



International Journal of Sustainable Energy and Environmental Research

journal homepage: <http://pakinsight.com/?ic=journal&journal=13>



SUSTAINABLE SOURCES OF ENERGY AND THE EXPECTED BENEFITS TO NIGERIAN ECONOMY

Anowor Oluchukwu F.

Department of Economics, Faculty of Social Sciences, University of Port Harcourt, Nigeria

Achukwu Innocent I.

Department of Electrical/Electronic Engineering, University of Port Harcourt, Nigeria

Ezekwem Ogochukwu S.

Department of Economics, Faculty of Social Sciences, University of Port Harcourt, Nigeria

ABSTRACT

Sustainable development entails conservation, preservation, accessibility and affordability. When it comes to energy usage, Nigeria relies mostly on conventional source of energy with quite high opportunity cost making it cost-wise comparatively inaccessible for the poor population. In this work, renewable energy sources like solar radiation which is abundantly present in Nigeria was found to offers a much cheaper alternative in meeting the energy demands since they are derived from natural processes that are replenished constantly. Reviews on the opportunities, government policies and strategic developments of renewable energy in Nigeria were carried out to ascertain its feasibility. From the results, it was possible to highlight how these energy sources can be beneficial in tackling the energy problem in Nigeria.

© 2014 Pak Publishing Group. All Rights Reserved.

Keywords: Conventional, Renewable, Energy, Sustainable development, Energy demand, Deforestation, Afforestation.

Contribution/Originality

There are several works abounding on renewable energy especially in Nigeria but none has focused on the sustainable energy and its expected benefits on the economy. This work is a wake-up call for structural reform in the energy sector in Nigeria to critically examine renewable sources of energy especially its impact on economic growth. This study we hope will help policy makers and government to know the structural changes that have taken place within the reform policies on ground in Nigeria. It will also provide useful information that will be relevant in formulating a more targeted reform policy that will be beneficial to both domestic and foreign investors. More over, this study would be a further addition to the literature already existing.

1. INTRODUCTION

Energy is constantly needed for the production of goods and services in order to steer the economy towards desirable directions. The demand for energy today is far greater in this highly technological society (Abiodun, 2012). The campaign for using renewable energy resources is becoming stronger today because of the finite nature of fossil fuel energy resources as well as the greenhouse gases emission which many scientists believe cause global warming and other forms of undesirable externalities. In response to global demand for applications of renewable energy resources to ensure sustainable economic growth and development, the Energy Commission of Nigeria (ECN) was established in 1979. The Energy Commission now has six centers spread across the country. These research centers have mandate to conduct researches and develop renewable and sustainable energy technologies as well as to popularize the applications of sustainable energy resources.

It has been so disturbing among analysts as well as scholars that Nigeria claiming the giant of Africa and attested as the most populous Black Country in Sub-Saharan Africa and nearly one quarter of Sub-Sahara Africa's population has not been able to meet her energy demand despite significant availabilities of natural and human resources that holds the potential for a super economy. Energy demand in Nigeria for both industrial and domestic usage has persistently continued to increase even as the supply is on a steady decline. An estimated 60-70 percent of the Nigerian population does not have access to electricity (Usman, 2009), which also means that they have little access to information since modern form of communication depends largely on energy from electricity. The common energy demand in the rural areas is energy for heating which is sourced from fuel-wood as Nigerians living in the rural areas depends mostly on fuel-wood.

Nigeria consumes over 50 million metric tonnes of fuel-wood annually; a rate which exceeds the replenishment rate through various afforestation programmes (Sambo, 2006). Fuel-wood energy is an energy source gotten from the combustion of wood. Using this kind of energy source has been the major cause of desertification in some states and erosion in the southern part of Nigeria. Deforestation has been a worrisome issue estimated to be about 350,000 hectares (which is equivalent to three point six per cent) per year of the present area of forests and woodlands, whereas reforestation is only at about 10% of the deforestation rate (Sambo, 2006). Moreover given the fact that petroleum products such as kerosene and petrol are purchased in the rural areas at higher prices in excess of their market prices, the people most times are left with tight option to rely heavily on fuel-wood so as to meet with the daily energy needs. Moreover, the use of the petroleum products and other forms of energy sources, as alternatives to fuel-wood, that are non-renewable never assure sustainability since they cannot be replenished; and even if they are, the rates at which they are replenished are slower than that of their usage. The challenges mentioned above informed the need to evaluate the expected benefits which can be derived from seeking alternative renewable sources of energy that can ensure sustainable growth and development; thus the objective of this study.

