Research Paper Engineering

The Profile of Energy Generation and Consumption in Nigeria

Ogbuagu, J.O Department of Pure and Industrial Chemistry, Nnamdi Azikiwe University, Awka, Nigeria

Akubue, P.C Department of Chemical Engineering, Nnamdi Azikiwe University, Awka, Nigeria

ABSTRACT

Nigeria's energy need is on the increase as the population is not balanced by adequate energy development availability. This paper explains the profile of energy generation and consumption in Nigeria with the challenges faced. The ever increasing demand and inadequate supply of energy in Nigeria has been a great challenge to her development. A robust solution must be found to end the nation's energy crises. Energy efficiency which is a component of energy consumption leads to important social benefits, such as reducing the energy bills for poor households. From an economic point of view, implementing the country's renewable energy target will have significant effects, but these can partly be offset by selling carbon credits according to the rules of the 'Clean Development Mechanism' agreed some 10 years ago, which will result in indirect health benefits. In the shift to Nigeria sustainable energy generation future, many factors need to be considered and appropriately addressed. These include a full exploitation and promotion of renewable energy resources, energy efficiency practices, as well as the application of energy conservation measures in various sectors such as in the construction of industrial, residential, and office buildings and transportation. Indeed, Nigeria receives a huge amount of solar radiation, has abundant wind energy resources, and large deposits of fossil fuel, as well as enormous hydro-power resources from Niger and Benue Rivers. About 80% of hydro-power remains untapped, the total 5.5KW-hr/m2/day of solar radiation is not utilized and wind energy resources remain unexploited. The solution lies in creating a mixed supply of energy whereby untapped renewable resources are combined with abundant non-renewable fossil fuel, including the massive quantities of gas wasted from crude oil exploitation.

KEYWORDS Energy consumption, economic growth, energy policy, energy profile, fossil fuel and renewable energy.

Introduction

Energy is fundamental and inevitable to our daily living as it lightens our environment, powers our homes and machines, schools, hospitals, offices, businesses, and promotes industrialization. Energy is of great importance as its availability will bring about job creation, development, wealth creation and an overall boost to the Nigerian economy. It is a known phenomenon that the economic growth of a nation depends on energy supply. While telecommunication market in Nigeria has recorded advancement and stability, the energy market in Nigeria is facing mixed challenges ranging from slow growth in generation capacity and high consumption rate, market deregulation process interference by Government, electrical transmission lines and distribution, equipment vandalism, pipe line vandalism and oil theft, poor maintenance of existing electrical facilities and corruption. Nigeria should not differ in the vogue of global energy market which focuses on building a cleaner, more diverse and more sustainable energy mix. This paper focuses on the profile of energy generation and consumptions and challenges in Nigeria and possible ways to ameliorate them via a sustainable energy system.

Energy has been described as a force multiplier that enhances man's ability to convert raw materials into useful products, providing varieties of useful services (Sorensen, 1983). It is of different kinds and forms with broad division under the renewable and non-renewable energy sources (Harmann, 2001). The non-renewable sources have been the most used and produce harmful emissions, making it environmentally unfriendly. These sources also deplete and do not produce adequate and consistent power for national consumption.

Indeed, energy has a major impact on every aspect of our socio-economic life. It plays a vital role in the economic, social and political development of our nation. Inadequate supply of energy restricts socio-economic activities, limits economic growth and adversely affects the quality of life. Improvements in standards of living are manifested in increased food production, increased industrial output, the provision of efficient transportation, adequate shelter, healthcare and other human services. These will require increased energy consumption. Thus, our future energy requirements will continue to grow with increase in living standards, industrialization and a host of other socio-economic factors and activities. It is pertinent to note that the impact of energy goes beyond national boundaries as energy supply can be used as an instrument of foreign policy in the promotion of international cooperation and development. (ECN, 2003)

Moreover, the energy needs of the countries of the world are increasingly growing. An international projection reported that the energy dependence of the world is expected to rise by over 34% between 2002 and 2025. The Nigerian government also needs to develop capacities and develop the infrastructure for harvesting wind for power generation from sites within regions having high wind capacity; trapping the abundant solar energy freely available in the nation; increase the capacities of the present hydro-power stations; increase refineries' processing capacities and also establish various power stations that will use the natural gas from crude oil exploitation to drive turbines for electricity generation. All the energy thus generated should be fed into the national grid, creating adequate mix of energy from the different sources and having a compact energy development process which will be suitable, sustainable, constantly available, environmentally friendly and economically viable in the long term national energy plan.

Background Facts

Nigeria is primarily an energy store house accommodating resources such as coal and lignite, natural gas, crude oil, solar, hydro, nuclear, wood fuel, geothermal, tide, biogas and biomass. In spite of the available vast resources, only four sources

(coal, crude oil, natural gas and hydro) are currently utilized in processed forms while two others (wood fuel and solar) are used in their crude forms for heating, cooking and lighting. However, since the late 1960's, the economy has been solely dependent on the exploitation of oil to meet the country's development expenditures. In 1990, oil revenue alone accounted for over 90% of export and 80% of the total government revenues with a contribution of about 30% to Gross Domestic Products (GDP). The dominant source of commercial energy is oil accounting for over 70% since the early 1970's. Up to early 1960's, coal production was significant and dominate the commercial energy supply. It was also the dominant source of energy for rail transportation and electricity generation (Ogbuagu et al, 2001). The responsibility of production and distribution of electricity was saddled with the National Electric Power Authority (NEPA), established by decree no. 24 of 1972 until recently when the sector was deregulated in order to allow private participation. The NEPA was charged with the statutory monopoly power to over-see electricity development throughout the country and produce electricity under a high proportion of in-operational generating plant capacities of 27%, overloaded and overstretched transmission lines; in addition to the problem of hydrological inadequacies in hydro-electric plants especially within the period of dry season. The foregoing challenges coupled with illegal access to transmission lines have culminated into frequent breakdown of electricity equipment (seemingly due to overload) and a large quantum of electricity losses in the transmission system (ranging between 20-30%), NEPA (now electric generating companies and distributing companies, Gencos and Discos) often responded to these anomalies by creating an electricity supply-demand artificial balance such as rationing, shedding and suppressed demand services. All these have resulted in the low quantum of electricity available for consumption. This current status of electricity supply in Nigeria reflects a situation of supply crisis in which industrial growth and socio-economic development paces are kept below the potential of the economy (Adeyemi and Ayomide, 2013).

