Impact of Energy Consumption and Environmental Degradation on Economic Growth in Nigeria

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6 January 2014

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ABSTRACT

The argument concerning the contribution of energy towards the growth objective and the adverse environmental impact its consumption brings along are contentious, whether to reduce energy consumption in order to reduce negative externality as it is just an intermediate input which its contribution is insignificant to the accomplishment of growth objective is the curiosity behind this study. The study empirically examined the impact of energy consumption and carbon emission on economic growth in Nigeria between 1981 and 2011. The research takes analytical/quantitative dimension. It is a multivariate study by including in the model two conventional determinants of Economic Growth, Capital proxy by Gross Capital Formation, labour proxy by labour participation rate, and other variables of study which are electricity consumption, energy use kt in oil equivalent and Co_2 emission. Restricted Error Correction Model (VAR) is used, Impulse Response function was carried out and the necessary diagnostic tests were examined with the aid of Econometrics View Package (E- view). The study reveals that the long run relationship exists among the variables and electricity contributes significantly to the economic growth. Further investigation using Granger causality analysis to examine the causal directions among the variables reveals bidirectional causality between electricity consumption and economic growth and indicates unidirectional causality running from energy use kt of oil to carbon emission. This brings the study to conclusion that electricity is not just an intermediate input; its contribution to the accomplishment of growth objective cannot be relegated to the background. Hence, Nigeria can pursue triple goals of energy security by exploiting renewable energy source, environmental sustainability and sustainable inclusive growth. Therefore necessary recommendations were made as a way forward to ensure that Nigeria move near the end of “catch up” phase by harnessing this nascent sector and policy measures to abate environmental degradation were also highlighted.

1 INTRODUCTION

Access to modern energy is assumed to be a precondition for poverty alleviation, sustainable development and the attainment of the millennium development targets. According to Salam (2006) energy is the indispensable force driving all economics activities. Ekpo (2013) stressed that the positive multiplier effect of constant power supply cannot be overemphasized. Meanwhile, the greater the energy consumption, the greater the carbon emission resulting from the consumption because the fossil fuel (Oil & Gas) constitute almost 75 % of Nigeria energy consumption while the renewable energy plays a minimal role.

In actual fact, considering the global warming problem and an increasing concern for limited supply of energy (non renewable) on one hand and an emerging paradigm shift on green economy at the other hand, the relationship between economic growth and counterproductive environmental pollution resulting from carbon (CO_2) emission attracts the interest of researcher and policy maker. The emission of CO_2 is a major cause of global warming (Mohammed J, et al. 2012). Consequentially, the investigation of whether the economic growth and energy consumption result in environmental degradation (pollution) as postulated by the famous Environmental Kuznets Curve (Kuznets, 1995) is inevitable.

Furthermore, the need to determine the relationship and the impact of energy consumption on economic growth derives from the increasing realization of the importance of energy to the economic growth of a nation. This has led many to question the conventional neoclassical production function analysis where land, labour, capital are recognized as the main factors of production. This analysis has been extended to include an energy variable. However, the magnitude of energy influence in the economy has been hotly debated by the macro economists. Consequently, efforts have been made to discover the exact relationship between energy and the other factors of production as to whether energy complements or substitutes other factors of production.

The benefits of energy to commercial, transportation, industrial and household cannot be over emphasized. Hence, an impressive performance of Gross Domestic Product (GDP) is driven by the effective supply and consumption of energy. As a key component of national sector, energy (electricity and crude oil produce) are the major sources of nation advancement and improvement in the standard of living of the people by stimulating other sectors like health, education, agriculture, commerce, transportation and industries etc. Emphasis has been shifted to energy (electricity and oil & Gas) as factor input with the economic important of stimulating economic growth. At individual level, increased in energy consumption is likely to be one of the most important causes of improvement in welfare of the people. At national Level, in this period of the digital economy, it is not possible to envisage development without the use of modern energy (Worlde Rufael, 2006). For the purpose of this study, the examination of the energy shall be separated to two components: The electricity, the most preferred energy component which its share in energy consumption has increased rapidly; crude oil which is the source of Natural gas (NLG), Liquefied Petroleum Gas (LPG) and Automotive Gas Oil (AGO) known as diesel.

It is important to note that electricity energy is vital for economic growth and quality of life not only because it enhances productivity of Labour, Capital and other factors of production. But, the fact that increased in energy consumption indicates the high social - economic status of the nation's concern (Adebola, 2011). In Nigeria reverse is the case, where for instance the estimated population of 170 million rationing between 3000 MW to 6000 MW of electricity supply, while the country with estimated population of 5.5 million like Libya has generating capacity of 4600 MW.

Despite the efforts of Federal Government of Nigeria to generate power capacity that will sustain the economy having recognized its importance to drive the economy to acme level, electricity supply in Nigeria is yet to be consistent i.e. it remains epileptic despite the enactment of the Electric Power Sector Reform (ESPR) Act in 2005. This has constituted a great impediment to the energy consumption which is required to drive the economy. As a result of this, Ekpo (2013) emphasized that government should redouble its efforts in ensuring that power failure become history; no economy develops with generator. It is noteworthy that, as at May 2012, the quantum of power generated in Nigeria was about 2800 MW in the country of about 150 Million. The power supply hit 4237 MW in August 2012, which was the highest power that has ever been generated as at then. According to Nnaji (2013) this increase is due to the sharp increase to gas availability from Nigeria Gas Company to the thermal plants. The power sector aimed of achieving 5000 MW if there can be consistent supply of gas to thermal plant and if the water levels can improve at the dams (Hydro power plant) like Kainji, Shiroro, and Jebba.

