a persistent battle between customers and the energy suppliers. This is evident in the most recent tussle between the major energy supplier EEDC (Enugu Energy Distribution Company) and Ebonyi youths on the epileptic nature of the energy supply coupled with the deliberate issuance of inflated bills to customers ([www.nigerianews24.com/articles/irregular-power-supply-ebonyi-youths](http://www.nigerianews24.com/articles/irregular-power-supply-ebonyi-youths)).

This has also attracted the attention of the Ebonyi State House of Assembly, to the extent that they adopted the motion (on irregular power supply and indiscriminate billing by EEDC) as a matter of urgent public importance, urging the EEDC to stop the fraudulent system of billing and improve on power supply in the State. They (Ebonyi State House of Assembly) further directed EEDC to distribute pre-paid meter and to desist from exploitation of the State through reckless billing system despite the irregular power supply in Ebonyi State (<http://sunnewsonline.com/new/?p=79614>). This points to the urgent need for the State to diversify/explore other sources of energy generation to save her citizens from such impasse.

This paper aims to identify/discuss;

- (i) sources of renewable energy in Ebonyi State,
- (ii) utilisation of renewable energy in Ebonyi State
- (iii) factors that affects large scale utilisation of these resources, and
- (iv) recommend possible solutions.

## SOURCES OF RENEWABLE ENERGY IN EBONYI STATE

The sources of renewable energy in Ebonyi State include; solar energy, biomass energy, hydropower, and wind energy. Ebonyi State is amongst the south-east states and is located in the derived savanna region (Akinsami, 1999) with typically two seasons (wet and dry). It has 13 Local Government areas and each local government is richly blessed with natural resources (renewable and non-renewable energy resources). Figure 1 shows the location of Ebonyi State in Nigeria while Figure 2 show the map of Ebonyi State and the respective local governments (shown in black highlights).



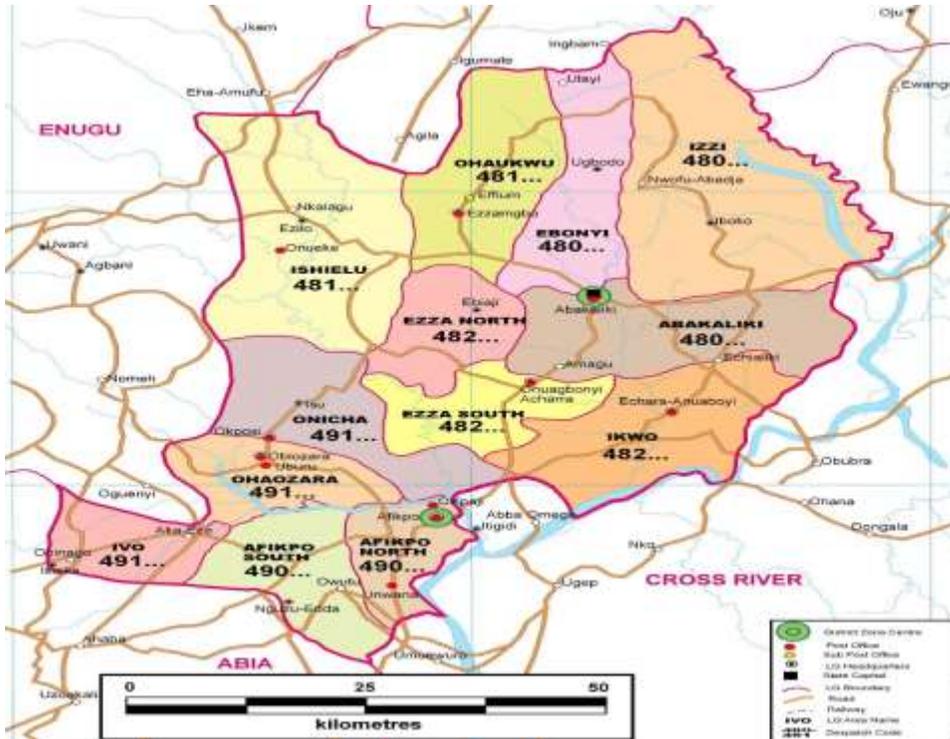
Figure 1. Map of Nigeria indicating Ebonyi State. ([www.ebonyionline.com](http://www.ebonyionline.com))

Figure 2. Map of Ebonyi State with her respective local governments.