In line with the trend witnessed in most developing countries, Nigeria energy consumption has increasingly experienced an upward trend with over 23% increase in energy use between 2000 and 2008 as shown in Figure 1. Since 1970, Nigeria's energy consumption has consistently maintained an upward trend.

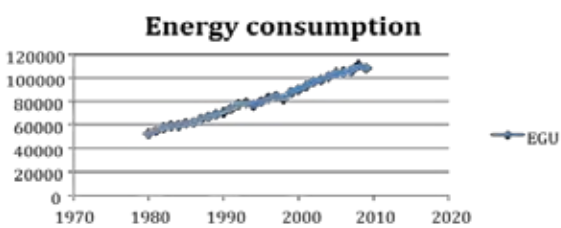

Figure 1: Energy Consumption Trend in Nigeria

Source: World Development Indicator Database

According to a recent report, only 20% of the nation's hydro-power potential is tapped for use, and the amount of solar radiation in the country is about 5.5KW-hr/m^2-day (ECN-UNDP, 2005), representing huge prospect for energy generation if a total capacity can be developed for that purpose. Despite this, infrastructure for energy supply has remained grossly inadequate. The country's four refineries produce about 30% of installed capacity of 445,000 bpd (ECN-UNDP, 2005) with the present consumption buffered by imports, thus taking the energy supply situation of the nation tend towards crisis state.

Obviously, the nation has been described as having capacity for wind energy utilization. Researchers have analyzed wind data from different stations within the country's six geo-political zones. Their outcome is that Nigeria has potential for wind power generation, with the potential rank in the order of north-east, north-west, north-central, south-east, south-south and south-west respectively (Fagbenle and Karayiannis, 1994). Offshore areas of Lagos, Ondo, Delta, Rivers, Bayelsa and Akwa Ibom States also have potentials for harvesting strong wind energy throughout the year.

Energy Situation in Nigeria

Nigeria is Africa's energy giant. It is the continent's most prolific oil-producing country, which, along with Libya, accounts for two-thirds of Africa's crude oil reserves. It ranks second to Algeria in natural gas (Sambo, 2008). Most of Africa's bitumen and lignite reserves are found in Nigeria. In its mix of conventional energy reserves, Nigeria is simply unmatched by any other country on the African continent. It is not surprising therefore that energy export is the mainstay of the Nigerian economy. Also, primary energy resources dominate the nation's industrial raw material endowment.

Several energy resources are available in Nigeria in abundant proportions. The country possesses the world's sixth largest reserve of crude oil. Nigeria has an estimated oil reserve of 36.2 billion barrels. It is increasingly an important gas province with proven reserves of nearly 5,000 billion m^3. The oil and gas reserves are mainly found and located along the Niger Delta, Gulf of Guinea, and Bight of Bonny. Most of the exploration activities are focused in deep and ultra-deep offshore areas with planned activities in the Chad basin, in the northeast. Coal and lignite reserves are estimated to be 2.7 billion tons, while tar sand reserves represent 31 billion barrels of oil equivalent. The identified hydroelectricity sites have an estimated capacity of about 14,250 MW. Nigeria has significant biomass resources to meet both traditional and modern energy uses, including electricity generation (Ighodaro, 2010).

The situation in the rural areas of the country is that most end users depend on fuel wood. Fuel wood is used by over 70% of Nigerians living in the rural areas. Nigeria consumes over 50 million tonnes of fuel wood annually, a rate which exceeds the replenishment rate through various afforestation programs. Sourcing fuel wood for domestic and commercial uses is a major cause of desertification in the arid-zone states and erosion in the southern part of the country. The rate of deforestation is about 350,000 ha/year, which is equivalent to 3.6% of the present area of forests and woodlands, whereas reforestation is only at about 10% of the deforestation rate (Famuyide et al, 2011).

The rural areas, which are generally inaccessible due to poor road networks, have little access to conventional energy such as electricity and petroleum products. The daily needs of the rural populace for heat energy are therefore met almost entirely from fuel wood. The sale of fuel wood and charcoal is mostly uncontrolled in the unorganized private sector. The sale of kerosene, electricity and cooking gas is essentially influenced and controlled by the Federal Government or its agencies - the Nigerian National Petroleum Corporation (NNPC) in the case of kerosene and cooking gas, and the defunct Power Holding Company of Nigeria, PHCN (now electricity Gencos and Discos) in the case of electricity. The policy of the Federal Government had been to subsidize the pricing of locally consumed petroleum products, including electricity. In a bid to make the petroleum downstream sector more efficient and in an attempt to stem petroleum product consumption as a policy focus, the government has reduced and removed subsidies on various energy resources in Nigeria. The various policy options have always engendered price increases of the products (Sambo, 2009).

