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## Exploitation of Renewable Energy Resources in Nigeria

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**Abstract** The ever-increasing Nigerian population has put more pressure on the limited energy supply from fossil fuels. The scenario has resulted in energy poverty and low capital development. It is essential to increase the energy supply to address the growing demand and maintain a clean and healthy environment. The study shows that Nigeria has abundant renewable energy resources (RES) potentials from photovoltaic solar energy to hydropower. The installation capacity of hydropower could be increased by 70% to 80% by the 2030s. Hence, the energy mix using RES could be greatly achieved if the government review, strengthen, and implement energy policies and involves the participation of public-private initiatives. Thus, increasing the support for financing RE infrastructures and improving energy supply.

**Keywords** Nigeria, Renewable energy resources, Energy poverty, Healthy environment

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### Introduction

An estimated 60-70% of the Nigerian population does not have access to electricity. Energy demand in Nigeria is dominated by fuelwood and women and children are the most affected in the energy crisis. The country has huge renewable energy (Solar, biogas, wind, hydro etc.) potentials because of its geophysical condition. [1] estimated the technical potential of solar energy in Nigeria with a 5% device conversion efficiency put at  $15.0 \times 10^{14}$  kJ of useful energy annually. This theoretical potential represents more energy striking the earth's surface in one and a half hours (480 EJ) than worldwide energy consumption in the year 2001 from all sources combined (430 EJ) [2].

However, energy from fossil fuel is non-renewable, depleting and major source of greenhouse emission which causes ozone layer depletion and leads to climate change. Population increase in Nigeria put pressure on demand energy at 28.4% annually [5]. The current global energy problem can be attributed to insufficient fossil fuel supplies and excessive greenhouse gas emissions resulting from increasing fossil fuel consumption [2, 3, 4, 5, 6]. Now carbon emission, greenhouse emissions are serious issues for environment pollution and climate change that have been forefront to the global community [3]. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly [1, 7, 8, 9].

Nigeria's population is increasing geometrically and this further put pressure on energy demand for socio-economic growth and development. If the growing population continues to depend on convectional energy; this will lead to overdependence on the non-renewable and depleting energy source which will not meet the demand and consequently increase the CO<sub>2</sub> emission and makes the environment highly unhealthy [2, 10, 11, 12]. The general objective of this paper focuses on the review of present energy situation of the nation with a view to



designing some techniques for exploring renewable energy into the Nigeria energy mix. Thus, increase the energy supply and improve the environmental quality due to low carbon emission rate.

### Nigeria energy situation and consumption

As a country's population grows and its economy expands its demand for electrical energy multiplies. If this demand is not met adequately a shortage in supply occurs. This shortage can assume crisis proportions [13]. According to Seccp [14] electric power as a major component in the requirements for effective industrialization and development is grossly inadequate in Nigeria. The Nigerian economy can be disaggregated into industry, transport, commercial, household, and agricultural sectors, with the household sector dominating energy consumption [15]. The energy consuming activities in the house-hold sector still remain mainly cooking, lighting, and operations of electrical appliances (i.e., non-substitutable electricity). It is still pertinent to note that our energy consumption is projected to grow geometrically while our ability to sustain our growth through energy generation, transmission and distribution continues to dwindle [16; 17; 18; 19]. Among the renewable sources, large hydropower all over the world plays an important role (approximately 80%) and contributes around 20% of the total energy generation [17]. But the use of hydropower is no longer increasing due to environmental limits throughout the world [18]. Hydropower is the largest (17%) renewable resource used for electricity generation. More than 150 countries are producing hydroelectricity by constructing dams [17; 18; 19].

Nigeria's primary energy consumption was about 108 Mtoe in 2011[13]. Most of the energy comes from traditional biomass and waste, which account for 83% of total primary consumption. The rest is from fossil fuels (16%) and hydropower (1%) [7]. Nigeria has oil reserves of about 35 billion barrels ( $5.6 \times 10^9 \text{ m}^3$ ) and gas reserves of about 5 trillion cubic metres, ranking 10th and 9th in the world, respectively. Global production in 2009 reached 29 billion barrels ( $4.6 \times 10^9 \text{ m}^3$ ) of oil and 3 trillion cubic meters of natural gas [1]. The energy capacity in Table 1 shows that Nigeria has strong energy potentials to meet the present and future energy demands, but the sector has not been fully developed as a result of weak energy policies, lack of political will and deep corruption.