In an attempt by FG to sustain and maintain the consistent power supply on 24th of August approved $300 million for the construction of Zungeru hydro-power plant in Niger state in conjunction with United Nations Industrial Development Organization (UNIDO). This was ventured into as one of the step to achieve the goal of sustainable Energy For All by injecting about 700 MW electricity into the national grid. The Federal Government efforts to ensure adequate power supply are indicated by the following quotation:

> "The construction work on Manbila hydro power plant is billed to commence by the first quarter of 2013 and all other power generations sources are being exploited. We are also working on several or small hydro power projects that will add about 30 MW. The FG has signed the MOU with Siemens of Germany for the production of 450 MW of electricity. In the same vein, 30 MW coal to power plant was being pursued under the public private partnership (PPP) scheme" – President Goodluck Jonathan (Punch, May 2013)

The latest giant stride by FGN to ensure adequate energy consumption to run the economy is indicated by the Federal Government investing $3.7 billion to improve the power transmission so as to wheel 20,000 MW (Punch, May 2013).

However, it is instructive to note that those huge investments have not improved the situation of power supply in Nigeria. Rather than witness any improvement the power generation capacity is getting worse. For instance official records showed recently that power generation capacity suffered a significant decline from 4517 MW recorded last December 2012, to a miserable level of 3300 MW in the middle of April 2013 (Punch, May 2013).

The use of energy in Nigeria, has, since 1960 been on the increase. Crude oil is another major source of energy in Nigeria and in the world in general. Crude oil being the mainstay of Nigeria economy plays a vital role in shaping economic landscape and destiny of the country. It was not until the end of Nigeria civil war (1970) that the oil industry began to play a prominent role in the economic life of the country.

As energy demand assuredly increased, supply became grossly inadequate. The challenge of meeting present energy demand in Nigeria is colossal in the sense that while seeking for sustainable energy supply and making energy choices, environmental problems of fossil have to be considered. Hence, in solving our energy supply constraints, options in a prospective energy mix should also be environmentally friendly, sustainable and efficient (conserving energy for more work). The consumption of the crude oil produce is adversely affected by the restrictions in supply through the activities of vandals, crude oil theft, and corruption by the government officials. This is evidenced by the NUPENG president's declaration (Achese, 2013) " it was alarming that the daily crude oil production is now fluctuating between 1.86 million barrels and 2.1 barrels as against the estimated 2.48 million bpd in the first quarter of the year 2013". This loss in oil production in the last quarter amounted to a loss of about N191 billion said NNPC (Punch, May 2013).

Crude oil has had certain impacts on Nigeria economy both positively and contrary. At this juncture, it is noteworthy that energy consumption (electricity and crude oil) have the negative side, which little or no attention is paid to by the policy makers. The negative impact can be considered with respect to the surrounding communities within which the oil are exploited, drilled and transported. These activities cause the pollution and environmental deprivation of means of livehood (Ebohon, 1996). But the most significant of the adverse effect which is the prominent part of the study is the carbon (CO_2) emission, the major cause of the greenhouse effects Crude oil is a non renewable source of energy which is a fossil by nature, its production and consumption brings about carbon (CO_2) emission which is environmentally unfriendly. Besides, increased extreme events (especially drought and floods) in Nigeria have in recent times led to the destruction of life's, properties and farmlands. This would require huge construction projects (through increased capital budgeting from both the States and Federal Government) to control floods and rising rivers levels along the coastal areas of southern Nigeria, River Niger, River Benue, and the Kaduna river. Empirically, economic growth and human development index were found to be positively related to the carbon (CO_2) emission, it implied that greenhouse gas emission accompanies Nigeria's economic growth and indicates that growth in Nigeria is not pursued in a sustainable manner that would meet the present needs of the people without compromising the ability of the future generation to meet their needs.

Nigeria as one of the leading producers and users of fossil fuel in the world, it is instructive to note that the oil resources could be a source of danger to the economy in the future if the issues of sustainable environmental management such as abatement of CO_2 emission and climate change adaptations strategies (KYOTO PROTOCOL) are not taken seriously now. To the best of researcher's knowledge, the empirical analyses of the twin impact of energy consumption and carbon emission on economic growth in Nigeria are very scanty. Most of the study in similar area either focused on the effect or relationship between energy consumption and economic growth. few studies established the impact of energy consumption and carbon emission on economic growth in a multivariate framework including capital and labour with the Nigeria as scope of the study. This is an indication that the earlier studies suffered from a number of methodological problems, especially the omitted variable bias (due to exclusion of capital and labour in the analysis of economic growth). Stern (1993) cited by Saibu (2013), is a probably the first study advocating and using a multivariate setting. The multivariate studies, following stern (1993) employed recent and powerful time series technique, (Stern, (2000); Masih &Masih, (1996, 1997, 1998); Asafu Adjaye, (2000); Yang, (2000); Glasure, (2002); Soytas & Sari, (2003,2004); Oh & Lee(2004); Worlde Rufael, (2005) etc). However, none of these studies has Nigeria as its scope of study. Even, the latest work of Saibu M. F. & Jaiyeola A. O. (2013), (Energy consumption, Carbon emission & Economic growth in Nigeria: Implication for Energy Policy and Climate Protection in Nigeria) doesn't include the conventional growth determinants which are capital & labour. The exclusion of these two conventional variables in such study might generate the problem of omitted variable bias. In view of these, this study will help to fill the gap by linking both energy consumption and carbon emission in a multivariate framework that capture capital proxy by gross capital formation and labour. The structure of this paper, apart from this section is as follow: Section two deals with review of related literature which reviews the relevant existing literature on the research topic. Section three consists of the methodology and theoretical framework. Chapter four presents the descriptive analysis and result obtained from estimation. section five deals with the summary, conclusion of the research study and policy recommendations were also provided.