With the restructuring of the power sector and the privatization of the electricity industry, it is obvious that for logistic and economic reasons especially in the privatized power sector, rural areas that are remote from the grid and/or have low consumption or low power purchase potential will not be attractive to private power investors. Such areas may remain unserved into the distant future (Sambo, 2009).

Meanwhile, electricity is required for such basic developmental

services as pipe borne water, health care, telecommunications, and quality education. The poverty eradication and Universal Basic Education programs require energy for success. The absence of reliable energy supply has not only left the rural populace socially backward, but has also left their economic potentials untapped. Fortunately, Nigeria is blessed with abundant renewable energy resources such as solar, wind, biomass, and small hydropower potentials. The logical solution is increased penetration of renewables into the energy supply mix (Sambo, 2008).

Current electricity situation in Nigeria

The electricity system in Nigeria centers on Gencos which accounts for about 98% of the total electricity generation (Famuyide et al, 2004). Power generation by other agencies such as the Nigerian Electricity Supply Company relies on thermal power for electricity generation unlike generating companies (Gencos) which relies on both hydro- and thermal power. However, electricity is also a consumer of fuel and energy such as fuel oil, natural gas, and diesel oil. The importance of these sources of energy and fuel for generating electricity has been decreasing in recent years. However, hydropower which is relatively cheaper than these sources has grown to be more important than other sources (Famuyide et al, 2004). More recently, the Power generating companies have generated electricity through a mix of both thermal and hydro systems. All the power, distribution, and substations are specially interlinked by a transmission network popularly known as the national grid. The entire electricity generated nationwide is pooled into the National Control Centre, Osogbo, from where electricity is distributed to all parts of Nigeria. The national electricity grid presently consists of 14 generating stations (3 hydro and 11 thermal) and 10 distribution companies (Odumodu, 2014).

In addition to these, most of the existing electricity plants in Nigeria are underutilized or not functioning at all. Numerous reasons could be sighted as responsible for the underutilization of these plants. Some of which are (1) scarcity of relevant manpower for adequate maintenance and general consumer indiscipline; (2) lack of essential spare parts for maintenance of the plants; (3) absence of local manufacturing capabilities; (4) lack of systematic studies of distribution networks to reduce the extraordinary losses that usually accompany haphazard system expansion; and (5) inability to convert gas flares to a source of electricity (Odularu and Okonkwo, 2009).

Energy Consumption Patterns in Nigeria

Energy consumption patterns in the world today shows that Nigeria and indeed African countries have the lowest rates of consumption. Nevertheless, Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy. Nigeria is rich in conventional energy resources, which include oil, national gas, lignite, and coal. It is also well endowed with renewable energy sources such as wood, solar, hydropower, and wind (Ogbuagu, 1993, Okafor and Joe-Uzuegbu, 2010).

The patterns of energy usage in Nigeria's economy can be divided into industrial, transport, commercial, agricultural, and household sectors. The household sector accounts for the largest share of energy usage in the country - about 65%. This is largely a reflection of low level of development in all the other sectors (ECN, 2005).

The major energy-consuming activities in Nigeria's households are cooking, lighting, and use of electrical appliances. Cooking accounts for a staggering 91% of household energy consumption, lighting uses up to 6%, and the remaining 3% can be attributed to the use of basic electrical appliances such as televisions, air conditioners and pressing irons (ECN, 2005).

The predominant energy resources for domestic and commercial uses in Nigeria are fuel wood, charcoal, kerosene, cooking gas and electricity (Sambo, 2009). Other sources, though less common, are sawdust, agricultural crop residues of corn stalk, cassava sticks, and, in extreme cases, cow dung. In Nigeria, among the urban dwellers, kerosene and gas are the major cooking fuels. The majority of the people rely on kerosene stoves for domestic cooking, while only a few use gas and electric cookers (Williams, 1998).

The rural areas have little access to conventional energy such as electricity and petroleum products due to the absence of good road networks. Petroleum products such as kerosene and gasoline are purchased in the rural areas at prices very high in excess of their official pump prices. The rural population, whose needs are often basic, therefore depends to a large extent on fuel wood as a major traditional source of fuel. It has been estimated that about 86% of rural households in Nigeria depend on fuel wood as their source of energy (Karekezi, 1997). A fuel wood supply/demand imbalance in some parts of the country is now a real threat to the energy security of the rural communities (ECN, 2005).

The energy consumption per capita in Nigeria is very small - about one-sixth of the energy consumed in developed countries. This is directly linked to the level of poverty in the country. Gross domestic product (GDP) and per capita income are indices that are used to measure the economic well-being of a country and its people (CBN, 2000). GDP is defined as the total market value of all final goods and services produced within a given country in a given period of time (usually a calendar year). The per capita income refers to how much each individual receives, in monetary terms, of the yearly income that is generated in his/her country through productive activities. That is what each citizen would receive if the yearly income generated by a country from its productive activities were divided equally between everyone.

Table 1: Headline Power Forecasts (Nigeria 2013-2019)

	2013e	2014e	2015f	2016f	2017f	2018f	2019f
Generation, Total, TWh	29.650	31.391	33.512	35.817	41.139	44.005	48.485
Consumption, Net Consumption, Terawatt hour(s), TWh	27.0	29.0	31.4	34.0	39.0	42.0	46.5
Capacity, Net, MW	8,089.8	9,109.8	9,361.8	9,810.7	10,177.2	10,844.4	12,096.0

e/f = Business Monitor International (BMI) estimate/forecast.
Source: BMI, EIA, UN Data

The estimates/forecast in Table 1 is based on the following assumptions and upticks:

There are tentative signs that the gas supply to some selected power plants is improving - with available capacity reaching a record level in July 2015 - at 4,748MW. This is still less than half of installed capacity, but the uptick has been driven by more stable gas supply to the Alaoji, Calabar and Ibom power stations.