Source: ([https://www.google.com.ng/search?q=detailed+map+of+ebonyi+state&es\\_sm](https://www.google.com.ng/search?q=detailed+map+of+ebonyi+state&es_sm))

## SOLAR ENERGY

Solar energy refers to the energy that comes from the sun. The abundance of solar radiation in Ebonyi State has been established (Nwankwo et al, 2011). Solar energy is currently utilised in Ebonyi State mostly by farmers for open sun drying of their agricultural products. Modern technological applications of solar energy such as large scale domestic hot water system, solar pumps, solar powered bore-holes, and use of solar fridges in hospitals are still unknown in the State while use of solar cells as building integrated photovoltaics (BIPV) is still at a very low scale. Infact the number of buildings lucky to have few solar panels on its roof is still less than fifty in the whole State. Other solar energy applications such as solar cameras for traffic control, weather monitoring, solar fans, solar clock, and modern applications of solar energy in agriculture (solar brooder, solar incubators, solar dryers, solar cooker, and solar still) are yet to be introduced in Ebonyi State.

## **BIOMASS ENERGY**

Biomass energy is abundant in Ebonyi State. However just like any other State in Nigeria, the biomass resources are mostly utilised as woodfuels for domestic purpose and in local industries. It is a common knowledge that the associated harmful environmental, health and social effects with the use of traditional biomass (wood fuel) and fossil fuels has enhanced the global growing interest in the search for alternate cleaner source of energy. Nigeria depends heavily on woodfuel as a source of fuel for most of her domestic energy needs, contributing over 50% of the primary energy supply with crude oil and hydro-power constituting the remainder (Omakaro, 2008; Nwofe, 2014). Biogas generation is commonly obtained through anaerobic digestion of organic waste under certain conditions. Biogas has been proven to be a practicable and promising technology which has the potentials of generating clean energy on a large scale. The use of biomass materials to generate biogas on a large scale is still yet to be available in the State.

Waste is abundant in Ebonyi State. This has been reported in the literature (Nwofe, 2013; Nnabude and Mbagwu, 2001; Akamu and Shridah, 2002; Welsh, 1966). One of the major source of waste in Ebonyi State is the rice husk hills in Abakaliki rice mill industry and in other rice mills that are strategically located at various parts of the state. Figure 3 gives a picture of a typical rice husk hill in Abakaliki Rice Mill industry. These mountains of waste are currently not being utilised in a sustainable manner. It is only the poor locals that scavenge those hills for survival by looking for remnants of rice in the husk hills (Figure 3) or for cooking fuels (on a very low scale). Municipal solid waste is also common in the State. These wastes are heaped at both government designated waste dumping sites and on undesignated sites within the metropolis. These wastes are poorly managed as there is no waste to energy industry in the State. A typical municipal waste dumping ground is shown in Figure 4. Management of wastes in Nigeria is mostly done in a very crude and primitive manner as noted by various research groups in the literature (Amoo and Fangbale, 2013; Elom, 2013; Nwulu and Agboola, 2011; Nwofe, 2013; Nwofe, 2014; Ogbonna, 2011; Olorutunde et al, 2013).

## **UTILIZATION OF RENEWABLE ENERGY IN EBONYI STATE**

The utilisation of renewable energy in Ebonyi State is still done either at a very low scale or by primitive methods. Some research groups have recently established the potentials of the rice husk hills in Abakaliki rice mill industry for generating biogas for domestic and industrial applications, and even for export if expanded on a large scale (Okeh et al, 2014; Akinbami and Momodu, 2012). Utilisation of these waste for biogas production will help to reduce the over reliance on woodfuel and fossil fuel for domestic energy needs, leading to a reduction in environmental pollution, greenhouse gas emissions and consequently climate change. The exploitation of the hydropower resources has not quite received a wide attention both in research and applications while solar energy is only consumed at a low scale especially in the agricultural sector where it is utilised for crop drying purposes. Use of building integrated photovoltaics has currently penetrated the State but the consumption rate is very negligible compared to the population of the State probably due to it high cost or other factors.