2. CONVENTIONAL SOURCES OF ENERGY

Over 85% of the energy used in Nigeria is from conventional supplies. Most developed nations are dependent on conventional energy sources such as fossil fuels (coal and petroleum oil). These are typical of non-renewable sources of energy because they cannot be regenerated or renewed or even replenished quickly enough to keep pace with their usage. It is an undeniable fact that industrialized societies depend heavily on non-renewable energy sources. Fossil fuels are prominent among the most commonly used types of non-renewable energy. The three main types of fossil fuels are coal, crude oil, and natural gas.

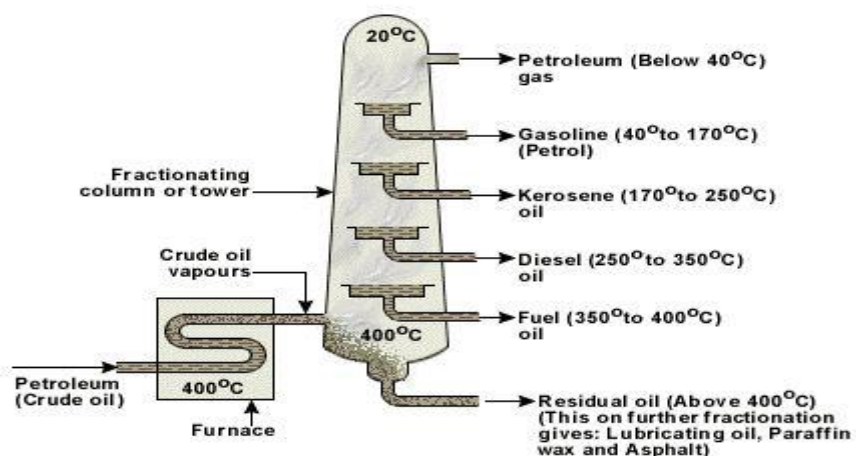
(i) Coal

Coal, as observed by many, is the most abundant fossil fuel in the world with an estimated reserve of one trillion metric tonnes. Differences in the pressure as well as temperature that prevailed during formation brought about different types of coal. Lignite is the softest coal (about 50% carbon), which also has the lowest energy output. Lignite is transformed into bituminous coal (which is about 85 per cent carbon content and three per cent water) as a result of persistent increase in temperature and pressure. The hardest type of coal (almost 100% carbon) is anthracite and it also produces the greatest energy when burned. Sulfur dioxide, which is a pollutant, is released into the atmosphere whenever coal is burned. In the less developed countries and in some rural areas of developed countries, coal is used for heating and cooking; also it is used to produce electricity. The coal reserves in Nigeria are estimated to be in excess of two point five (2.5) billion tonnes (Sambo, 2009)

(ii) Crude/Petroleum Oil

Crude oil, sometimes called liquid petroleum, is a fossil fuel that is refined into many different energy products like petrol, diesel, kerosene, motor oil, etc. Besides its use as a source of energy, crude oil also provides base material for plastics, provides asphalt for roads and is a source of industrial chemicals. Despite its limited supply, crude oil is a relatively inexpensive fuel source. It is preferred, given to less opportunity cost, fuel source over coal. For instance, an equivalent amount of crude oil produces more kilowatts of energy than coal. Crude petroleum also burns cleaner, producing about 50 percent less sulfur dioxide than coal. Crude oil, however, does cause environmental problems like most conventional energy sources. The burning of crude oil releases atmospheric pollutants such as sulfur dioxide, nitrogen oxides, carbon dioxide and carbon monoxide. These gases are not environmentally friendly because they are smog-precursors that pollute the air and greenhouse gases that contribute to global warming and also inhibit sustainable development.