Efforts to make the grid more efficient - and transform Transmission Company of Nigeria (TCN) into a viable entity, remain critical to any power sector transformation. President Buhari extended Manitoba Hydro International (MHI)'s contract to manage TCN in July 2015, although MHI has since threatened to pull out after alleging that contracts were breached.

Nigeria's government finalised plans to build nuclear power plants at Geregu in Kogi and Itu in Akwa Ibom. Rosatom will co-finance the plants; as well as build and own.

Table 2: Nigeria Total Petroleum Consumption 1980-2013

	Total Petroleum Consumption (Quadrillion Btu)	Total Petroleum Consumption (Thousand Barrels Per Day)	Consumption of Motor Gasoline (Thousand Barrels Per Day)	Consumption of Jet Fuel (Thousand Barrels Per Day)	Consumption of Kerosene (Thousand Barrels Per Day)	Consumption of Distillate Fuel Oil (Thousand Barrels Per Day)	Consumption Residual Fuel Oil (Thousand Barrels Per Day)	Consumption of Liquefied Petroleum Gases (Thousand Barrels Per Day)	Consumption of Other Petroleum Products (Thousand Barrels Per Day)	Total Consumption of Refined Petroleum Products for Bunkering (Thousand Barrels Per Day)	Consumption of Residual Fuel Oil for Bunkering (Thousand Barrels Per Day)
1980	0.3	170.0									
1981	0.4	200.0									
1982	0.4	215.0									
1983	0.4	202.0									
1984	0.4	210.0									
1985	0.5	222.0									
1986	0.4	208.3	83.2	9.7	31.0	46.7	19.5	3.4	14.9	6.0	3.6
1987	0.4	218.0	84.7	8.9	34.1	40.1	24.2	3.9	22.1	14.9	4.1
1988	0.5	234.1	88.8	7.0	37.9	37.3	35.1	3.9	24.2	5.6	4.0
1989	0.5	244.0	98.0	12.8	31.1	42.8	34.4	4.2	20.8	14.6	4.9
1990	0.5	251.0	98.0	13.0	33.0	48.0	35.3	4.6	19.1	14.5	5.1
1991	0.5	258.7	105.2	11.1	37.1	47.4	37.6	3.8	16.5	15.2	5.5
1992	0.5	264.7	112.7	7.4	32.2	57.5	30.4	4.6	19.9	5.3	3.8
1993	0.5	270.8	111.7	8.3	35.7	62.5	28.9	4.4	19.3	15.4	5.7
1994	0.5	252.0	98.9	0.0	34.7	60.8	27.6	2.0	27.9	14.7	5.1
1995	0.6	284.0	99.0	0.0	37.3	66.5	29.5	5.3	46.5	14.8	5.5
1996	0.6	286.1	81.4	8.5	37.1	59.2	13.9	1.7	84.1	15.0	5.5
1997	0.6	277.3	77.3	10.8	22.3	56.1	33.4	0.7	76.6	7.2	5.5
1998	0.5	260.1	76.3	13.6	21.6	47.2	21.3	0.6	79.4	14.7	5.2
199	0.5	252.0	69.8	9.4	20.2	52.1	31.7	0.6	68.2	14.4	4.6
2000	0.5	245.6	117.8	3.9	26.9	49.3	33.5	0.6	13.6	9.2	2.9
2001	0.6	305.7	150.8	9.1	35.4	53.8	31.2	2.9	22.5	10.9	5.7
2002	0.6	303.9	154.8	8.0	33.2	53.4	27.1	3.3	24.1	14.0	5.4
2003	0.6	288.5	150.3	8.4	23.6	54.2	39.7	0.9	11.3	18.9	7.4
2004	0.6	277.1	149.3	4.1	19.9	44.1	16.4	0.7	42.5	14.0	3.4
2005	0.6	311.6	154.9	4.9	28.1	51.4	24.0	1.3	47.1	16.1	4.2
2006	0.6	284.5	149.5	4.9	36.5	41.2	22.2	0.8	29.3	17.2	0.0
2007	0.5	232.2	142.1	5.0	36.6	40.7	19.3	0.0	25.2	17.3	0.0
2008	0.5	263.0	163.7	18.1	16.9	29.8	15.8	1.3	23.5	35.0	7.3
2009	0.5	252.9	163.8	13.7	12.1	23.9	19.8	0.8	8.3	25.7	7.8
2010	0.6	283.1	135.1	3.5	44.4	20.3	26.0	2.8	5.9	16.6	8.5
2011	0.6	287.4									
2012	0.6	300.0									
2013	0.6	302.0									

Source: International Energy Statistics

There was an uptick on the total petroleum consumption from 2000 to 2013 in Table 2. This is a reflection of low level of development and fuel wood as predominant energy resources for domestic and commercial uses in Nigeria.

The Nigerian energy challenge

Nigeria's energy need is on the increase, and her increasing population is not balanced by adequate energy development programme. The present urban-centered energy policy is deplorable, as cases of rural and sub-rural energy demand and supply do not reach the center stage of the country's energy development policy. People in rural areas depend on burning wood and traditional biomass for their energy needs, causing great deforestation, emitting greenhouse gases, and polluting the environment, thus, creating global warming and environmental concerns. The main concentration has been to supply energy to the cities and various places of industrialization, thereby creating an energy imbalance within the country's socio-economic and political landscape. The sole dependence on hydro-power sources for energy supply has also not been adequate, as this is controlled by factors such as the seasonality in the levels of water at the different hydro-power stations. The present and ever increasing population in comparison with the total capacity of available power stations means that Nigeria is not able to meet the energy need of the people. Rural dwellers still depend on charcoal and wood for cooking and heating. The poor outcome is blamed on the inability of the NNPC and its subsidiary, the Nigeria Gas Company (NGC) to maintain regular supply, due to the high incidence of vandalism on the Trans-Forcados pipeline in the western axis and Escravos-Lagos gas pipeline in the eastern axis (Premium Times, 2015).

