



Sustainable energy development in Nigeria: Current status and policy options



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ABSTRACT

Sustainable energy development focuses on maintaining the provision of energy in a manner that can enhance the short-, medium-, and long-term economic development of a country. The provision of sustainable energy requires the development and implementation of technologies that can improve the energy situation of a given country, such as renewable energy, energy-efficient technologies, and the proper use of conventional energy resources. To achieve this, effective energy policy options must be instigated that can adjust to changing circumstances. In Nigeria, the development of sustainable clean modern energy is an immense challenge, as is the proper use of the country's conventional energy resources. This is as due to the lack of effective support policies and poor participation by the government in clean energy development. The energy situation in Nigeria could be improved by the provision of adequate energy policy options designed to augment existing energy policies. This study critically reviews the current status of energy resources in Nigeria and the associated policies. Important policies, unavailable under current government strategies, are proposed and prioritised based on their likelihood of success in short, medium and long term. Among the most important policies based on priorities are policies to address crude oil theft, complete deregulation of the petroleum subsectors, utilisation of associated gases, creation of favourable business climate for private investors, increase attraction for Foreign Direct Investment in clean energy technology, Renewable Portfolio Standards development, introduction of Tendering Schemes, use of efficient fuel stoves, development of Demand-Side Bidding and Energy Efficiency Standard Law. We believe that these proposed policy options could improve the sustainable development of Nigeria's energy resources.

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1. Introduction

The term “energy policy” can be defined as the process, manner, or techniques with which the government of a country addresses issues of energy development such as energy generation, distribution, and consumption [1]. The ultimate goal of a country's energy policy is to achieve sustainable energy development, that is, the maintainable provision of energy growth that can satisfy present generation needs without compromising the needs of future generation [2].

Sustainable development is an approach to the continued economic development of the world that equally balances the three pillars of sustainability: social, environmental, and economic considerations [3]. Provision of sustainable energy invariably involves the development and implementation of technologies (e.g., renewable energy and energy-efficient technologies) that will improve the energy situation within a given country.

The importance of the global quest for sustainable energy development has increased dramatically in the modern world, which has raised the issue of sustainable economic development and growth. Therefore, sustainable energy development has emerged as one of the most promising means of addressing the challenges of energy demand [4].

In many countries, achieving sustainable energy has proved difficult and in some cases, especially in African countries, almost impossible. In Nigeria, providing access to sustainable clean modern energy has proven difficult and the efforts made by the government have yielded few results over the years. The energy policies in Nigeria have effectively failed to improve the energy situation of the country since their establishment [5–7]. This is because of a lack of available policy options to address the changing energy situation of the country and the ineffectiveness of the present policies to address the current situation in the energy sector.

Given the lack of progress made through Nigeria's current energy policies, as highlighted above, a critical review of the current status of the development of energy resources in Nigeria and the associated policies is required. This paper reviews the current status of the development of energy resources in Nigeria and the associated policies. Furthermore, some policy options that could help ensure sustainable energy development in Nigeria are presented. The remainder of this paper is organised as follows. Section 2 presents an

appraisal of conventional energy resources in Nigeria together with the associated policies and policy options. Section 3 discusses the various renewable energy resources available in Nigeria, including an account of their current development, and the associated policies, and policy options. Energy efficiency and conservation policy options are presented in Section 4, and Section 5 presents our conclusions based on this review.

2. Non-renewable energy resources

Nigeria has considerable reserves of conventional energy resources. It is the world's largest producer of oil and it has the largest reserves of natural gas on the African continent. It therefore became the world's fourth leading exporter of liquefied natural gas (LNG) in 2012. Nigeria is also a member of the Organisation of the Petroleum Exporting Countries (OPEC), which it joined in 1971 after over 10 years of oil production that began in the late 1950s [8]. Coal reserves stand at 2.175 billion tonnes, but production has long since ceased as the government has concentrated on the oil and gas resources.

Nigeria is also rich in tar sand or oil sand, which is a combination of clay, sand, water, and bitumen (a heavy black viscous oil). Tar sands can be mined and processed to extract the oil-rich bitumen, which can be refined into oil [9]. Table 1 lists the conventional energy reserves in Nigeria and their potentials.

According to the US Energy Information Agency estimate, the total primary energy consumption in Nigeria in 2012 was about 4.5 quadrillion Btu (British thermal units). This comprised 80% from traditional biomass and waste (wood, charcoal, manure, and crop residue) and much smaller percentages from oil and natural gas (Fig. 1).

The Nigerian oil and gas sector is regulated by the Nigerian National Petroleum Corporation (NNPC), which was established in 1977 with the secondary responsibility of overseeing the development of the upstream and downstream oil sectors [12]. Despite the large energy resources in Nigeria, energy consumption is relatively low compared with other African countries with comparable energy resources (Fig. 2). This low energy consumption is due to the recurrent scarcity of petroleum products at vehicle petrol stations, while

Table 1
 Conventional energy reserves in Nigeria and their potentials.
 Source: Ref. [10]

Resource type	Reserves		Production	Domestic utilization (natural units)
	Natural units	Energy units (Btoe)		
Natural gas	187 trillion SCF	4.19	6 billion SCF/day	3.4 billion SCF/day
Crude oil	36.22 billion barrels	5.03	2.5 million barrels/day	450,000 barrels/day
Tar sands	31 billion barrels of equivalent	4.31	Insignificant	Insignificant
Coal & lignite	2.175 billion tonne	1.52	–	–
Nuclear element	None	–	–	–

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