Figure 3. Picture of rice husk hills in Abakaliki rice mill industry.



Figure 4. Picture of a municipal solid wastes in Abakaliki metropolis.

## **FACTORS THAT AFFECTS LARGE SCALE UTILIZATION OF RENEWABLE ENERGY IN EBONYI STATE**

**Poverty-** Poverty is one of the fundamental issues hampering large scale utilisation of renewable energy resources in Ebonyi State. It is a common knowledge that the initial cost of installation of most renewable energy technologies such as solar PV devices and biogas technology is very high. The poverty rate in Ebonyi State is about 73.6% (WWW.Vanguard, 2013). With such staggering rate of poverty, it is glaringly clear that only very few individuals can afford to install PV devices, solar water heaters or other solar powered devices in their homes. Also a biogas plant that will generate enough biogas for the domestic energy need of an average family of five occupants will not be easily affordable. However, it is pertinent to note that the benefits of renewable energy technologies far outweighs other source of energy due to its shorter payback times, and clean and sustainable energy supply (Ramakrishna Reddy et al, 2006, Nwofe, 2013).

**Awareness-** Lack of awareness plays a major role in the setbacks on the utilisation of renewable energy. There is need for more awareness on the merits of using renewable energy technologies. Most people are not aware that the high initial cost can easily be offset by the short payback times and very long life cycle of the renewable energy devices. Solar energy is a free and non-depletable resource which produces clean electricity that is environmentally safe. Awareness on the advantages of these huge natural renewable resources can be made through the media, schools, mobile networks, social networks and other related institutions.

**Lack of Manpower-** There is need for more manpower training in renewable energy in the state. This will involve experts from the University and hiring of technical experts from the industries to help train the locals in fabrication and installation of renewable energy related products.

**Government insensitivity-** Lack of Government attention to the exploitation and use of renewable energy is another significant factor. Ebonyi State government is more committed to harnessing of solid minerals probably due to the quick gains associated to it or lack of advice to Government by experts in the renewable energy sector. It could also be due to the unreadiness of Government to embark on long-term sustainable projects.

## **CONCLUSIONS AND THE WAY FORWARD**

Renewable energy utilisation is a fundamental step to achieving energy availability and sustainability. Irregular power supply in Ebonyi State is a serious issue. The federal government of Nigeria under the leadership of Dr Goodluck Ebele Jonathan has made bold steps in a bid to overcome the shortfall in the electrical energy demand in Nigeria by decentralising the power sources and also encouraging independent energy providers. Projects aimed at power generation

to feed the national grid using renewable energy sources such as wind farms, solar PV and biofuels are also in progress. Waste to energy is yet to be utilised in Ebonyi State. However, Lagos State is currently generating significant amount of power from waste (Tobore, 2012) and waste to energy potentials in other states has been established (Popoola et al, 2013). Ebonyi State should strive to overcome her power challenges by opening up the renewable energy sources such as; waste to energy as currently practiced in Lagos State, solar PV farms, extensive biofuels industry, and also pay reasonable attention to R&D in renewable energy technology for increased manpower in the State. Government should also provide soft loans to people to enable them have more access to renewable energy related products. Involvement of non-governmental organisation (NGO) will also boost more financial access to Ebonyi State indigenes, and thus give room to increased consumption/development of renewable energy related products. This will go a long way in alleviating the suffering of Ebonyians in the power sector.