Figure-1. Fractional Distillation of Crude Oil



(iii) Liquefied (Natural) Gas

Natural gas production is often a by-product of crude oil recovery, as both commonly share underground reservoirs. After recovery, propane and butane are removed from the natural gas and made into liquefied natural gas (LNG). LNG is shipped in special pressurized tanks as a fuel source for areas not directly served by natural gas pipelines. Natural gas is refined severally to remove impurities and water vapor, and then transported in pressurized pipelines. Certainly the use of natural gas is growing rapidly as the day goes. Besides being a clean burning fuel source, the primary rationale for this is that natural gas is easy and inexpensive to transport once pipelines are in place. In developed countries, natural gas is commonly used primarily for heating, cooking, and powering machines and vehicles. It is also used in a process for making ammonia fertilizer for farming purposes.

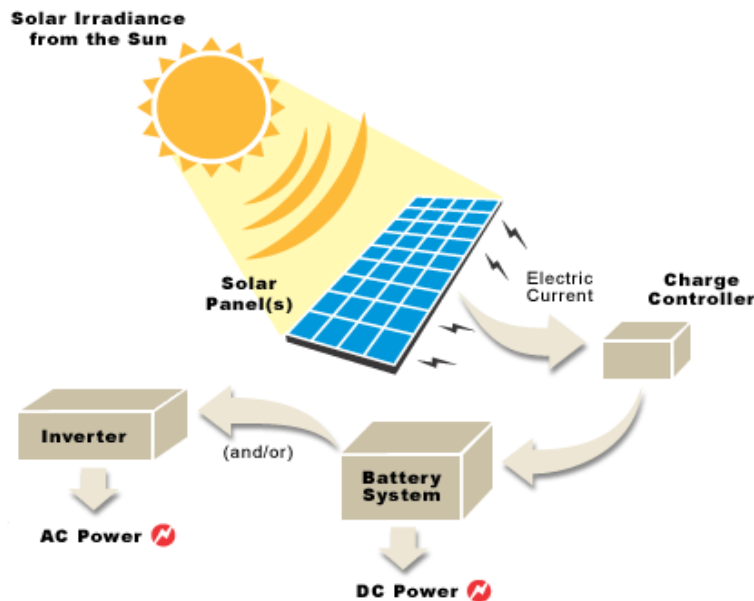
2.1. RENEWABLE/ SUSTAINABLE SOURCES OF ENERGY

Renewable energy sources are also called non-conventional energy sources that are continuously replenished by natural processes. For example, Solar energy, Wind energy, Biomass energy, Hydro energy, Geothermal, Wave and Tidal energy etc., are typical examples of renewable sources of energy.

(i) Solar Source of Energy

Solar energy or power is the energy derived from the sun radiations. Solar energy can be utilized in two different ways, as solar heat and solar electric (solar photovoltaic). Solar heat uses the sun's heat to produce hot water or air, cook food, drying materials etc ([Ilenikhena, 2010](#)). Solar photovoltaic (PV) uses sunlight to produce electricity for domestic and industrial uses such as: lighting, and powering electric appliances.

Figure-2. Solar Photovoltaic module



(ii) Wind Source of Energy

Wind Energy involves the utilization and conservation of air in motion to provide energy for power generation and for other useful purposes. Examples of wind energy are: wind turbines for power generations, winds mills used for mechanical power generation, wind pumps which are used for pumping water or drainage and sails which is used to power ships by propelling it.

Due to recent development in wind energy mostly in developed countries (especially in Europe) with desire to reduce environmental impacts of the convectional energy resources, there is a general growing interest in the wind energy development in Nigeria (Adaramola, 2011). Wind power is obviously not a new development as this power comes in the form of traditional windmills -for grinding corn, pumping water, sailing ships, etc., which have been in use for centuries. Today wind power is harnessed, with better technology, to generate electricity in a larger scale.

(iii) Hydro Source of Energy

Hydro energy is the use of gravitational force of falling or flowing water to generate electricity. The hydropower is the largest and most widely form of renewable energy sources that can be found commonly in almost every part of this world. Basically the hydropower plants are constructed and located in big dams that have high gravitational forces, the hydroelectric does not produce any waste directly or indirectly which make it to be considered the sources of energy that has lower level output of the greenhouse carbon dioxide (CO₂).

Nigerian's Hydro Potential is high and hydropower currently accounts for about 32% of the total installed commercial electric power capacity (Zarma, 2006). The hydro power was approximated to account for 20% of the world's electricity, and also 88% of the total electricity generated from renewable energy.