2 LITERATURE REVIEW

2.1 Introduction

The objective of this section is first, to examine the related theories. And, to take systematic review of some of the empirical studies on energy consumption,carbon emission and economic growth in Nigeria which has educed a wide variety of analytical perspective among researchers and academics and policy makers. Electricity power sector in Nigeria is to be examined along with the Nigeria Power Sector Reform Act (2005). The renewable energy policy for Nigeria is also part of the discussion in this section.

2.3 Theoretical Literature

2.3.1 Economic Foundation of Energy Demand

Analysis of demand for energy is not different from that of any other commodity. There are characteristics of energy demand, institutional features of energy markets, and problem of measurement that require particular attention in analyzing energy markets. But the microeconomic foundation of energy demand is the same as for other commodities.

Demand for energy can arise for different reasons. Households consume energy to satisfy certain needs and do so by allocating their income among various competing needs so as to obtain the greatest degree of satisfaction from their expenditure. Industries and commercial users and agricultural sector demand energy as input of production and their objectives is to minimize the total cost of production. Therefore the motivation is not the same for the households and the productive users like agricultural sector.

From the basic microeconomic theory, the demand for a good is represented through a demand function which establishes the relation between various amounts of goods consumed and the determinants of those amounts (Ademola, 1995., Quant and Anderson, 1995). The main determinants of the demand are: price of good, price of related goods, disposable income of the consumers, preferences and taste etc.

This simple functional form can be adapted to this study and written as follows:

$$Q = f \quad (P, Po, I \text{ etc.})$$

Q - Quantity demanded of energy

P - Price of energy

Po - Price of other goods

I - Income.

2.3.2 Contemporary discussions on energy demand have been dominated by the theories namely; Rebound Theory, Putty-putty Model, and Putty-Clay Model.

I) Energy Rebound Theory according to Jim Di Peso (2011), this theory form an argument infrequently used by critics of energy efficiency policies. They assert that the more efficiently you use energy, the more energy you will use. Since efficiency drives down the costs of energy, the argument goes, people demand more energy, which negates some or all of the efficiency gains.

The most extreme variation of the rebound argument is "backfire:" efficiency causes energy consumption to rise above the pre-efficiency level. Accordingly, if backfire is true, inefficiency results in less energy consumption. For instance, if one acquired a hybrid-electric car with better mileage, rebound theorists say that one will drive more as a result, offsetting efficiency gains through increased gasoline consumption.

Model of Energy Use

II) Putty-Putty Model was developed by Robert S. Pindyck and Julio J. Rotemberg (1983). The key features of this model are that capital and energy are highly complementary and that capital is subject to adjustment costs. Because of the adjustment costs, the capital stock moves slowly over time in response to change in energy prices. Since energy and capital are highly complementary in production, energy moves slowly as well. In the long run, the capital stock adjusts to permanent differences in energy prices and so does energy use.

III) Putty-Clay Model is a model that put forward that a large variety of capital goods are combined with energy with different fixed proportions. The putty-clay model delivers a low elasticity of energy use in the short run, because existing capital uses energy in fixed proportions. In the long run, in response to permanent differences in energy prices, agents invest in different capital goods with different fixed energy intensities. As a result, in the long run energy use is responsive to differences in energy prices.

2.4 Empirical Review

The pioneer study of the relationship between energy consumption and economic growth was the seminal work of Kraft and Kraft (1978), although this work did not consider the effect of carbon emission on growth as specified by this research work. This simply implies that the earlier studies in this area of research neglect the environmental implications of energy consumption relationship with Economic growth. However, it is still of significant to the work at hand.

Kraft and Kraft (1978) in the study of energy consumption and economic growth of USA which covered from 1947-1974 employed standard granger causality test and discovered that there exists unidirectional relationship running from GDP to energy consumption. Another time series study by Ebohon (1996) on energy consumption, economic growth and causality in developing countries which has Nigeria and Tanzania as its scope with data from 1960 - 1984, employed regression and granger causality test found that complementary relationship exist between energy consumption and economic growth. It stated further that causality between energy consumption and economic growth is not instantaneous but the causality between economic growth and energy is instantaneous. Another study by Menyah and Worlde- Rufael (2010) examined energy consumption, pollutant emissions and economic growth covering the period 1965- 2006 with South Africa as the focus of study employed Bound Test Cointegration Analysis, found a short and long run relationships exist between pollutant emission and economic growth. Further granger causality test found a unidirectional causality running from carbon emission to economic growth, from energy consumption to economic growth and from energy consumption to CO_2 emission. The conclusion was that South Africa has to sacrifice economic growth or reduce its energy consumption per unit of output or both to reduce pollutant emission.

Some researchers as in Mohammed et al. (2012) investigated energy consumption carbon emission and economic growth nexus in Bangladesh: cointegration and dynamic causal analysis. The study covered the data period 1972-2006 and employed Johansen Bivariate cointegration method and ARDL, the granger causality was tested with vector error correction model and came out with the result that CO_2 granger cause both Economic growth in the short and long run. Result also indicated that unidirectional causality exist from energy consumption to economic growth both in the short and long run, while in the short run bidirectional relationship exist between energy consumption and economic growth.

Furthermore, Mohammad et al. (2011) in their study on dynamic modeling of causal relationship between energy consumption, CO_2 emission and economic growth in India with the data covering 1971 to 2006 confirmed the existence of bidirectional granger causality between energy consumption and CO_2 emissions in the long run but neither CO_2 emissions nor energy consumption and income in any direction in the long run implying that India could pursue energy conservation and emission reduction with efficiency improvement policies without impending economic growth.