The nature of Nigeria's energy crises can be characterized by two key factors. The first concerns the recurrent severe shortages of the petroleum product market of which kerosene and diesel are the most prominent. Nigeria has five domestic refineries owned by the government with a capacity to process 450,000 barrels of oil per day, yet imports constitute more than 75% of petroleum product requirements. The state-owned refineries have hardly operated above a 40% capacity utilization rate for any extended period of time in the past two decades. The gasoline market is much better supplied than kerosene and diesel because of its higher political profile. This factor explains why the government has embarked on large import volumes to remedy domestic shortages of the product. The weaker political pressures exerted by the consumers of kerosene (the poor and low middle class) and diesel (industrial sector) on the government and the constraints on public financing of large-scale imports of these products, as in the case of gasoline, largely explain their more severe and persistent market shortages (Adenikinju, 2005).

The second dimension of Nigeria's energy crises is exemplified by such indicators as electricity blackouts, brownouts, and pervasive reliance on self-generated electricity. This development has occurred despite abundant energy resources in Nigeria. The electricity market, dominated on the supply side by the state-owned PHCN (now Gencos and Discos), formerly called NEPA, has been incapable of providing minimum acceptable international standards of electricity service reliability, accessibility, and availability for the past three decades (Adenikinju, 2005). Though the peak electricity demand has been less than half of the installed capacity in the past decade, load shedding occurs regularly. Power outages in the manufacturing sector provide another dimension to the crisis. In 2004, the major

manufacturing firms experienced 316 outages. This increased by 26% in 2005, followed by an explosive 43% increase between 2006 and 2007. This poor service delivery has rendered public supply a standby source as many consumers who cannot afford irregular and poor quality service substitute more expensive captive supply alternatives to minimize the negative consequences of power supply interruptions on their production activities and profitability. An estimated 20% of the investment into industrial projects is allocated to alternative sources of electricity supply (Nnaji et al, 2010).

Nigeria Differential Energy Prices

Nigerians have paid different prices on energy consumption, ranging from fuel price increases despite oil subsidy to hike in electricity tariffs.

Table 3: Fuel Price in Nigeria from 1973 to Date

Year	Regime	PMS Price ₦	PMS Price Adjusted to ₦	Price Change ₦	Percentage %	Total percent Price Change per Regime %
1973	Yakubu Gowon	0.06	0.0845	0.0245	41	41
1976	Murtala Mohammed	0.0845	0.09	0.0055	7	7
1978	Olusegun Obasanjo	0.09	0.15	0.06	67	67
1982	Shehu Shagari	0.15	0.2	0.05	33	33
1986	Ibrahim Babangida	0.2	0.395	0.195	98	
1988	Ibrahim Babangida	0.395	0.42	0.025	6	
1989	Ibrahim Babangida	0.42	0.6	0.18	43	
1991	Ibrahim Babangida	0.6	0.7	0.1	17	163
1993	Ernest Shonekan	0.7	5	4.3	614	614
1993	Sani Abacha	5	3.25	-1.75	-35	
1994	Sani Abacha	3.25	15	11.75	362	
1994	Sani Abacha	15	11	-4	-27	300
1998	Abdulsalam Abubakar	11	25	14	127	
1999	Abdulsalam Abubakar	25	20	-5	-20	107
2000	Olusegun Obasanjo	20	30	10	50	
2000	Olusegun Obasanjo	20	22	-8	-27	
2002	Olusegun Obasanjo	22	26	4	18	
2003	Olusegun Obasanjo	26	42	16	62	
2004	Olusegun Obasanjo	42	50	8	19	
2004	Olusegun Obasanjo	50	65	15	30	
2007	Olusegun Obasanjo	65	75	10	15	167
2007	Umaru Yar'dua	76	65	-11	-14	-14
2012	Goodluck Jonathan	65	141	76	117	
2012	Goodluck Jonathan	141	97	-144	-31	
2014	Goodluck Jonathan	97	87	-10	-10	75
2015	Mohammadu Buhari	87	140	53	61	

Source: The Guardian, December 25, 2015

The last effort to remove subsidy in 2012 was not the first time government proposed or indeed partially removed subsidy on petroleum products as shown in Table 3. From 1973 to 2012 there have been at least 18 increases in petrol pump prices with about 6 of them within the period of this democracy. Government has curiously advanced the same argument each time – to use the money to provide "critical infrastructure". In 2006 when Nigeria exited its Paris Club debt, government promised that the savings to be made (i.e. funds that would have been used to service the debts) will be invested in the same "critical infrastructure" – education, health and public works. Unfortunately, there has been a decline in the state of our public infrastructure since then. Moreover the legal framework for the deregulation of the petroleum industry is nowhere as the Petroleum Industry Bill (PIB) was not passed by the 6th and the 7th National Assemblies. It is pertinent to note that the key objective of the 2012 Petroleum industry Bill (PIB) was to "deregulate and liberalize the downstream sector" (Onuegbu, 2015).