**Table 1:** Energy balances for Nigeria in 2012 kilotonne of oil equivalent (ktoe) [6]

	Coal and peat	Crude oil	Oil products	Natural Gas	Hydro	Biofuels and waste	Total
Production	30	129,409	0	33,645	487	108,142	271,712
Imports	0	0	8,440	0	0	0	8440
Exports	0	-126,413	-755	-21,032	0	0	-148,201
International marine bunkers	0	0	-397	0	0	0	-397
International aviation bunkers	0	0	-186	0	0	0	-186
Stock changes	0	1830	538	0	0	0	2368
TPES*	30	4,825	7,640	12,613	487	108,142	133,736
Total Primary Energy Supply							
TPES (%)	0.02%	3.61%	5.71%	9.43%	0.36%	80.86%	100.00%

Nigeria is endowed with convectional and renewable energy potentials. Despite the huge energy resources, the country is very far from meeting the energy demand of her populace. The increase in population of Nigeria put high pressure on energy demand for socio-economic development. Population is a major driver of energy demand while its most important determinant is the level of economic activity and its structure measured by total Gross Domestic Product (GDP) alongside with its shares by various sectors and sub-sectors of the economy [8]. At present, the nominal electricity generating capacity in Nigeria is less than 6000MW. The actual capacity is about half of the installed capacity [10]. Fig. 1a and 1b show the energy consumption and production in Nigeria in 2011. All renewables combined accounted for only 19% share of electricity production in the world, with hydroelectric power providing almost 90% of it as shown in Fig.1c [10]. Therefore, substituting

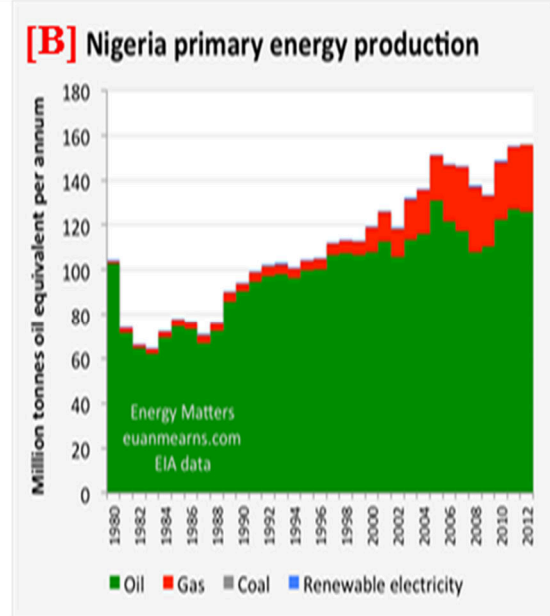
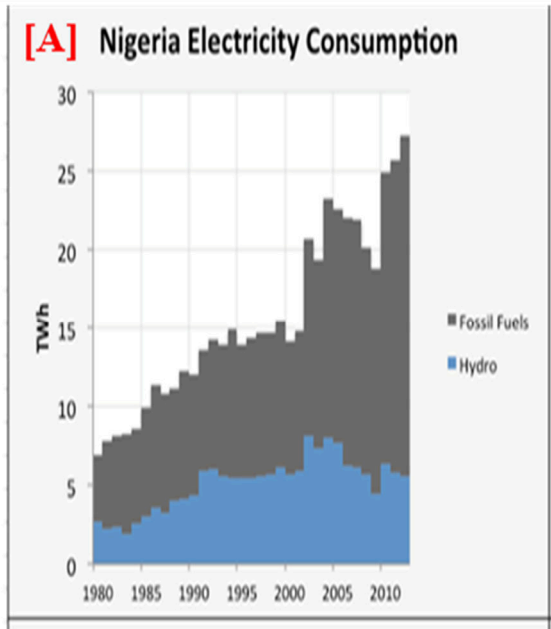


fossil fuels with renewables for electricity generation must be important part of any strategy of reducing CO<sub>2</sub> emissions into the atmosphere and combating global climate change.

Wijeratu *et al.* [20] indicated that Nigeria had a 12,500 MW installed energy capacity with 3900 MW and 3100 available and supplied. Akuru *et al.* [21] revealed that the total installation capacity increased by 15.04% in 2017 relative to the 2015 installation capacity. Despite Nigeria's huge power challenge, the nation still supplies regular and interrupted power supply to countries such as the Republic of Benin and Nigeria based on agreed terms and agreements. Ojo *et al.* [22] reported that the sole dependency of Nigeria on fossil energy indicates a bottleneck to renewable energy policy formation and implementation. It was indicated increasing global awareness toward the adoption of RES in more than 173 nations. Thus, some sets of policies and strategies act as a working document on RE policies involving South Africa, UK, and Nigeria as summarized in Table 2. Shortage of energy supply is mainly due to the overdependence on fossil fuels. Therefore, it is significant to bridge the gap of insufficient energy supply through the introduction and adoption of RE resources.