Investigative study of Soytas and Ramazan (2007) on energy consumption economic growth and carbon emissions: challenges faced by an EU candidate member. Turkey was focused on in the study. And the investigation employed the long run granger causality perspective in a multivariate framework uncovered that carbon emissions seems to granger cause energy consumption, but the reverse is not true. The lack of long run causal link between income and emissions implying that to reduced carbon emissions, Turkey does not have to forgo economic growth. Similar study of Saibu and Jaiyesola (2013) on the energy consumption carbon emission and economic growth in Nigeria: implication for energy policy and climate protection in Nigeria. The study adopted a dynamic methodology of the form of granger causality and dynamic regression model which came up with the conclusion that there is causal relationship between oil production, carbon emission from gas flaring and economic growth in Nigeria, more importantly carbon emission contributed an impediment to sustainable economic growth in Nigeria.

Apergis and Payne (2009) in the study of the relationship between energy consumption and economic growth, conducted on group of common wealth of independent state, employed panel cointegration and panel causality test unfold that both energy consumption and economic growth cause carbon dioxide emission in the short run. In the long run there appears to be a bidirectional causality running between energy consumption and carbon emission. Tsani (2010) worked on the energy consumption and economic growth: a causality analysis. Has Greece as the scope of study employed the Toda and Yamamoto (1995) granger causality test. Then investigation revealed that at aggregate level of energy consumption empirical findings suggest the presence of unidirectional causal relationship running from total energy consumption to real GDP at disaggregated level.

Presely and Babette (2012) in causal relationship between energy consumption and economic growth in Liberia engaged parametric and non parametric granger causality approach, and the study found the evidence of distinct bidirectional granger causality between energy consumption and economic growth. Further work covering the region was the investigative study on energy consumption and economic growth: evidence from the economy of 15 ECOWAS countries conducted by Nadia (2012) employed the 3 stage approach consist of panel unit root test, panel cointegration and granger causality. The result shows that GDP and energy consumption as well as GDP and electricity moves together in the long run. Testing the causality using panel based error correction models, it revealed that causality is running from GDP to energy consumption in the short run and from energy consumption to GDP in the long run.

Wolde – Rufael (2005) documented from the research study on energy demand and economic growth: African experience, which covered the period between 1971 and 2001 with 19 African countries using the bound test approach, the evidence of a long run relationship for only 8 of the 19 countries and causality for 12 countries. It shows that past values of economic growth have a predictive ability in determining the present value of energy consumption. And, past value of energy consumption have a predictive ability in determining the present value of economic growth. There were feedback income African countries while there was a lack of causal relationship for others. Similar study in Africa, Eggoh (2011) in his study of energy consumption and economic growth: revisited in Africa countries with 21 African countries as the scope of study covering the period 1970 to 2006, using the panel analysis points out that there is long run equilibrium relationship between GDP, energy consumption. It was found that decreasing energy consumption decrease growth and vice versa.

Musfat (2008) posited in the study of energy consumption and economy growth in Turkey during past 2 decades from 1987 to 2009 that Turkey energy demand has risen rapidly as a result of socio economic development. Total primary energy production meets only 27 % of the total primary energy demand.

As noted by Alero and Ibrahim (2012); Akinlo (2008) Adebola (2011); Mohammed et al. (2011); Saibu and Jaiyeola (2013); Soytas (2009); Mustafa Balat (2008); Akinlo (2008); Ebohon (1996), most of these works have several similarities, but with conflicting results. The obvious similarities are the utilization of time series and causality test to investigate the relationship and the impact. The causality test is even applicable to multiple country studies that employed Panel test. The diverse and conflicting results of the studies might be resulting from different, methodology employed in the analysis; different stages of development of the country concern; quality and quantity of data available for the study.

It is revealed from the empirical review so far that there are four possible relationships on the link between energy consumption economic growths. A unidirectional causality running from real economic growth and energy consumption and running from economic growth to CO_2 emission are interpreted to mean that the country is not entirely depend on energy consumption for its economic growth. This is known as Conservative Hypothesis which states that energy conservation policy and reduction in CO_2 emission measures can be embarked upon with modest or no undesirable effect on economic growth. And unidirectional relationship running from energy consumption and economic growth or carbon emission to economic growth denotes an Energy-Dependent Economy such that energy consumption or and carbon emission is a prerequisite for economic growth. In such a case inadequate provision and consumption of energy may limit economic growth or lead to poor economic performance. The situation where there is no relationship or causality between energy consumption and economic growth known as Neutrality Hypothesis implies that policies to promote energy consumption and to also reduce carbon emission with different conservation policies and demand side management of energy would not have effects on economic growth. Finally, the Feedback Hypothesis suggests that energy consumption and growth are interrelated and complement each other.

2.5 Renewable Energy Policy in Nigeria

The policy of renewable energy otherwise known as the policy guidelines is the federal government of Nigeria overarching policy on all energy derived from renewable resources. The policy guideline sets out the federal government's vision, policies and objectives for promoting renewable energy (alternative source) in the power sector. It is obvious that the conventional source of electric power supply (thermal and hydro) has become a burden to Nigeria in term of finance and efficiency in recent times, there has been agitation for diversification of energy supply sources to meet the power challenges of the country. The nature and extent of renewable energy demand and utilization in a national economy are to a large extent indicative of the pace of the economic development. For a productive, fast, and sustainable economic growth Nigeria must pay adequate attention to the optimal development and utilization of her energy needs.