Highlights of the new electricity tariffs show that consumers will henceforth experience different levels of increases across Nigeria, but will no longer pay the monthly fixed charge. Currently, consumers pay fixed charges ranging from N220 to N750 for residential consumers, depending on their locations, and thousands of naira for commercial users (Daily Sun, 2015). The Multi-Year Tariff Order (MYTO) 2015 Distribution Tariffs (2015-2024) shown in Table 4 which contains the new tariff structure will come into effect from February 1, 2016. By the National Electricity Regulatory Commission, NERC's classification, R2 consumers are residential customers with single or three- phase meters. They are further classified as consumers who use their premises exclusively as a residential house, flat or multi stories house. While R1 consumers are considered the lowest income class who live in residences with electricity lifeline of 50kwh. The monthly consumption is considered to be below 50 kilowatts. Also, C2 and C3 consumers are described as consumers who use their premises for any other purpose other than exclusively as a residence or as a factory for manufacturing goods.

Table 4: The Multi-Year Tariff Order (MYTO) 2015 Distribution Tariffs 2015-2024

Distribution Companies (Discos)	States/Areas Covered	Consumers Class	Current Tariffs ₦ per kwh	Increment in Tariffs ₦ per kwh	New Tariffs ₦ per kwh	Percent Increment %
Abuja Electricity Distribution Company, AEDC (Abuja Disco)	Abuja FCT, Kogi & Niger	R2 Consumers	14.70	9.60	24.30	65.31
Ikeja Electricity Distribution Company, IEDC (Ikeja Disco)	Abule-Egba, Akowonjo, Ikeja, Ikorodu, Oshodi & Shomolu	R2 Consumers	13.21	8.09 8.59	21.30 (SP) 21.80 (TP)	61.24 65.03
Eko Electricity Distribution Company(Eko Disco)	Lagos Island, Ajah, Ibeju-Lekki, Ikoyi, Mushin, Ebute-Meta, Ijora, Badagry, Festac, Apapa & Surulere	R2 Consumers	15.63	8.37 10.16	24.00 (SP) 25.79 (TP)	53.55 65

Kaduna Electricity Distribution Company, KEDC (Kaduna Disco)	Kaduna, Sokoto, Kebbi & Zamfara	R2 Consumers	17.00	9.37 11.05	26.37 (SP) 28.05 (TP)	55.12 65
Benin Electricity Distribution Company, BEDC (Benin Disco)	Edo, Delta, Ondo & Part of Ekiti	R2 Consumers	14.82	9.26 9.63	24.08 (SP) 24.42 (TP)	62.48 64.98
Yola Electricity Distribution Company, YEDC (Yola Disco)	Adamawa, Borno, Taraba & Yobe	R2 Consumers	15.00	8.25 9.75	23.25 (SP) 24.75 (TP)	55.00 65.00
Port Harcourt Electricity Distribution Company,PHEDC (Port Harcourt Disco)	Rivers, Bayelsa, Cross River & Akwalbom	R2 Consumers	15.09	9.82 (FR)	24.91 (FR)	65.08
Kano Electricity Distribution Company, KEDC (Kano Disco)	Jigawa, Kano & Katsina		16.01 16.01	4.25 10.04	20.26 (SP) 26.41 (TP)	26.55 62.71
Jos Electricity Distribution Company (Jos Disco)	Plateau, Gombe, Bauchi & Benue	R2 Consumers	16.75	10.18	26.93	60.78
Enugu Electricity Distribution Company, EEDC (Enugu Disco)	Aba, Anambra, Ebonyi, Enugu & Imo	R2 Consumers C2 Consumers C3 Consumers	16.44 29.05 29.05	10.69 13.15	27.13 (FR) 42.20 42.97	65 45.27 47.92
Ibadan Electricity Distribution Company, IEDC (Ibadan Disco)	Kwara, Ogun, Osun, Oyo & Parts of Niger State	R2 Consumers	16.11	8.8	24.97	54.62

Excerpt from the Guardian Nigeria, December 28, 2015

*SP: Single Phase Meter
*TP: Triple Phase Meter;FR: Flat Rate

Vision for 2020 Energy Access for All

Through the deployment of clean energy, the goal of energy access for all can be met. Advanced and locally appropriate technologies can make Nigeria energy secure by 2020 through the provision of reliable, modern energy services that are affordable and efficient. The national grid will not necessarily provide all these services. We envision the utilization of renewable technologies for households, small-scale businesses and primary health centers on a large scale, along with a modernized, efficient transportation sector using compressed natural gas and renewable electricity instead of diesel. This vision can be realized with the right amount of political will, a conducive investment environment and the involvement of the people. The people who share the vision of a prosperous green Nigeria.

Nigeria: National Energy Policy

The National Energy Policy establishes guidelines for the protection of the environment in the exploitation of Nigeria's fossil fuels. It also emphasizes the exploration of renewable and alternative energy sources, primarily solar, wind and biomass.

The resulting policy document covers the development, exploitation and supply of all the nation's energy resources. It also covers key energy utilization sectors; energy related issues such as environment, energy efficiency and energy financing and energy policy implementation. It includes strategies for systematic exploitation of the energy resources, the development and effective use of energy manpower, supply of rural energy needs, efficient energy technology development and use, energy security, energy financing and private sector participation. The strategies are finally harmonized and grouped into short-medium- and long- term measures for easier implementation.

Planning and Policy Implementation

Energy planning and policy implementation in the country take place at four different levels. **At the National Level**, they involve macro-planning and policy implementation as part of the multi-sectoral national development policies and plans which are the responsibilities of the National Planning Commission. **At the Sectoral Level**, they involve overall sectoral planning, monitoring and co-ordination of policy implementation for the energy sector, in all its ramifications.