## REFERENCES

- Anikwe, M. A. N., and Nwobodo, K. C. A. (2002). Long term effect of municipal waste disposal on soil properties and productivity of sites used for urban agriculture in Abakaliki, Nigeria. *Bioresource Technology*, 83(3), 241-250.
- Akanmu, I. Y., and Shridha, M. K. C. (2002). Management of rice mill waste in Abakaliki, Ebonyi State, Nigeria (Doctoral dissertation, M. Sc. Dissertation).
- Amoo, O.M., and Fangbale, R.L., (2013). Renewable municipal solid waste pathways for energy generation and sustainable development in the Nigerian context. *International Journal of Energy and Environmental Engineering*. 4(42), 1-17.
- Akinbami, J. F., and Momodu, A. S. (2012). Electrical energy production pathway for sustainable development in Nigeria: a case study of energy recovery from agro-forestry wastes. *International Journal of Sustainable Energy*, 31(3), 155-173.
- Akinsami, O. (1999). *Senior Secondary Agricultural Science*, Longman Publishers, Malaysia.
- Ettu, L. O., Ibearugbulem, O. M., Anya, U. C., Nwachukwu, K. C., and Awodiji, C. T. G. (2013). Strength of Blended Cement Soilcrete Containing Afikpo Rice Husk Ash and Saw Dust Ash. *International Journal of Engineering Research and Development*, 52-57.
- Ezemonye, M. N., and Emeribe, C. N. (2013). Appraisal of the Hydrological Potential of Ungauged Basin Using Morphometric Parameters. *Ethiopian Journal of Environmental Studies and Management*, 6(4), 376-380.
- Elom, N. I., (2013). Healthcare solid wastes management protocols in Nigeria and implications for human health risk – A review. *Continental J. Environmental Sciences*, 7(1), 11.
- <http://www.distancesfrom.com/ng/EBONYI-STATE-latitude-longitude-EBONYI-STATE-latitude-EBONYI-STATE-longitude/LatLongHistory/891025.aspx>. Accessed October 6, 2014.
- [http://en.wikipedia.org/wiki/Ebonyi\\_State](http://en.wikipedia.org/wiki/Ebonyi_State). Accessed August 29, 2014.
- <http://www.nigerianews24.com/articles/irregular-power-supply-ebonyi-youths-give-eeedc-ultimatum-as-lawmakers-pass-nigerian-tribune>. Accessed October 3, 2014.

<http://sunnewsonline.com/new/?p=79614> . Accessed October 3, 2014.

<http://www.ebonyionline.com/about-ebonyi-state/> . Accessed October 4, 2014.

<http://www.vanguardngr.com/2013/01/sokoto-is-poorest-state-nbs/> ( Accessed October 6, 2014)