In view of this, it gives access to electricity services as a crucial to achieving economic and social development targets outlined in the National economic empowerment and development strategy (NEEDS) and the Millennium Development Goals (MDGs). Therefore, federal Government is committed to reaching these sustainable development targets through the mobilization of the power sector. In its effort to the realization of these objectives, the federal government seeks to implement the policy on renewable energy in collaboration with other level of government, communities and the private sector for the following specific reasons according to (Sambo, 2011):

I. To enhance energy security in the nation through diversifying the energy supply mix;
II. To increase energy access especially in the rural and semi-urban areas;
III. To facilitate employment creation and empowerment and;
IV. To protect the environment and mitigate climate change.

Renewable energy is energy which comes from natural resources such as Sunlight, Wind, Rain, Tides and Geothermal heat. They are naturally replenished (Umejei, 2011). Renewable energy has overwhelming benefits because it is sustainable and complies with the various form of green environment which has taken center stage all over the world. To the end, Nigeria cannot be left behind in the desire to adapt to renewable energy as a viable of source of electric power.

However, while a renewable source of energy has taken shape in other nations, Nigeria is still limited to conferences and seminars with no viable action plan to achieve it. The renewable energy that contributes to the energy mix in Nigeria includes: tar sand, hydro power, solar energy, Wind energy, Geothermal energy.

First and foremost, renewable energy represents an important tool and a common framework to integrate for the federal government's overall effort to expand access to electricity nationwide. Improving access to electricity services nationwide become imperative and toward the realization of the objectives of the needs and MDG targets in stimulating economic growth, employment generation and poverty alleviation.

2.7 The Nigeria Power Reform Act (2005)

Ishola (2005) explicitly explains that power sector reforms is being pursued in many countries on the promise that a reformed system would be more efficient and effective in addressing power demand and meeting the sustainable development agenda. According to the World Bank (1994) power sector reform seeks to improve performance, supply side efficiency and demand side efficiency. Considering the usefulness of electricity which is the ability to improve the social status through facilitates provision of basic needs such as health, education, food and water source of employment, yet many developing countries enjoy significantly low levels of electrification. In view of this electricity status in Nigeria, a successful reform needs to ensure universal access to reliable electricity.

Prior the year 2000, electricity sector has experienced no meaningful reforms in the sector since 1896, the first recorded electricity generation in Nigeria, and 1972, the period of amalgamation of electricity company of Nigeria (ECN) and Niger Dams Authority (NDA) into National Electricity Power Authority (NEPA.) This amalgamation results in the monopoly structure of the electricity supply in Nigeria. This monopoly structure is thought to be a large contribution to the under performance of the nations power utilities. The power sector institution is mainly characterized by unreliability of power supply, low capacity utilization, deficient maintenance, poor procurement of spare parts and high transmission and distribution losses. Electricity reform in Nigeria is the critical approach to realization of effective generation, transmission and distribution of power. Immediately after the inauguration of the democratically elected civilian administration in 1999 led by President Olusegun Obasanjo, Electric Power Sector Reform Implementation Committee (EPIC) was inaugurated by National Council on Privatization (NCP) to recommend measures for sector reforms, promote policies goals of liberalization, competition and private sector led growth (Banwo and Ighodalo, 2006).

The Federal Government reforms agenda was informed by the following objectives:

I. To reduce the business operation cost in order to attract new investment through provision of quality and dependable power supply to the economy for industrial, commercial, and socio- domestic activities in Nigeria
II. To meet the growing demand for stable and reliable power required in small and medium business sectors.
III. To meet the desires and needs to be up to global standard in power generation and power consumption.

Reform is seen as the best option to change this poor power sector status.

The reform program as approved by Federal Executive Council is intended to achieve five cardinal objectives:

I. Unbundle NEPA
II. Privatize the unbundled entities
III. Establish a regulatory agency
IV. Establish a rural electrification agency and fund
V. Establish a power consumer assistance fund.

In transformation of the electricity sector, Federal Government of Nigeria through the activities of bureau of public enterprises (BPE) took the following step:

I. The electricity (Amendment) Decree 1998 and the NEPA (Amendment) Act in 1998 were passed, terminating the monopoly status of NEPA and gives room for private sector participation in the power sector.
II. Unbundling the state owned power entity into generation, transmission and distribution capacities.
III. Provision for the transfer of assets, liabilities and staff of NEPA to PHCN and then to successor generation, transmission and distribution companies.
IV. Setting up of Independent Regulator, known as National Electricity Regulatory Commission (NERC).

V. Incorporation of 18 new successor companies comprising of 6 generation companies, 1 transmission company and 11 distribution companies in November 2005, subsequently granting the later greater operation autonomy in 2006.

VI. The approval of market rules to guide the operations in the electricity sector in 2008 (NERC).

The Power Reform Act 2005 in Nigeria is the road map to improve power sector; it is a properly articulated program. That is to say, it is not accidental. Similar reform has been carried out by other countries and it has been success story for them all.

In Nigeria situation, the ministry of power involves itself in the operation, hence no clear separation and control in the process. Even though Bureau of Public Enterprises (BPE) own these companies, the ministry of power continue to run them that is why no significant improvement is recorded since last eight years of the reform. Expect some marginal improvement in the sector; Nigeria is still stranded in the 2005 status.

So far, the power sector reform process has not yielded any significant impact on the sector. Currently, Nigeria generating capacity is still less than 5000 mega watts as at May 2013 (Punch, 2013).

The call for power sector reform in Nigeria is expected to bring about the same competitive opportunity in the sector as being witnessed in the communication sector, which will ultimately promotes economic growth and in the long run have trickling down effects on Nigerians.

