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Current status and future prospects of renewable energy in Nigeria

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ABSTRACT

Nigeria is faced with chronic electricity crisis that has resulted in the crippling of most sectors of the economy. It is estimated that only 40% of Nigerians are connected to the national grid and the connected population are exposed to frequent power outages. Nigeria's electricity grid is mainly powered by large hydropower and depleting hydrocarbon resources. Fossil-based electricity generation contributes not only to increase in carbon footprints, but also exposes the country to changes in price of petroleum resources and political instability from the oil producing region of the country. The country is blessed with abundant Renewable Energy (RE) resources that have not been fully exploited; these renewable resources have the potentials to change the status quo of power generation and consumption in the country. Availability of Renewable Energy Sources (RESs) in all parts of Nigeria has been demonstrated in several studies. However, there is presently no comprehensive review of RE development in Nigeria. This contribution aims to fill this gap by focusing on the current status and future prospects of RE in Nigeria as well as identifying the key challenges confronting full scale RE development in the country. We discussed the existing government policies and legislations, and proposed others that can help speed up the adoption of RE in Nigeria. We also compared RE development in Nigeria with four other sub-Saharan African countries. We hope that this paper will stimulate further research on how to address the energy crisis in Nigeria using the RESs.

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1. Introduction

The industrial growth and development of any nation are directly proportional to energy resources at its disposal. Energy resources provide not only economic power, but also play a critical role in any modern society. Nigeria is endowed with abundant conventional (fossil fuel) energy resources, such as oil, gas, coal, etc. These sources have predominantly contributed over 90% of the country's income and also dominate the fuel sources for electrical energy production and other energy needs of the populace.

Electricity, which was first generated for public use in Nigeria in 1896 is heavily dependent on the fossil fuel sources. Although it has been generated for over a century, electricity demand in Nigeria is at present far more than the supply, thereby affecting the country's socio-economic and technological development [1,2]. Nigeria is the most populous country in Africa, with population of over 155 million people[3] and the majority of the citizens are living below the \$1.0 per day poverty level [4]. Only 40% of Nigeria's population is connected to the national electricity grid; the connected population faces power problems 60% of the time [1,5]

The energy crisis has crippled the nation's industrial sector, which claimed it needed 2000 MW (e) to run in 2009, and the Manufacturers Association of Nigeria (MAN) says it spends more than N 1.8 billion (US \$ 11, 340 million) weekly in the running and maintenance of power generators [6]. The use of these generators in the industries has resulted in high cost of energy; since energy cost constitutes 40% of the production cost in Nigeria. At present, the cost of production in Nigeria is nine times higher than that of China [7].

The prevalent energy crisis has therefore put enormous pressure on the economic growth and development in the country. In addition to that, the continuous depletion of the conventional energy resources, unstable oil price in the international market, increasing demand to reduce carbon footprints and attempt by the developed and emerging worlds to seek other forms of energy sources to meet their energy needs will in the foreseeable future lead to a considerable reduction in income accrued to the nation from its petroleum resources. The sustainability of Nigeria as a nation will therefore be at risk unless other sources of energy are exploited to block the loopholes in the nation's income due to the dwindling income generated from the fossil-based sources, and to provide energy sources for electricity generation in the country.

The over-dependence of the energy sector on petroleum that has slowed down the development of alternative fuels [8,9] must be reversed. There is the need for diversification to achieve a wider energy supply mix, which will ensure greater energy security for Nigeria. The way forward is the exploration of the RESs, such as solar, wind, hydro, biomass, etc., which are also abundant in nearly all parts of the country. RESs are sustainable, limitless and environment friendly [10]. The potential of RESs in Nigeria is about 1.5 times that of fossil energy resources in energy terms [11]. RESs have significant potential to improve and make a difference on the low level access to electricity in Nigeria [12].

The Nigerian Government has recognized the important role the RE would play in overcoming the present energy crisis and therefore intensifies its efforts by promoting the RE in the country through development of various energy reforms, policies and legislations. The research communities are also not left out in the quest to pursue the

RE development in Nigeria as demonstrated in the large body of research works that have been carried out on RE. Notable among these are the work of Udoakah and Umoh [13] on meeting the energy needs of Nigeria using RE, the work of Shaaban and Petinrin [12] on tapping of RE potentials for development of useful and stable electric energy supply in Nigeria. It also includes the work of Oyedepo [14] that examined the perspective of energy efficiency and RE for achieving a sustainable development in Nigeria. Other studies are Ohunakin and colleagues [15] on the utilization of solar energy as RE option in Nigeria, Mohammed and colleagues [16] on the potentials of bioenergy resources for bioelectric power generation in Nigeria and various works on wind energy potentials in different parts of Nigeria [17–21]. Further works on solar energy potentials can be found in [22–27] and small hydropotentials in [28–30].

Although these studies have demonstrated the availability of RESs in all parts of the country, there is presently no comprehensive review of RE development in Nigeria. This contribution aims to fill this gap by focusing on the current status and future prospects of RE in Nigeria as well as identifying the key barriers confronting the utilization of the full potential of RE in the country. We also discussed the existing government policies and legislations, and proposed others that can help speed up the adoption of RE in Nigeria.

2. Energy reserves and utilization in Nigeria

The primary energy sources are mainly utilized for electricity generation, transportation, heating and cooking in Nigeria. Energy

Table 1
Nigeria's RE reserve per capacity as at December 2005 [4,31].

Energy source	Reserves
Large hydro	11,235 MW
Small hydro	3500 MW
Animal waste	61 million tons/yr
Crop residue	83 million tons/yr
Solar radiation	3.5–7.5 kwh/m ² -day
Wind	2–4 m/s at 10 m height
Wave and tidal energy	150,000 TJ/(16.6 × 10 ⁶ toe/yr)

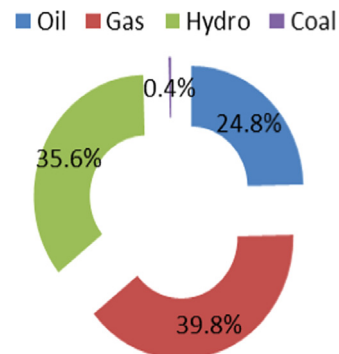


Fig. 1. Percentage contribution for the energy sources in Nigeria as of 2001 [8].

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