# A Quantified Assessment Of Energy Demand In A Developing Nation In The Year 2022 – A Nigerian Perspective

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**ABSTRACT:** This study critically assessed the available energy resources and their relevant to socio-economic development and probable energy demand in Nigeria. The study also examined the energy policy and shortfalls on the implementation. With all these as a base, the study critically examined some of the methodology to forecast energy requirement and used it to estimate the energy demand of Nigeria in the year 2022 Result was derived from the applicable methods used, such as, by eight-year growth pattern, by analogy with Brazil which is comparable with End-used estimate by Prof Salawu (1985).

**Index Terms:** Energy demand, estimated requirement, time horizon, forecasting methods, planning and policy

## 1.0 INTRODUCTION

Energy is the basis of any modern industrial development. Therefore any country aspiring to achieve modern economic and technological development must plan its energy demand. World economics are heavily dependent on energy and Nigeria is not an exception. As Alam (2006) puts it, “energy is the indispensible force driving all economic activities” in other words the greater the energy consumption, the more the economic activities in the nation and as a result a greater economy emerges. Today Nigeria is seen as one of the greatest developing nation in Africa with highly endowed natural resources. However, increasing access to energy in Nigeria has proved to be not only a continuous challenge but pressing issue with the international community. Economic growth is a prerequisite for a nation to move from a third world country to a developing country like Nigeria, the greater the economic growth, the better its chances to become more developed. With adequate utilization of energy potentials to meet the demand in the year 2022, the nation will experience high level of economic growth. The energy demand in Nigeria is far outstrips the supply. Nigeria is faced with acute energy problems which are hindering its development, notwithstanding the availability of vast natural resources in the country.

### 1.1 Research Objectives

The study is set towards capacity building for energy planning and determination of the actual energy demand and supply strategy for a 10 year time horizon, to survey the Nigerian energy resources, assess the energy policy and examine some of the methodology to forecast the energy requirement in the next ten years from 2012


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## 2.0 LITERATURE REVIEW

Energy exist in the form of heat, light, motive force or chemical changes, when substances like coal, petroleum, gas, wood, biomass etc are burned or subjected to controlled pressure and temperature. Energy stored in fossil fuels, coals, crude oil and natural gas produces steam coupled to generators in power stations. Conceptually, energy is perceived operationally as “the capacity to perform or do things” Energy has pervasive impact on the economy and environment such that the progress or development of any country in the world is measured by per capita energy consumption or the contribution of the energy sector to the gross domestic product (GDP) of that country. Energy apart from serving as pillar of wealth creation (export and revenue generation etc), in Nigeria it is also the nucleus of operations and the engine of growth for all sectors of economy. Nigeria is blessed with abundant energy resources but suffers from perennial energy crisis that has appeared to have defied every solution Available information without rigorous analysis shows that Nigeria is a “primary energy stored house with such resources as coal, petroleum and natural gas but today Nigeria suffer from power outage regularly, table 2.1 present information on energy consumption pattern in Nigeria, table 2.2 shows statistical information on future installed electricity generation by fuel in percentage. The exploitations of Nigeria energy resources began with coal in 1909 and dropped from 50% to 1% in 1990. This situation looks as if the nation went asleep with the petroleum dominated scenario of 1970s and early 80s during which reasonable supplies were cheap and available than today. It is difficult to explain how Nigeria got to this state of affairs with all these energy resources available within its borders. The crisis with coal and other energy resources was intensified with the discovery and development of petroleum. The use of petroleum energy in place of coal in railway transportation, electricity generation etc led to the neglect of other energy resources. Access to energy is the dividing line between the poor countries and rich countries. This explains why the developed countries of the world have and consume far more energy than the developing and the underdeveloped countries. If any country must tackle the problem of poverty, the country will need to provide energy for her citizens. In planning for the Nigerian energy demand for the next ten years, measures for energy efficiency must be incorporated. If we use energy efficiently, it will lead to saving of personal income, it will help reduce the building of more power stations.