3 RESEARCH METHODOLGY

3.1 Introduction

This section discussed the theoretical framework of the study, model specification, sources and characteristics of data, statement of hypotheses, techniques and model estimation procedure, employed in the study on the Impact of Energy Consumption and Carbon emission on Economic Growth in Nigeria.

3.2 Theoretical Framework

This study is anchored on the theoretical framework of Robert Solow (1956) who in his celebrated work of the core factors influencing economic growth isolated a key exogenous factor which significantly impact growth potential among economies. As noted by Abaido (2011), legion of empirical studies after Solow's work have significantly increase our understanding of the dynamic of economic growth and the key involving factors responsible for differential growth among developed and developing countries around the world. However, the Solow version of Neo classical is more suitable for this study due to its dynamism. The Solow model focuses on four variables: Output (Y), Capital (K), labour (L), and "knowledge" or the effectiveness of labour (A). At any point, the economy has some of amount of capital, labour and knowledge Romer (2009). These are combines to produce output. The production function takes the form:

$$Y(t) = f\,(K(t), A(t), L(t)) \qquad (3.1)$$

Y(t) = output at time t, K(t) = capital at time t, L(t) = labour at time t, A(t) = knowledge at time t.

A(t) and L(t) enter the model multiplicatively, hence A(t) L(t) is effective labour

Hence, the specific example of production function is the Cobb Douglas function

$$Y = f\,(K_{(t)}, A_{(t)} L_{(t)}) = K_{(t)}^{\alpha} A_{(t)} L_{(t)}^{1-\alpha} \qquad (3.2) \qquad 0 < \alpha < 1$$

$$Y/AL = K/AL^{\alpha} (AL/AL)^{1-\alpha} \qquad (3.3)$$

$$Y/AL = y \text{ and } K/AL = k. \qquad (3.4)$$

Therefore, $y = k^{\alpha}$ (3.5) $y_t = f\,(k_t)$

This production function is very useful for the framework of the research at hand and shall be adapted to incorporate the variables of analysis in this study.

Movement of Labour / knowledge, Capital over time

Growth rate of Capital = $\Delta K/K$ $\quad \Delta K = K_{(t)} - K_{(t-1)}$ (3.6)

Growth rate of Labour = $\Delta L/L$ $\quad \Delta L = L_{(t)} - L_{(t-1)}$ (3.7)

Labour is growing at the rate **n**

Growth rate of knowledge = $\Delta A/A$ $\quad \Delta A = A_{(t)} - L_{(t-1)}$ (3.8)

Knowledge is growing at the rate **g**

Therefore, $k = K_{(t)} / A_{(t)}L_{(t)}$ (3.9)

Using Quotient Rule to derive the fundamental Solow equation model from equation 3.2

Hence, $$\Delta k = \frac{\Delta K_{(t)}(A_{(t)}L_{(t)}) - (\Delta A_{(t)}L_{(t)})\, K_{(t)} - (A_{(t)}\, \Delta L(t))\, K_{(t)}}{(A_{(t)}L_{(t)})^2}$$

$$\Delta k(t) = \frac{\Delta K_{(t)}}{A_{(t)}L_{(t)}} - \frac{\Delta A_{(t)}\, K_{(t)}}{A_{(t)}\, (A_{(t)}L_{(t)})} - \frac{\Delta L(t))\, K_{(t)}}{L_{(t)}(\, A_{(t)}L_{(t)})}$$

Note: $\Delta Kt = sY_{(t)} - dK_{(t)}$, $\quad \frac{\Delta A_{(t)}}{A_{(t)}} = \mathbf{g}$, $\frac{\Delta L_{(t)}}{L_{(t)}} = \mathbf{n}$ and given that $Y/AL = f(k)$

$$\Delta k(t) = \frac{sY_{(t)} - dK_{(t)}}{A_{(t)}L_{(t)}} - k_{(t)}\mathbf{g} - k_{(t)}\mathbf{n} \qquad = sf(k_{(t)}) - dk_{(t)} - g(k_{(t)}) - n(k_{(t)})$$

$\Delta k(t) = sf(k_{(t)}) - (n+g+d)k_{(t)}$ (3.10) (Key equation of Solow model)

$f(k(t))$ is output per unit of effective labour

$sf(k_{(t)})$ is actual investment per unit of effective labour

$(n+g+d)k_{(t)}$ is breakeven investment.

A Baseline Case: Economic Growth, Natural Resources, Environment.

The analysis is extended to incorporate the energy resources (oil and electricity) with the environmental factors as they affect economic growth.

Thus the production function 3.1, becomes

$$\boldsymbol{Y(t) = K_{(t)}^{\beta}\ EC_{(t)}^{\lambda}\ EU_{(t)}^{\theta}\ C0_{2(t)}^{\delta}\ (A_{(t)}L_{(t)})^{\gamma}}\ . \qquad (11)$$

Note:

$Y_{(t)}$ is economic growth proxy by GDP Per Capita Constant 2000 US Dollar

$A_{(t)}$ and $L_{(t)}$ enter the model multiplicatively, hence $A_{(t)}$ $L_{(t)}$ is effective Labour proxy by Labour Participation Rate, total (% of total population ages 15+)

$K_{(t)}$ is Capital at period *t* proxy by Gross Capital Formation

$EC_{(t)}$ is Electricity Power Consumption (KW Per Capita)

$EU_{(t)}$ is Energy Use Kt of oil Equivalent

$C0_{2(t)}$ is Carbon Emission (Metric Ton Per Capita)

Log both sides of the equation 3.3

$$\ln Y(t) = \beta \ln K_{(t)} + \lambda \ln EC_{(t)} + \theta \ln EU_{(t)} + \delta \ln C0_{2(t)} + \gamma (\ln A_{(t)} + \ln L_{(t)}) \quad (12)$$

Differentiating both sides with respect to time, we obtain the following:

$$gy = \beta gk + \lambda gEC + \theta gEU - \delta gC02 + \gamma (n+g) \quad (13)$$

At the balance Growth Path (BGP) rate of growth of Y and growth of K is the same.