(iv) Biomass Source of Energy

Biomass is another renewable resource of energy derived from the carbonaceous waste of various human and natural activities. It can be derived from various sources which include the by-products from the wood industry, agricultural crops, raw material from the forest, household wastes etc. Biomass is certainly does not deplete the environment as it does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel. The major advantage of biomass is that it can be used to generate electricity with the same equipment that is now being used for burning fossil fuels hence guarantee sustainable development. It is an important source of energy and worldwide after coal, crude oil and natural gas the most important fuel.

In 2003, the Federal Government of Nigeria approved a National Energy Policy, which encourages the optimum utilization of the country's energy resources, including renewables, for sustainable national economic development with the active participation of the private sector (Sambo, 2011). The following policies as highlighted below are articulated for solar energy, biomass and wind:

- Solar Energy - The nation shall aggressively pursue the integration of solar energy into the nation's energy mix and the nation shall keep abreast with worldwide developments in solar energy technology.
- Biomass Energy - The nation shall effectively harness non-fuel-wood biomass energy resources and integrate them with other energy resources and the nation shall promote the use of efficient biomass conversion technologies.
- Wind - The nation shall commercially develop its wind energy resource and integrate this with other energy resource and the nation shall take necessary measures to ensure that this form of energy is harnessed at sustainable costs to both suppliers and consumers in the rural areas.

In 2007, a biofuel policy initiated by Nigerian National Petroleum Corporation (NNPC) was approved by the Federal Government. The policy articulates amongst other things, a seeding programme within which up to 10% mixture of ethanol in premium motor spirit and 20% of biodiesel in petro-diesel by volume are to be imported and used as automotive fuels in the country. Biofuel opportunities abound in Africa.

She stands as the platforms for the future of biofuel. More so, the mass developments of renewable energies markets in Africa is very important to her inhabitants in the areas of sustainable development (Olaniyi, 2007). Biofuel have been getting a lot of attention from Southern Africa to Western Africa in the past years. A lot of programmes had been initiated by various Africa countries' governments on biofuel development and deployments.

3. METHOD AND MATERIALS OF STUDY

The aim of this study is to gain a deeper understanding about the potential of renewable energy and investigate how to support, promote and courage its growth in Nigeria. Due to the nature and objective of the study, the qualitative research methods have been chosen. In the qualitative

approach which aims at answering questions from the public institution, email interviews were conducted. The case company chosen was Energy Commission of Nigeria.

The Energy commission of Nigeria (ECN) was established in 1979, with the mandate for planning and the co-ordination of policies affecting the national energy and its entire ramification. The commission is the highest government agency that is empowered to carry out the overall energy sector planning and policy implementation, promote the diversification of energy resources by developing and optimal utilization of all the alternative energy resources available in Nigeria which are Solar, Wind, Biomass and Hydropower. The head office of the commission is located in Abuja the Federal Capital of Nigeria.

4. RESULTS ANALYSES AND DISCUSSIONS

The data was collected by using qualitative research method. The results of the research are thus indicated below.

Table-1.Fossil Fuel and Nuclear Type Resources

S/N	Type of Resource	Quantity of Reserves		Level of Production	Domestic Utilization (In Natural units)
		Natural Units	Energy Unit (Btoe*)		
1	Crude Oil	36.22 billion barrels	5.03	2.5 million barrels per day	450,000 barrels per day
2	Natural Gas	187 Trillions SCF	4.19	6 billion SCF per day	3.4 billion SCF per day
3	Coal	2.175 billion tonnes	1.52	(insignificant)	(insignificant)
4	Tar Sands	31 billion barrels of equivalent	4.31	-	-
5	Nuclear	Not yet qualified	-	-	-

Table-2.Renewable Energy Resources

S/N	Resource Type	Reserves		Production	Domestic Utilization (Natural units)
		Natural Units	Energy Unit (Btoe*)		
1	Hydropower Large	11,240 MW	0.8 (over 40years)	1938 MW	1938 MW
2	Hydropower Small	3,500 MW	0.34 (over 40years)	30 MW	30 MW
3	Solar	3.5 – 7.0 KWh/m ² /day (4.2 million MWh per day using 0.1% Nigeria land area)	5.2 (40years and 0.1% Nigeria land area)	6MWh per day Solar PV	6MWh per day Solar PV
4	Wind	(2 - 4) m/s at 10m height (main land)	0.0003 (4m/s @ 12% speed)	-	-
5	Biomass	Fuelwood 11 million hectares of forest and woodland	-	0.120 million tones per day	0.120 million tones per day