The demand for energy leads to economic growth. It is true that consumption is derived from demand. That is whatever is consumed must have been demanded. Birol (2007) argues that demand for energy has surged and in that respect, the unrelenting increase has helped fuelled global economic growth. Yu and Choi (1985) carried out a research on the Philippines and found that there is a positive relationship between energy consumption and economic growth. They went further to define the relationship as a unidirectional one where economic growth served as dependent variable and energy consumption was the independent variable. Asafu Adjaye (2000) carried out the same research on Singapore and Indonesia respectively and found out the same unidirectional causality effect of energy consumption and economic growth. Breshin (2004) said that electricity is vital for driving growth in the energy manufacturing and social sector. He went further to say that a parallel (positive) growth trend existed between energy demand and gross domestic product (GDP). Ageel and Mohammed (2001) ran a co-integration on energy and its importance to economic growth in Pakistan, a developing nation like Nigeria and found that increase in energy consumption leads to economic growth. Oviemumo (2006) agrees that "energy efficiency is the indispensible component of any effort to improve productivity" and of course contribute to economic wealth. Majority of Nigerian are dependent on fossil fuel and fuel wood. The over dependence on fossils and fuel wood (used mainly by poor rural commuters) have not yielded enough capacity to meet increasing demands.

### 2.2 An Outlook Of Nigeria Energy Policy

In recognition of the vital role, energy plays in the aspect of human activity, investigation revealed that Nigerian government has over the years adopted various approaches to develop the country's major source of energy, but none has yielded result. Other than the energy policy guidelines which were published in 1999 by the federal ministry of science and technology, Nigeria does not have a comprehensive energy policy which should spell out who is responsible for what in energy related decisions, the priority in terms of developing the numerous energy sources. The study revealed that Nigeria energy commission produced an energy policy document in 2000 which has not yet been made public to comprehend the extent of energy crisis in Nigeria. Also since 2005 when inter-ministerial committees submitted their report on Nigeria energy policy it is yet to be finally adopted. Experts in energy and environmental sector have warned that absence of national energy policy could inflict substantial damage on the country's natural resources and environment. It is therefore researcher's view that the absence of energy policies backed up by sound strategies for their implementation would expose the country to a more severe energy crisis.

## 3.0 SURVEY OF NIGERIAN ENERGY RESOURCES

There is no country or region in the world that does not have one form of energy or the other, however, the distribution of resources is uneven. Nigeria for instance is self sufficient in energy but suffers from energy crisis due to inability to harness and develop other viable resources.

### 3.1 Petroleum Energy

Crude oil is the dominant source of commercial energy use, accounting for over 80% of national commercial energy consumption. Crude oil has been a major economic growth determinant. For the past three decades, it has claimed the topmost position in the export list of the country (National Bureau of Statistics 2006). As at 2010, the Nigeria proven crude oil reserve stood at 40 billion barrels. As a member of the Organization of Petroleum Exporting Countries (OPEC), Nigerian daily crude oil production today is 2.4million barrels. The effect of oil as an energy source is glaring and is majorly felt in the economic account.

### 3.2 Natural Gas Energy

Besides being abundance in Nigeria, natural gas has numerous potentials. Gas is the major substitute to other fuels in electricity generation. Domestic utilization of natural gas account for 80% mainly for power generation while remaining goes to industrial sector. The known reserve of natural gas has been estimated at about 187.44 trillion standard cubic feet and it is expected to last more than a century. Nigeria has the largest gas reserve in Africa and is among the top ten in the world (office of statistics).

### 3.3 Coal Energy

Coal started playing an important part in the national economy soon after its discovery in Enugu in 1909. Nigeria is heavily endowed with 22 mines of coal resources which have a total proven reserve of over 2.5billion tones. Coal was the first source of energy to be exploited in Nigeria; it then immediately became the power source of the nation but its relevance began to drop immediately after oil was discovered.

### 3.4 Solar Energy

The total land area of Nigeria is 923.76km$^2$. Salawu (1985), it is estimated that Nigeria received 5.08 x $10^{12}$kwh of energy per day from the sun and if solar appliances with 5% efficiency are used to 1% of the countries surface area, then 2.5 x $10^6$mwh of electricity would be produced.

### 3.5 Wind Energy

In Nigeria, not much has been done yet in the area of wind energy or geothermal etc.

### 3.6 Fuel Wood

As stated earlier, the total land area of Nigeria is 923.76km$^2$ or 92.4 million hectares. The forest area is 31.34m hectares or about 10% of the total land area is reserved forest land. Currently over 65% of Nigerians live in rural areas and for this rural dwellers fuel wood account for over 80% of domestic energy consumption for cooking and heating.

### 3.7 Nuclear Energy

Presently there are unspecified deposit of Uranium and Thorium bearing minerals in various locations in the country. The present government has brought up the idea of building nuclear plant.

### 3.8 Biomass Energy

The energy content of biomass can be harnessed and converted into useful energy through biomass briquettes and biogas.