Hence, $gy = \beta gk$

Therefore, $gy = gk = \beta gk$.

$$gy - \beta gy = \lambda EC + \theta EU - \delta C02 + \gamma (n+g)$$

$$\frac{gy\,(1-\beta)}{1-\beta} = \frac{\lambda}{1-\beta}(gEC) + \frac{\theta}{1-\beta}(gEU) - \frac{\delta}{1-\beta}(gC02) + \frac{\gamma}{1-\beta}(n+g) \quad (14)$$

Therefore, the extended version of the Solow growth model indicates that growth rate of Electricity Consumption, Energy Use and Environmental factor (Carbon emission) are determinants of output with positive and negative relationship in case of environmental factor.

3.3 The Functional Form of the Model

For the purpose of the research work the relationship among the dependent and independent variables is presented as follows:

$$PCGDP = f\,(GCF, LP, EC, EU, C0_2) \qquad (3.15)$$

3.4 Model Specification

on the basis of the above functional relationship the study specify multivariable VECM model as follows:

$$\Delta PCGDP_t = \alpha_1 + \sum_{i=1}^{p=2} a_i^{PCGDP}\Delta PCGDP_{t-i} + \sum_{j=1}^{p=2} \beta_j^{PCGDP}\Delta GCF_{t-j} + \sum_{k=1}^{p=2} \gamma_k^{PCGDP}\Delta LP_{t-k} + \sum_{l=1}^{p=2} \lambda_l^{PCGDP}\Delta EC_{t-l} + \sum_{m=1}^{p=2} \theta_m^{PCGDP}$$
$$\Delta EU_{t-m} + \sum_{n=1}^{p=2} \delta_m^{PCGDP}\Delta C0_{2t-n} + \phi_1 ECM_{1t-1} + e_{1t} \qquad (3.16)$$

Where:

PCGDP = Gross Domestic Product per capita 2000 US Dollar

GCF= Gross Capital Formation

LP = Labour Participation Rate Labour Participation Rate, total (% of population ages 15+)

EC = Electricity power Consumption (KW Per Capita)

EU = Energy Use Energy Use Kt of oil Equivalent

$C0_2$ = Carbon Emission Metric Ton Per Capita

α = Constant term, a= PCGDP coefficient, β = GCF coefficient, γ = LP coefficient, θ = EU coefficient, λ = EC coefficient, δ = $C0_2$ coefficient.

ϕ = Speed or rate of adjustment

p = lag length for the Vector Error Correction Model

e = White Noise Disturbance Error Term.

3.5 Techniques and Model Estimation Procedure.

The descriptive and quantitative techniques of analysis are used for the study. The quantitative technique of analysis would be carried out; Vector Autoregressive (VAR) model is employed to estimate the necessary coefficients with the aid of E-view statistical package.

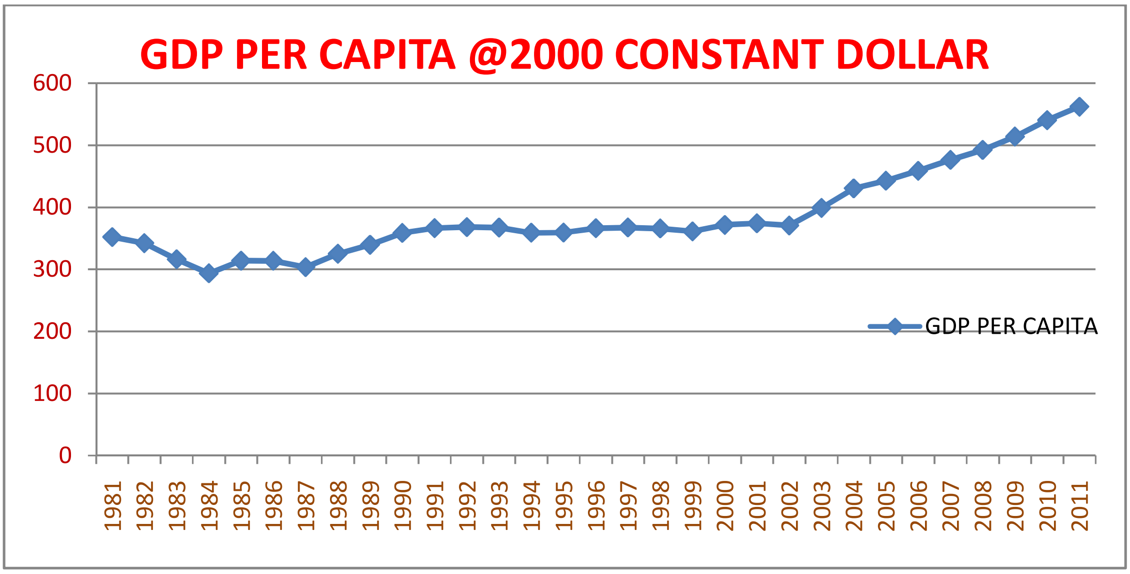
4 DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This study is based on times series data which covers 1981 to 2011. The data were sourced from the WDI 2012. The variables of interest in the study are GDP per capital, Electricity Consumption, Energy Usage Kt of oil equivalent and Carbon Emission ($C0_2$) in metric ton per capita, the conventional economic growth variables are included, capital is proxy by gross capital formation and labour is proxy by labour participation rate. Descriptive analysis is slightly used to examine the trend of the times series data and Restricted Vector Auto Regressive (VAR) is employed for the analysis. For the purpose of clarity, this chapter is structured into 5 sections. Section 4.1 focused on descriptive analysis. Section 4.2 focused on the econometrics analysis of the study while section 4.3 presents the Granger Causality analysis. Section 4.4 examined the residual diagnosis of the model.