Continue

Animal waste	211 million assorted animals	-	0.781 million tonnes of waste per day	Not available
Energy Crops and Agric residue	28.2 million hectares of Available land (30% of total land)	-	0.256 million tonnes of assorted crops per day	Not available

4.1. Use of Renewable Sources of Energy in Nigeria

From the results highlighted above, it can be clearly seen that Renewable Energy sources are quite abundant in Nigeria and also has a very promising future. Below are the various application of Renewable Energy sources in Nigeria.

Table-3.Application of Renewable Energy Sources

ENERGY TYPES				
S/N	Biomass Energy	Solar Energy	Hydro Energy	Wind Energy
1	Biomass Electricity	Solar Water pump	Hydro Electricity	Wind Electricity
2	Improved Woodstove	Solar Refrigerator	Hydro mills	Wind mills
3	Biogas Digesters	Solar Street Light	Hydro Pump	Wind Pump
4	Biodiesel	Solar Traffic Light	-	-
5	Bioethanol	Solar Water Heater	-	-
6	-	Solar Cooker	-	-
7	-	Solar Dryer	-	-
8	-	Solar Pasteurizers	-	-

Figure-3. Solar Cooker

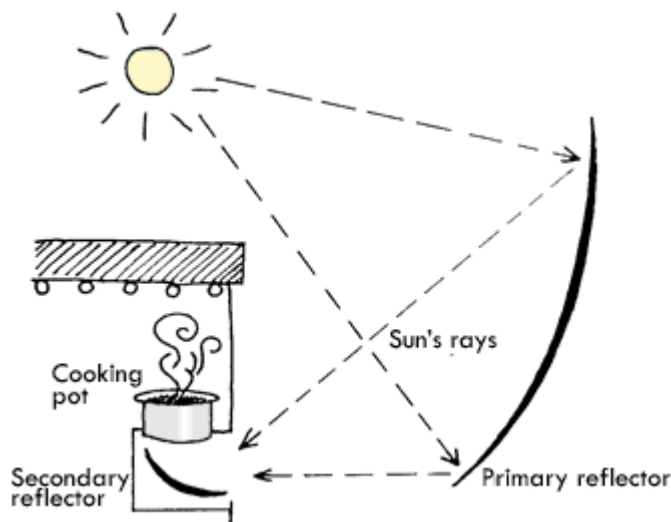
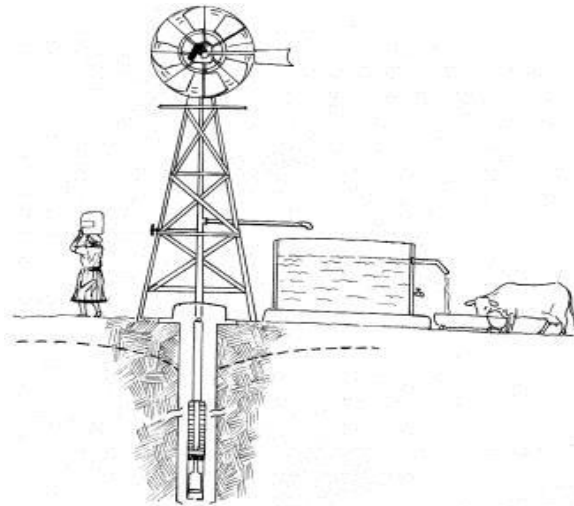


Figure-4. Wind Pump



5. BENEFITS OF RENEWABLE ENERGY SOURCES

In the interest of promoting a more secure, economic, and environmentally responsible energy future, the country must develop a Sustainable Renewable Master plan. The following benefits can be achieved by doing this:

- Working together and consciously towards reducing green house gases effects.
- Elimination of agricultural and household wastes that could be used for bio-fuel production.
- Ensuring that a clean smoke-free cooking fuel is provided.
- Adequate electrification of rural area and renewable alternatives to fossil fuel.
- Address the unsustainable actions associated with the problems of environmental degradation as a result of unwarranted pollution, deforestation, destruction of land and aquatic lives, and vegetation loss.