### 3.9 Electricity

A major energy product which has emerged from the development of Nigerian energy resources is electricity. Although at independence in 1960 the country inherited a rudimentary electric power generation and distribution system under the Electricity Corporation of Nigeria (ECN) now the Power Holding Company of Nigeria (PHCN) has a total installed capacity of about 5,000 megawatts from the hydropower station at Jebba, Kainji River and Shiroro, four gas thermal plants at Afam, Delta, Ijora and Sapele. Coal burning plants were the main source of electricity until the late 70s. Government strategy for improved supply of electricity has been based on a shift from one power generating source to another in keeping the changing technology. Electricity is the world's most important form of energy and a vital ingredient of everyday life. It affects directly or indirectly all aspect of industrialization and development process of every nation. (EPIC, 2004), it was stated that the country consumes about half its capacity. With an increased population coupled with diversification of economic activities, energy demand is rising but yet, electricity supply is relatively stagnant.

## 4.0 SOME METHODOLOGICAL CONSIDERATION IN FORECASTING ENERGY DEMAND

Forecasting energy demand for a country that has less statistical data for such a distance future is always shrouded in obscurity makes short term forecasting still subject to uncertainty. However, when a forecast is deemed essential, effort must be made to obtain some data which is as much accuracy as possible. Several forecasting techniques have been developed and as a first step, it is desirable to outline briefly some of the techniques as a guide to the choice of methods. For short and medium term forecast, a commonly used technique is that of fitting a linear to past and extrapolating it. Sometimes a logarithmic curve is used. This may not be ideal for our own purpose because the period is long. Energy demand in Nigeria is unlikely to follow a linear trend given rapid pace of development that appears attainable. An alternative method that has been found quite useful is to relate energy consumption to some micro-economic variables such as, GNP and GDP. This method has variants. Some may use only one micro-economic variable and others may use multiple correlations to relate energy consumption to several economic activities such as in industrial productions, constructions and gloss capital formation. The main difficulty in the various versions of this method is that the macro-economic variables have to be forecast first before they can in turn be used to forecast energy demand. It is clear that this method can only be used for very crude estimates. A simple version of this method can only be used to obtain one global estimate. There are methods of non-linear trend curve fittings, which are mathematically very intricate and time consuming. They require extensive data bank of long duration. These methods are unsuitable here because extensive data are not available. The next three methods are practical and will be our major tool. The first method is that of historical analogy. In it, a more advance country is selected which at some period in the past attain a level of economic development, which the country for which a forecast is to be made would be expected to attain at the forecast horizon. The energy consumption of more advance country in the past is then imputed to the second at the future data. Ideally, both countries should be fairly similar geographically. At the stages where the past consumption of one is imputed as the future consumption of the other would be more plausible if the economic and demographic are fairly close. The second method is that of estimating energy demand by "end used" to which energy is put and surveyed and by estimating the future growth in this sector, the demand for energy in each at the target date is assessed and aggregated to obtain a global figure for the whole economy. In a situation where there is no well established pattern for energy consumption, it is apparent that in this sort of study one must inevitably engage in a lot of crystal gazing. One peer into the future to foresee that developments appear likely in various energy using sectors or industries to estimates their probable magnitude and approximately assesses the apparent energy consumption for each sector. The aggregate sum of the sectoral energy demand is taken as the global figure at the target date. The end-use approach has the same uncertainties as the other methods but because of its dis-aggregative estimate for each sector, it seems likely to be more all embracing than any other methods and may therefore be said to be more 'accurate' on that account. One may not however talk of pure accuracy in this type of exercise. Forecasting the future by whatever method is inherently prone to uncertainties.

## 5.0 APPLICATION OF METHODOLOGY

### 5.1 Estimate of energy demand by historical and geographical analogy.

To start with, we know that in the year 1979, the Nigerian total per-capita energy consumption according to office of statistics was 14,340MJ. Assuming that it is approximately true that energy consumption doubles in every 8 years in most developing countries, a rough estimate can be obtained for several years ahead. This trend is reasonably confirmed for Nigeria in table 5.1. On this basis, the following pattern of total per-capita energy consumption may be postulated as follows

**Table 5.1 Estimate of Energy Demand By Eight- Year Growth**

| Time/Period | Energy consumed in MJ |
|---|---|
| 1979 | 14, 340MJ |
| 1987 | 28, 780 MJ |
| 1995 | 57, 560MJ |
| 2003 | 115, 120MJ |
| 2011 | 230, 240MJ |
| 2019 | 460, 480MJ |
| 2027 | 920, 960MJ |