**Table 2:** Drivers and challenges for RE

Factor	Country	Drivers	Challenges
	Nigeria	Internal policies and treaties on RE. Prominent Nigeria Energy Policies and Strategies: Inadequate or weak policies Uncertainty and ambiguity regarding procurement regulations. - Renewable Electricity Action Programme - Nigerian Biofuel Policy and Incentives  - Renewable Energy Master Plan (REMP) 2005 and 2012 Political instability and low political interest in RE	Market entry (Crude oil-based power plants).  Inconsistency in political support at the federal, state and local government  Economic challenges – Crude oildependent economy. Bureaucratic challenges . - Sustainable Energy for all Action Agenda  Ensuing RE market and renewable industry



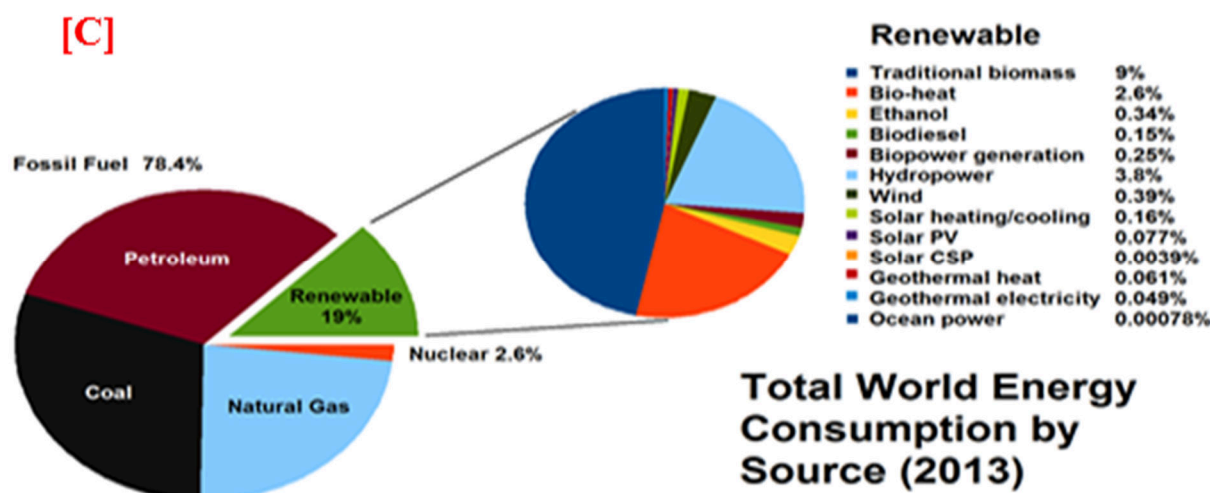


Figure 1: Nigeria primary energy production (a), United States- Electricity from non-hydro-renewables (b), and Share of total world renewable energy (c). Sources [16, 18].

### Renewable energy and its applications in Nigeria

Renewable energy is energy that comes from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy replaces conventional fuels in four distinct areas: electricity generation, air and water heating/cooling, motor fuels, and rural (off-grid) energy services. Renewable energy is one of the means of tackling the global challenges of climate change [16]. Nigeria faces serious energy crisis due to declining electricity generation from domestic power plants which are basically dilapidated, obsolete, and unreliable and in an appalling state of disrepair, reflecting the poor maintenance culture in the country and gross inefficiency of the public utility provider [18]. The recent rapid rise in the growth of solar PV and wind-based power generation capacity is not only to gradually replace the conventional power supply system but also to meet the obligations of global climate protection. The developing countries (China, India, and Bangladesh) which are still struggling to produce enough power for their growing industrialization as well as other sectors are focusing on power supplement from the alternative sources [7].

### Conclusion

The progressive increase in Nigeria's population further compounds the pressure of limited energy supply. However, energy demand could never be achieved only with fossil fuels but with a combination of the energy mix. However, moving toward clean and renewable energy resources is essential to address the challenges of energy poverty. Also, this doubles as a means of reducing the emission of greenhouse gases, mitigating climate change, and providing a friendly environment. The paper reviews Nigeria's energy situation, consumption patterns, and RES applications. Hence, Nigeria has great potential for renewable energy resources in solar energy, hydropower, biomass, and others. Therefore, to fully harness the potential of RES, the government at every level is required to review and modify the existing energy laws, and implement and monitor the energy process on a real-time basis. Besides, government and interested stakeholders should genuinely invest in the human capacity and RE infrastructures.

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