6. CHALLENGES OF ACHIEVING RENEWABLE ELECTRICITY IN NIGERIA

As promising as renewable energy can be to the economic development of Nigeria, there are some factors militating against expected optimum benefits. These include:

- Capacity Limitation - The technical expertise to develop, deploy and manage renewable energy is inadequate, and worst still, not relied upon in the country as expertise is often sourced from outside the country.
- Financial and Fiscal Incentives - Financial and fiscal incentives are not available to fast-track the development of the supply and demand sides of the renewable electricity market.
- Lack of Awareness - There is the general lack of awareness of the benefits of renewable electricity supply.
- Inadequate Resource Assessment - Reliable resource database to assist investment decisions for renewable electricity industry is absent.

- **Inadequate Institutional Framework** - With the mandate of the NERC limited to electricity plant capacities of 1MW and above, there is no agency to license smaller capacities that are often associated with renewable electricity.
- **Intermittency of Resource Availability** - All renewable resources for electricity generation are available intermittently and cyclic. The challenges of energy storage and system management during periods of lack of resource add to the complexity of the systems.
- **Zero Resource Cost** - Apart from bioelectricity, resource for renewable electricity is free. Even though this is an advantage for reducing the operating cost of renewable electricity systems, the challenge is to make renewable electricity systems overwhelmingly competitive.
- **High Initial Investment Cost** - renewable electricity systems have high initial cost. This has limited the penetration of the system into the electricity market.
- **Deregulated and Liberalized Energy Industry** - With the deregulation and liberalization of the energy sector in Nigeria, conducive atmosphere is created for appropriate tariffs on electricity services in the country. This opportunity would enable renewable electricity to be competitive in the market from the medium to long term.

7. CONCLUSION AND POLICY RECOMMENDATIONS

Renewable energy is considered a viable solution to the energy challenges of countries including Nigeria especially in the remote as well as rural areas and to the restrictions posed by inability to replenish when desired and the unacceptable rising cost of conventional or traditional sources of energy. National Energy Policy exists that encourages the exploitation of renewable energy resources and its integration into the nation's energy supply mix for sustainable national development, through private sector participation. A draft National Renewable Energy Master-plan (NREM) also exists to fast track renewable energy development in the country.

The way forward should include the immediate completion and approval of the National Energy Master-plan, Institutionalization of the National Energy Policy and the National Energy Master-plan through an Act of the National Assembly for economic sustainability, Establishment of a Renewable Energy Fund to serve as the instrument for the provision of financial incentives to local manufacturers, suppliers and users of renewable energy electricity, especially with reference to the rural areas and the enormous financial benefits now derived from the non deplete-able fossil resources need to be partly invested in the development of renewable energy electricity infrastructure in partnership with the private sector.

REFERENCES

- Abiodun, O., 2012. Review of renewable energy sources in Nigeria - security and challenges. *International Journal of Advanced Renewable Energy Research*.
- Adaramola, 2011. Wind speed distribution and characteristics in Nigeria. *ARNP Journal of Engineering and Applied Sciences*.
- Ilenikhena, P.A., 2010. Solar energy applications in Nigeria. *National Centre for Energy and Environment*.

- Olaniyi, A.K., 2007. Biofuels opportunities and development of renewable energies markets in Africa: A case of Nigeria. Centre for Jatropha Promotions & Biofuels (CEJAB).
- Sambo, A.S., 2006. Renewable energy electricity in Nigeria: The Way Forward, Energy Commission of Nigeria Abuja.
- Sambo, A.S., 2009. Prospects of coal for power generation in Nigeria. Energy Commission of Nigeria Abuja.
- Sambo, A.S., 2011. Renewable energy policy and plans in Nigeria. Energy Commission of Nigeria Abuja.
- Usman, M., 2009. Rural solar electrification in Nigeria: Renewable Energy Potentials and Distribution For Rural Development, Centre for Energy and Environment.
- Zarma, I.H., 2006. Hydro power resources in Nigeria. Energy Commission of Nigeria Abuja.

BIBLIOGRAPHY

- Onyema, M.C., 2010. Alternative energy sources for agricultural production and processing in Nigeria. International Food Policy Research Institute.