Now let's look into a country which has passed a stage which Nigeria may reasonably expect to attain in the year 2022. It is desirable to select a country compared, which Nigeria may be judged to have fairly close similarities. Of course, no two countries can be identical, but some countries approximate each other more than the rest. Nigeria and Brazil have certain similarity, they both grow the same range of tropical crops; cocoa, cotton, rubber, coffee, palm products, groundnuts, etc. Brazil is the largest exporter of coffee in the World as Nigeria is the largest exporter of groundnut (peanuts) before the oil boom in 1970. Brazil is a larger country and has more mineral resources especially high grade coal than Nigeria. But to balance this, if one may put it this way, Nigeria produces and exports far more high grade crude oil. In 1971-72, Brazilian

economy grew at 11% while that of Nigeria grew at about 12% (office of statistics). It would therefore appear that both countries are fairly similar in terms of economic growth potential.

*According to a survey of Brazilian economy in the year 2000, the following data were given:*

Population: 168, 510, 000 growing at the rate of 3.1% p.a

Rural 54%, Urban 46%
GNP: $72.5 x$10^9$
Per Capita $430

Total per capita energy consumption: 700, 720MJ

Now assuming the population of Nigeria in the year 2000 to be 139, 550, 000 and growing at the rate of 2.8%, it may be expected that Nigeria's population in the year 2022 would be about (228, 860, 000) 228.86 million; if an annual growth rate of about 8% up to the year 2022 is assumed, the GDP in that year should be about $38.8 x $10^9$, and assuming 95% of the GDP is GNP. We have Nigeria GNP in 2022 as about $36.8 x $10^9$. This is about half to Brazil's GNP in the year 2000. It may therefore, on the basis of the above similarities, input Brazil's total per-capita energy consumption in 2000 to be the Nigeria's probable total per capita energy consumption in 2022. Therefore one may postulate the following for Nigeria in 2022

Population: 228.86 million
GNP: $36.8 x $10^9$

Total per capital energy consumption: 690, 720MJ

As stated earlier, looking ten to fifteen years ahead is a hazardous exercise in the best of circumstances. One would consider the circumstances to be ideal if there has been a long and stable tradition of energy consumption with well kept statistics on energy consumption by sectors and various energy uses. The situation is far from ideal. Very few countries in the world possess accurate energy consumption by end-use even among some of the advance countries. Nigerian per-capita energy consumption are available only from 1960/1970 and even for those, there are discrepancies between the figures in energy consumption summaries of the federal office of statistics and those given by the United Nations in its statistics of the world energy consumption. Prof Salawu (1985), the development oriented forecast per-capita energy demand for Nigeria up to the year 2020 by the end use approach estimated Nigeria energy demand from 1985-2020. The approach analyzed energy consumption of Nigeria, sector by sector, namely: Household, transport and industrial sector. The total per-capita energy demand in 1979 and the year 2000 are 14,340MJ and 110,180MJ respectively and it was projected that by the year 2020 it will be 6times the former which is almost the same with my result.

### 5.2 Summary of estimated Nigerian energy demand by the year 2022

i. By eight-year growth pattern 680,650MJ
ii. By analogy with Brazil 690,720MJ
iii. By End-Use estimate: 661,080MJ

## 6.0 CONCLUSION/RECOMMENDATION

In this study, a forecast is made to estimate the energy requirement of Nigeria for the general development of the country up to the year 2022. The total estimated energy requirement considered and recommended that by the year 2022, all towns and villages will be served by electricity; similarly all household will be provided with at least the minimum requirement of electric energy for lightning and domestic use, all streets and lanes will be lit at night. All other end-use of electric energy (except those requiring obligatory electric energy) will be provided by other non-conventional energy sources. The use of kerosene and LPG which are becoming increasingly popular in the urban areas for lighting and cooking will be phased out by 2022. The end use will be provided by alternative sources such as biomass and fuel wood. Most of the conventional energy sources will be replaced by non-conventional means by the year 2022. By 2022 all electric generation will be more of hydro, coal, urban waste and other non conventional sources with less hydrocarbon. Biomass energy will be generated and use for cooking supported by fuel wood. By 2022, emphasis will be put on rail for major transportation because trucks uses 4 times as much fuel as rail for movement of goods. The comprehensive policy instrument will be necessary to promote energy efficiency and utilization. From the information gathered during the study, the author therefore wish to recommend policy option that Nigerian Government can explore for efficient use of energy.

- It will be necessary for government to set up a ministry that will be responsible for energy planning and utilization.
- Lack of trained personnel is a major factor hindering the development of energy in Nigeria. Training and Retraining is recommended.
- Government should set up a national fund for energy efficiency, planning and utilization, increase funding is vital; it is certain that energy sector is capital intensive and would require huge amount of investment. Public and private sector should form partnership to tackle this investment problem.