The function ensures consistency of sub-sectoral energy policies and plans with the overall national energy policies and plans; and the implementation of the latter is in accordance with provisions. **At the Sub-sectoral Level**, more specific sub-sectoral planning and policy implementation for the development, exploitation and utilization of particular energy resources, are carried out in the various energy sub-sectors, namely oil and gas, electricity, solid minerals, etc. These involve the Ministries of Petroleum Resources, Power and Steel, Solid Minerals, and others respectively. Other energy utilization subsectors such as transport, industry, agriculture, as well as research and development, are also relevant. Finally, **at the Operational Level**, activities involve the execution of the policies and plans developed at the sub-sectoral level by operational establishments such as the NNPC, NEPA (Gencos and Discos), Nigerian Coal Corporation and other public and private operators. (ECN, 2003)

Energy issues are multidimensional in nature and there are strong interactions between factors that affect energy demand, supply and consumption, which must be recognized in order to have an effective energy plan.

Energy Planning and Policy Implementation Objectives

The policy objectives and implementation strategies have been carefully defined with the fundamental guiding premises that energy is crucial to national development goals and that government has a prime role in meeting the energy challenges facing the nation. Furthermore, the dependence on oil can be reduced through the diversification of the nation's energy resources, aggressive research, development and demonstration (R D& D), human resources development, etc. Consequently the overall energy policy objectives may be summarized as follows:

- To ensure the development of the nation's energy resources, with diversified energy resources option, for the achievement of national energy security and an efficient energy delivery system with an optimal energy resource mix.
- To guarantee increased contribution of energy productive activities to national income.
- To guarantee adequate, reliable and sustainable supply of energy at appropriate costs and in an environmentally friendly manner, to the various sectors of the economy, for national development.
- To guarantee an efficient and cost effective consumption pattern of energy resources.
- To accelerate the process of acquisition and diffusion of technology and managerial expertise in the energy sector and indigenous participation in energy sector industries, for stability and self-reliance.
- To promote increased investments and development of the energy sector industries with substantial private sector participation.
- To ensure a comprehensive, integrated and well informed energy sector plans and programmes for effective development.
- To foster international co-operation in energy trade and projects development in both the African region and the

world at large.
- To successfully use the nation's abundant energy resources to promote international co-operation.

The following points summarize the objectives stated by the Nigerian National Energy Policy:

1. Optimum development of Nigeria's energy sources
2. Diversification of energy sources
3. Achievement of national energy security
4. Efficient energy supply
5. Guarantee of adequate, reliable and sustainable supply of energy for national development
6. Development of human and institutional capacity
7. Encouragement of greater indigenous participation in the energy sector
8. Promotion of local and foreign investment to boost private sector participation in the energy sector.

Recommendations

To ensure consistent energy generation and avoid inconsistencies in energy plans, it is imperative that a comprehensive and integrated approach to energy planning and implementation be evolved. The planning must consider the interactions between the energy sector and the rest of the economy, the interactions between the sub-sectors of the energy sector itself, and the plans within each sub-sector. The need to conserve the present energy generated in the country using energy-efficient products and the appropriate practices is essential for sustainable development. Therefore, it is recommended that the country should do the following:

1. Develop policies on energy efficiency and integrate them into the current energy policies. A comprehensive and coherent energy policy is essential in guiding the citizens towards an efficient usage of its energy resources.
2. Promote energy-efficient products and appropriate practices at the side of the end users and energy generation.
3. Create awareness on renewable energy and energy efficiency.
4. Establish an agency to promote the use of energy-efficient products and ensure the appropriate practices.
5. Develop and imbibe energy efficiency technologies.
6. Carry out a resource survey and assessment to determine the total renewable energy potential in the country as well as identify the local conditions and local priorities in various ecological zones.
7. Establish a testing and standards laboratory for renewable energy technologies similar to that in South Africa.
8. Take advantage of global partnerships, such as the Residential Energy Efficiency Project initiative of UK, to assist the country in a creative integration of renewable energy systems.
9. Establish a renewable energy funding/financing agency such as India's Indian Renewable Energy Agency.
10. Develop appropriate drivers for energy efficiency policies implementation.
11. Clean energy facilities should be embraced in the different sectors of the Nigerian economy.
12. More efficient passive and full usage of solar technologies in the residential, commercial, and industrial sectors.
13. Biogas from wastes as a source of cooking fuel in homes.
14. Use of energy-efficient lighting.
15. Implementation of renewable biomass as a fuel in highly efficient cook stoves.
16. Efficient production of charcoal as a fuel in homes and small and medium enterprises.
17. Use of biofuels in efficient cooking stoves and lamps in homes.
18. Use of compressed natural gas (CNG) as a transport fuel.
19. Use of biofuels as a transport fuel.
20. Public enlightenment on the use of energy efficient and energy saving products.
21. Introduction of a bus rapid transit system to other cities and expansion of the Lagos system.
22. Shift from high carbon intensive fuels to natural gas for energy generation in industries.
23. Development of a CNG infrastructure to distribute natural gas to industries located at sites remote from the existing pipelines.
24. Use of solar and wind energy for irrigation water pumping and farm electricity supply.
25. Utilization of agricultural residues for electricity generation.
26. Generation of biogas from wastes produced by the livestock and animal husbandry.
27. Implementation of combined heat and power (CHP) facilities in industries.
28. Implementation of energy efficiency improvements in manufacturing industries.
29. Implementation of CHP facilities in commercial facilities.
30. Passage and implementation of Petroleum Industry Bill (PIB)
31. A thorough reassessment of national distribution lines, poles, transformers and other technical details necessary for progressive supply of electricity.

