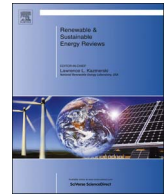




Contents lists available at ScienceDirect

## Renewable and Sustainable Energy Reviews

journal homepage: [www.elsevier.com/locate/rser](http://www.elsevier.com/locate/rser)

## Towards 100% renewable energy in Nigeria

Udochukwu B. Akuru<sup>a,\*</sup>, Ifeanyichukwu E. Onukwube<sup>b</sup>, Ogbonnaya I. Okoro<sup>c</sup>, Emeka S. Obe<sup>a</sup><sup>a</sup> Department of Electrical Engineering, University of Nigeria, Nsukka, Enugu State, Nigeria<sup>b</sup> Pilgrim Micropower Limited, Ajah, Lagos State, Nigeria<sup>c</sup> Department of Electrical and Electronic Engineering, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria

## ARTICLE INFO

## Keywords:

Climate change  
Conventional energy sources  
Electricity  
Renewable energy  
Nigeria

## ABSTRACT

Electricity is the basic tool that drives industrialization, technological advancement, engineering transformation and economic growth all over the world. The situation of Nigeria's electricity power sector is one that has defied virtually every effort made to resurrect it from its state of dilapidation. A major concern is "can there ever be stable and cost effective electricity in Nigeria?" The authors are positive this can be realised, but not without considering other forms of electricity energy resources available in Nigeria other than the conventional sources of electricity which is currently the mainstay. A deliberate transition from conventional sources of electricity energy to renewable and environmental friendly sources is critical for national development, even though recent development show the Nigerian government is backsliding in adopting renewable energy technologies. This paper will be used to highlight the different sources of renewable energy which is critical to solve the lingering problem of electricity generation in Nigeria. Hence, based on the literature, modeled scenarios and field experience, the authors discovered it is much easier for individuals to drive this transition to 100% renewable energy than to continue to depend on government forever.

## 1. Introduction

No modern nation can substantially reduce poverty in the absence of massive energy use, and countries with higher incomes and higher human development indexes also tend to be those with higher energy consumption [1,2]. Therefore, the use of energy today, whether for electricity, transportation or any other application, has surpassed any other era of human existence. In Nigeria, energy is the mainstay of growth and development because it serves as a tradable commodity for earning the national income, which is used to support government development programs [3]. Due to population outburst, inevitable industrialization, more agricultural production and improving living standards, the demand for energy in Nigeria is rising.

Nigeria is blessed with abundant primary energy resources enough to meet its present and future development requirements [4]. However, what really comes to mind when one talk about energy infrastructure in Nigeria is the electric power systems. Therefore, energy will imply electricity power henceforth in this paper. Electricity is a form of energy, which enjoys considerable and diverse applications because of its flexibility and ease of transmission and distribution. Availability of electricity remains a major factor in the location of industries and a strong instrument of social and economic development.

Nigeria is a very interesting country to visit if one is lucky not to have been born elsewhere. This is because Nigeria is greatly blessed with all forms of energy, but has only been able to convert a little of above 4500 MW for electricity use at any given point in time for its close to 170,000,000 estimated population [5]. This peak value generation has mostly remained elusive since May 2013 to date as the current generated capacity fluctuates lately between 3500 and 4000 MW, though government tells pundits that it has a hard-hitting installed generation capacity of about 10,000 MW. Well, there is no doubt to this figure because of the 10 National Integrated Power Projects (NIPPs), with combined capacity of 5455 MW at various stages of completion before 2014 as shown in Table 1. The NIPPs currently contributes over 1000 MW to the national grid which is expected to peak in 2015 at 4771 MW.

Meanwhile, there have been huge investments by the government pumped into the power sector in the recent past, and running into billions of dollars, but without any meaningful impact [2]. A clearer picture of the volume of investment into Nigeria's power sector is easily interpreted from Fig. 1. It is rather unfortunate that the graph of Nigeria's projected and installed capacity has been at variance over the years in spite of the geometric increment in power sector investments (see Fig. 2). Mention too, is that all these investments have been

\* Corresponding author.

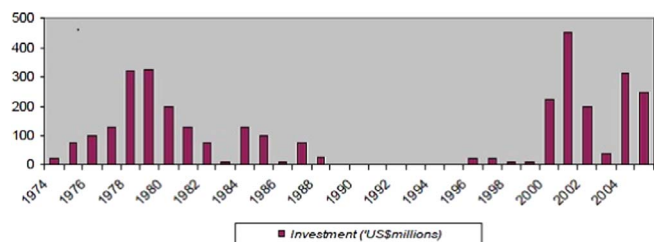
E-mail addresses: [udochukwu.akuru@unn.edu.ng](mailto:udochukwu.akuru@unn.edu.ng) (U.B. Akuru), [edisonforsure@gmail.com](mailto:edisonforsure@gmail.com) (I.E. Onukwube), [oiokoro@yahoo.co.uk](mailto:oiokoro@yahoo.co.uk) (O.I. Okoro), [simon.obe@unn.edu.ng](mailto:simon.obe@unn.edu.ng) (E.S. Obe).