Government need to increase the budgetary allocation to the sector.

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## REFERENCE

[1]. Alam (2006), Economic growth with energy

[2]. Birol F (2007), World energy prospects and challenges, Melbourne: Blackwell publishing

[3]. YU E. Choi (1985), "The casual relationship between energy and GNP, an international comparison" J.Energy. Dev.

[4]. Asafu-Adjaye J (2000), "The relationship between energy consumption, energy prices and economic growth: Time series evidence from Asian developing countries" Energy Econ22. 615-625

[5]. Ageel A, Butt MS (2001), "The relationship between energy consumption and economic growth in Pakistan" Asia-Pac. Dev. J.8(2): 101-109

[6]. Electric power sector reform implementation committee (EPIC) (2004), National electric power policy.

[7]. Jochem E (2004), World Energy assessment. Energy and challenges of sustainability. Energy end-use efficiency" PP. 174-212

[8]. National Bureau of Statistics (2006) Nigerian National Committee of the World energy Council (2007) Communiqué on Africa forum on energy efficiency 8-9th January

[9]. Oviemumo A (2006), Impact of energy on the manufacturing sector of Nigeria.

[10]. Prof. Salawu (1985), Energy estimate in Nigeria by end-use approach.

[11]. Energy commission of Nigeria (2008), "Assessment of Energy options and strategies for Nigeria Energy Demand Supply and Environmental Analysis for Sustainable Energy Development (200-230)" Report No. ECN/EPA/2008/01.

[12]. Survey of the Brazilian Economy: (Washington D.C, Brazilian Embassy 2000).

[13]. US Energy Supply Project to 2010. Washington D.C 1979

[14]. W.I Okonkwo (2000), National center for Energy Research & Development, University of Nigeria Nsukka.

**Table 2.1 ENERGY CONSUMPTION PATTERN IN NIGERIA 2000-2010**

| Energy type | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|
| **Coal** | $10^6$tce | 6.8 x$10^3$ | 6.3 x$10^3$ | 6.3x$10^3$ | 5.2 x$10^3$ | 3.5 x$10^3$ | 3.0 x$10^3$ | 1.8 x$10^3$ |
| | % | 0.04 | 0.03 | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 |
| **Hydro** | $10^6$tce | 4.29x$10^3$ | 4.59x$10^3$ | 4.59x$10^3$ | 5.28x$10^3$ | 5.88x$10^3$ | 6.95x$10^3$ | 7.88x$10^3$ |
| | % | 12.0 | 14.5 | 14.6 | 16.8 | 17.8 | 19.6 | 21.7 |
| **Petroleum** | $10^6$tce | 12.14 x$10^3$ | 12.41 x$10^3$ | 12.88 x$10^3$ | 13.21 x$10^3$ | 13.35 x$10^3$ | 18.56 x$10^3$ | 19.11 x$10^3$ |
| | % | 40.2 | 40.5 | 40.8 | 42.2 | 42.8 | 48.5 | 49.2 |
| **Natural Gas** | $10^6$tce | 15.75 x$10^3$ | 15.81 x$10^3$ | 15.98 x$10^3$ | 15.99 x$10^3$ | 16.12 x$10^3$ | 16.38 x$10^3$ | 18.98 x$10^3$ |
| | % | 52.5 | 52.8 | 52.3 | 53.3 | 54.6 | 54.8 | 59.8 |
| **Total** | | 32.18 x$10^6$ | 32.81 x$10^6$ | 33.45 x$10^6$ | 34.48 x$10^6$ | 35.35 x$10^6$ | 41.89 x$10^6$ | 45.97 x$10^6$ |
| | % | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**Table 2.2 FUTURE INSTALLED ELECTRICITY GENERATION BY FUEL IN PERCENTAGE**

| Fuel type/% use | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Coal** | 0.0 | 9.9 | 13.8 | 15.3 | 15.6 |
| **Gas** | 78.6 | 48.5 | 53.5 | 53.0 | 59.0 |
| **Hydro** | 21.3 | 18.9 | 13.6 | 19.7 | 8.6 |
| **Nuclear** | 0.0 | 9.4 | 5.3 | 8.3 | 6.7 |
| **Solar** | 0.1 | 13.1 | 11.0 | 10.4 | 8.3 |
| **wind** | 0.0 | 0.1 | 2.9 | 2.3 | 1.8 |

***Source: International Association for Energy Economics***