Conclusion

There are growing concerns in creating alternative energy sources capable of meeting the energy needs of the Nigeria population, as those of the present sources and usage are expensive, unsuitable and unsustainable. Prominent among the policy recommendation, is the need to strengthen the effectiveness of energy generating agencies by ensuring periodic replacement of worn-out equipment in order to drastically curtail transmission power losses. The gas being flared at the different crude oil refining sites could be used to generate abundant electric power for homes and industries. Nigeria should strive for a well-rounded energy mix, combining the available renewable energy with the non-renewable fossil fuel. In addition to these, the existing research and development centers and technology development institutions should be adequately strengthened to support the shift towards an increased use of renewable energy. Human resource development, critical knowledge, and know-how transfer should be the focus for project development, project management, monitoring, and evaluation. The preparation of standards and codes of practices, maintenance manuals, life cycle costing, and cost-benefit analysis tools should be undertaken as urgent priority.

References

Adenikinju, A. (2005). Analysis of the cost of infrastructure failures in a developing economy, the case of electricity sector in Nigeria'. African Economic Research Consortium AERC Research Paper 148, Nairobi. February 2005.

Adeyemi, A. O. and Ayomide, A. (2013). Electricity Consumption and Economic Growth in Nigeria, Journal of Business Management and Applied Economics, 2(4):1-14.

Anuforo, E. (December, 2015). Longer Darkness, Higher Tariff for Electricity Consumers, The Guardian Nigeria, p.58-59.

CBN (2000). 'The changing structure of the Nigerian economy and implications for development'. Research Department, Central Bank of Nigeria, Lagos: Realm Communications.

Daily Sun (December, 2015). New Hike in Electricity Tariffs, Daily Sun Nigeria, p.17.

ECN (2003). National Energy Policy, Energy Commission of Nigeria: Federal Republic of Nigeria. Retrieved 05 October, 2015.

ECN-UNDP (2005). Renewable energy master plan: final draft report, Energy Commission of Nigeria and United Nations Development Programme. Retrieved 17 June, 2007)

Fagbenle, R.O. and Karayiannis, T.G. (1994). On the wind energy resources of Nigeria, International Journal of Energy Research, 18 (5): 493-508.

Famuyide, O.O, Anamayi, S.E., Usman, J.M. (2011). Energy Resources' Pricing Policy and Its Implications on Forestry and Environmental Policy Implementation in Nigeria, Continental Journal of Sustainable Development, 2:1-7.

Famuyide, O.O., Adu, A.O. and Ojo, M.O. (2004). Socio-Economic Impacts of Deforestation in the Sudano-Sahelian Belt of Nigeria, Journal of Forestry Research and Management, 1(1&2):94-106.

Hermann, S. A. (2001). Solar manifesto, London: James and James, p.1-22.

Ighodaro, C.A.U. (2010). Co-Integration and Causality Relationship between Energy Consumption and Economic Growth: Further Empirical Evidence for Nigeria, Journal of Business Economics and Management, 11(1):97-111.

International Energy Statistics (February 2015). Nigeria Total Petroleum Consump-

tion: 1980-2013, Nigeria Data Portal. Retrieved from http://nigeria.opendataforafrica.org/phebrhc/nigeria-total-petroleum-consumption-1980-2013

Karekezi, R. (1997). Renewable Energy Technologies in Africa, Zed Books Limited with African Energy Policy Research Network (AFREPREN) and Stockholm Environment Institute (SEI).

Nnaji, C.E. and Uzoma, C.C. (2010), CIA World Factbook, Nigeria.

Odularu, G.O. and Okonkwo, C. (2009). Does Energy Consumption Contribute To Economic Performance? Empirical Evidence from Nigeria, Journal of Economics and Business, 12(2): 43-47.

Odumodu, O. (February, 2014). Power Sector Privatisation: Darkness in the Shadows of Light, Nigerian Orient News Magazine, 4(38): 12-18.

Ogbuagu, J.O. (1993). Energy Education- Implications in Nigeria, Nigerian Journal of Solar Energy, 12:134-141.

Ogbuagu, J.O., Ogburubi, I. and Nwosu, M.C. (2001). Renewable Energy Sources in Nigerian Environment: An Overview, African Journal of Environmental Studies, 2(2):27-31.

Okafor, E.C.N. and Joe-Uzuegbu, C.K.A. (2010). Challenges to Development of Renewable Energy for Electric Power Sector in Nigeria, International Journal of Academic Research, 2(2):211-216.

Onuegbu, H.C. (December, 2015). Oil Subsidy, Cost of Governance and Budget Restructuring in Nigeria, Presented to the Inaugural Philip Asiodu Economic Initiative (PAEI) Roundtable Conference, Abuja, Nigeria.

Premium Times (2015). Nigeria's energy crisis worsens: only 5 of 23 power plants functional, The Premium Times Nigeria. Retrieved 15 October, 2015.

Sambo, A.S. (2008). Matching Electricity Supply with Demand in Nigeria, International Association of Energy Economics, 4:32-36.

Sambo, A.S. (2009). Strategic Developments in Renewable Energy in Nigeria, International Association of Energy Economics, 4:15-19.

Sorensen, H.A. (1983). Energy conversion systems, New York: Wiley, p.485-491.

U.S department of Energy (2005). Energy information administration, International Energy Outlook. Retrieved 15 October, 2015.

Williams, C.E. (1998). 'Reaching the African Female Farmers with Innovative Extension Approaches: Success and Challenges for the Future'. Paper Presented To The International Workshop on Women Agricultural Intensification and Household Food Security, University of Cape Coast, Ghana, 25th-28th June.