<http://dx.doi.org/10.1016/j.rser.2016.12.123>

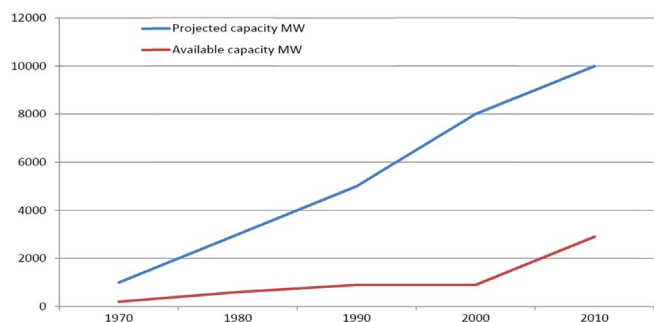
Received 27 November 2015; Received in revised form 26 November 2016; Accepted 26 December 2016  
1364-0321/ © 2016 Elsevier Ltd. All rights reserved.

**Table 1**  
Newly Completed/On-going Power Projects [6].

S/N	NIPPs	Capacity (MW)	Expected completion date as at September 2013
1	Alaoji Generation Company Nigeria Limited	1,131	June 2014
2	Benin Generation Company Limited	508	December 2013
3	Calabar Generation Company Limited	634	June 2014
4	Egbema Generation Company Limited	381	June 2014
5	Gbarain Generation Company Limited	254	June 2014
6	Geregu Generation Company Limited	506	May 2013
7	Ogorode Generation Company Limited	506	All units commissioned
8	Olorunsogo Generation Company Limited	754	All units commissioned
9	Omoku Generation Company Limited	265	June 2014
10	Omotosho Generation Company Limited	513	All units commissioned



**Fig. 1.** History of Nigeria's power sector funding [7].



**Fig. 2.** Nigeria's projected and available megawatts (MW) capacity (1970–2010).

focused on non-renewable energy mix between gas-fired and hydro power plants at a ratio of 3:1, though small hydro is a type of renewable energy (RE) that is usually classified apart.

While the current mix cannot be blamed for the country's dismal power sector performance given that the whole of Africa do renewable energy at only 1% at the moment [8], however there are secondary reasons to fault this outlook, especially when the world average for renewable energy is currently over 20%. Besides, overdependence on diesel which has higher landed costs in most African countries as a fuel for power generation has been touted to be around \$US400/MWh, which in some cases is more expensive than most renewable energy technologies. The usual challenges haunting electricity production in Nigeria have been government monopoly, unprofessionalism, wheeling losses of more than 20%, corruption, lack of maintenance, and project abandonment [7–9]. The effects have resulted to widening the gap between demand and supply, relocation of industries leading to unemployment, negative signal to potential investors, inflation, and frequent power outages leading to hardships amidst psychological trauma, among many others.

Already, the immediate past government in Nigeria (2011–2015) did all it could to right the wrongs of its past contemporaries, a process which is becoming a vicious cycle with every new government. Considering the steps taken so far, it earned some benefit of doubt. For instance, government has broken its own monopoly by privatising power assets in the first phase of a process that will open doors to other private investors to buying the 10 NIPPs when they are fully completed.

In another strident move, it has documented as a guide, ROADMAP FOR POWER SECTOR REFORM in August 2013. Before now, there was the National Electric Power Policy (2002), National Energy Policy (2003) and the Electric Power Sector Reform (ESPR) Act (2005). The factorial in all these policy initiatives is the brainchild of ex-president Jonathan's government motivation to set up the Power Sector Reform Roadmap in 2010 to implement the successful delivery of the imperative milestones that would transform the industry by taking the following steps: the corporatization, commercialisation and eventual privatization of the successor Power Holding Company of Nigeria (PHCN) companies, the inflow of private sector investment, the creation of new power generation and distribution entities, and the subsequent development of a competitive electricity market [10].

Doing something differently, so as not to end up with the routine results, there is the need to give adequate attention to the potentials of renewable energy which is more environmental friendly, and becoming cost effective with greater delivery efficiency. The fact is that out of just 50% of the country's population who have “access” to electricity, only 10% of the rural populace is in this number [7]; and the relationship is non-linear considering that more than half of the overall populations are rural dwellers. The casual approach of government to renewable energy in the Roadmap for Power Sector Reform: Revision 1 [10] is very discouraging. In the 86-page booklet, only less than a page was dedicated to justify its decision to side-line renewable energy sources for power generation, citing questionable grounds such as high cost of execution for solar and unfavourable wind speed for wind, and then summing it up to just 4% allocation for the contribution of renewable energy towards the country's 28,000 MW capacity projection by 2020. This action shows that government in Nigeria is discontinuous – usually referred to as policy somersault – as it has failed to follow an earlier commitment to pursue close to 3 000 MW RE by 2025, which is 3 times the current target [11].

The importance of RE cannot be overloaded in the current study. That is why in this paper a strategic pursuit is made towards amplifying the potentials that Nigeria stands to gain if it reconsiders its position by acquainting with the state-of-the-art in renewable power generation, and the prospects it offers the country's drive for electrical power availability, security and sustainability. This done, the country stands to benefit through secure, “safe”, and cheap energy supplies to more of rural communities, as well as technological and economic growth. The main contribution of this paper will be achieved by providing contemporary information and statistics on renewable energy potentials, conversion technologies and 100% integration efforts.

The remainder of this paper will be organised as follows: Section II will be used to review the available renewable energy sources; Section III will be used to discuss the prospects of 100% renewable energy worldwide; Section IV will be used to highlight major bottlenecks to 100% renewable energy, especially for Nigeria; section V will be used to appraise the current situation in Nigeria and argue for successful drive towards 100% RE; lastly, Section VI will then be used to draw a conclusion.

Download English Version:

<https://daneshyari.com/en/article/5483094>

Download Persian Version:

<https://daneshyari.com/article/5483094>

[Daneshyari.com](https://daneshyari.com)