- Kela, R., Usman, K. M., and Tijjani, A., (2012). Potentials of Small Hydro Power in Nigeria: The Current Status and Investment Opportunities. *Natural gas*, 9(12.0), 17-03.
- National Population Commission, (2006). Office of the National Population Commission, Abakaliki, Ebonyi State.
- National Bureau of Statistics, NBS (2010). Annual Abstracts of Statistics, Federal Republic of Nigeria. 1 - 611.
- Nwankwo, S.N., Nnabuchi, M.N., and Ekpe, J.E., (2012). Construction and Characterisation of a pyranometer using locally available materials for global solar radiation measurements, *Asian Transactions on Basic and Applied Sciences*. 2(4), 26.
- Nwofe, P.A., (2013). Determination of the Generation rate of solid waste in Abakaliki Metropolis, Ebonyi State, Nigeria. *Continental J. Environmental Sciences*. 7(2), 1-3.
- Nwakpu, P. E., and Osakwe, I. I. (2007). Trends in volume and magnitude of foetal waste of slaughter Animals (2000–2005) in Ebonyi State of Nigeria. *Research Journal of Animal Science*, 1(1), 30-35.
- Ngumah, C.C., Ogbulie, J.N., Orji, J.C., and Amadi, E.S., (2013). Biogas potential of organic waste in Nigeria. *Journal of Urban and Environmental Engineering*. 7(1), 110.
- Nwofe, P. A. (2014). Utilization of Solar And Biomass Energy-A Panacea to Energy Sustainability In A Developing Economy. *International Journal of Energy and Environmental Research-ea Journals.org.*, 2(3), 10-19.
- Nwulua, N. I., and Agboola, O. P. (2011). Utilizing renewable energy resources to solve Nigeria's electricity generation problem. *International Journal of Thermal & Environmental Engineering*, 3(1), 15-20.
- Nwofe, P. A. (2014). Potentials of Renewable Energy in a Developing Economy. *International Journal of Advanced Research*, 2(9), 334-342.
- Nwofe, P. A. (2014). Need for Energy Efficient Buildings in Nigeria. *International Journal of Energy and Environmental Research-ea Journals.org.*, 2(3), 1-9.
- Nnabude, P. C., and Mbagwu, J. S. (2001). Physico-chemical properties and productivity of a Nigerian Typic-Haplustult amended with fresh and burnt rice-mill wastes. *Bioresource technology*, 76(3), 265-272.
- Nwofe, P.A. (2013). Comparative analysis of domestic energy use in Nigeria – A review. *Continental J. Renewable Energy* 4(1), 7-17.
- Nwofe, P.A. (2014). Waste Resources and Climate Change: Implications and Mitigation. *International Journal of Science and Research* 3(9), 1602-1606.
- Nwofe, P.A., (2013). Waste management and environmental sustainability: A case study of selected cities in Ebonyi State, *Continental J. Environmental Sciences*. 7 (1), 20-28.
- Nwofe, P. (2013). Deposition and Characterisation of SnS Thin Films for Application in

- Photovoltaic Solar Cell Devices (Doctoral dissertation, Northumbria University).
- Ogbodo, E. N. (2009). Effect of crop residue on soil chemical properties and rice yields on an ultisol at Abakaliki, Southeastern Nigeria. *Am Eurasian J Sustain Agric*, 3(3), 442-447.
- Ogbodo, E. N. (2011). Effect of crop residue on soil chemical properties and rice yield on an Ultisol at Abakaliki, Southeastern Nigeria. *World Journal of Agricultural Sciences*, 7(1), 13-18.
- Okeh, O. C., Onwosi, C. O., and Odibo, F. J. C. (2014). Biogas production from rice husks generated from various rice mills in Ebonyi State, Nigeria. *Renewable Energy*, 62, 204-208.
- Omokaro, O. (2008). Energy Development in a Fossil Fuel Economy: The Nigerian Experience. *National Dialogue to Promote Renewable Energy and Energy Efficiency in Nigeria*.
- Olorutande, A.J., Adeoye, P.A., and Alao, F., (2013). Municipal solid wastes collection and management strategies in Akure, South-Western Nigeria. *Caspian Journal of Environmental Sciences*. 11(1), 1.
- Ogbonna, D.N., (2011). Characteristics and waste management practices of medical wastes in healthcare institutions in Port Harcourt, Nigeria. *Journal of Soil Science and Environmental Science*. 2, 132.
- Popoola, L. T., Gutti, B., Adeniran, J. A., and Adeoye, B. K. (2013). The potentials of waste-to-energy system in Nigeria: A study of pyrolysis conversion of wood residue to bio-oil in major cities of south-western Nigeria. *Advances in Applied Science Research*, 4(2), 243-251.
- Ramakrishina Reddy, K.T., Reddy, N.K, and Miles, R.W. (2006). Photovoltaic properties of SnS based solar cells. *Solar Energy Mat. & Solar Cells* 90, 3041-3046.
- Tobore, I.E. (2012). Solid waste management in Nigeria. WASTE™. <http://www.d-waste.com/new-infographics/item/124-solid-waste-management-in-nigeria.html>. Accessed October 7, 2014.
- Ubani, O. J., Umeh, L., and Ugwu, L. N. (2013). Analysis of the Electricity Consumption in the South-East Geopolitical Region of Nigeria. *Journal of Energy Technologies and Policy*, 3(1), 20-31.
- Welsch, D. E. (1966). RICE MARKETING IN EASTERN NIGERIA.