4.1 Descriptive Analysis

Fig 4.1 GDP Per Capita

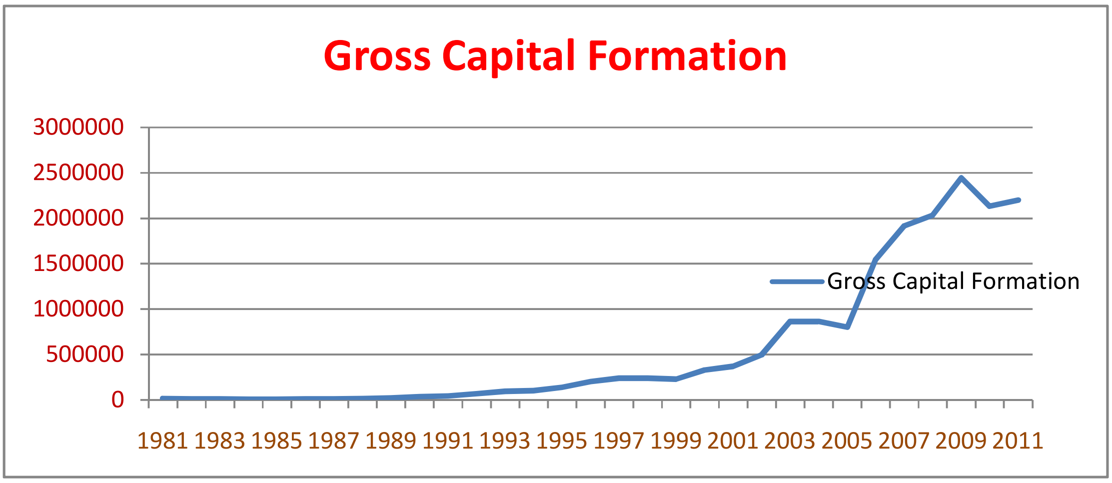


Source: Author; WDI 2012

In general, the trend of the GDP per capita shows that there has been a continuous increase of the variable in Nigeria. But, critical observations of the table revealed that the value decreased from

$352.08 in1981 the year which the study begins to $293.60 in 1984. The GDP per capital also increased in 1985 from $314.17 and decreased slightly in 1987 to $303.66 before it finally continue to increase at a small rate to $430.60 in 2004 when it begins to increase to the observable rate of $561.90 in the last year of the observation, 2011.

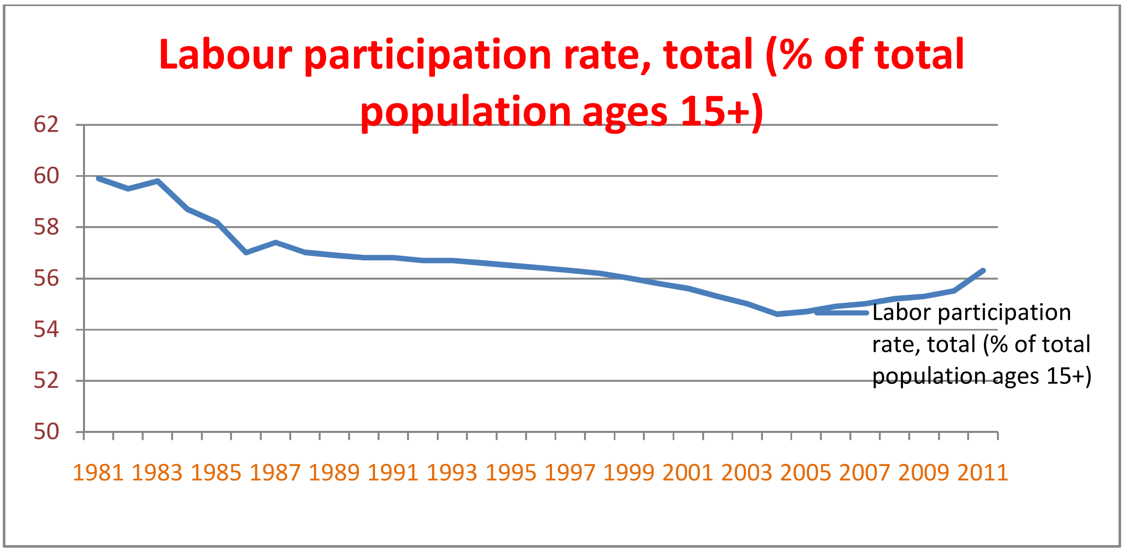
Fig 4.2 Gross Capital Formation



Source: Author; WDI 2012.

The above chart depicts the trend of gross capital formation in Nigeria. This variable is used to proxy the capital variable as one of the conventional factors that primarily influence the Economic growth proxy by the GDP per capital. From the beginning of the year of study, the value of this variable is not encouraging. This is obvious by considering its average value for the first decades of study (1981- 1990) which isN17774.01. The country started recording a noticeable amount of GCF from the year 1990 with the value of N40121.3. The average value of GCF in the following decades (1991-2000) was N171233.3 which is significantly higher than the gross capital formation in the preceding decade. The following decade recorded a substantial improvement in the gross capital formation as we experienced outlier in this period, most especially between the year 2006 with gross capital formation of 1,546,525.7 and the year 2011 with the gross capital formation of 2,200,911.

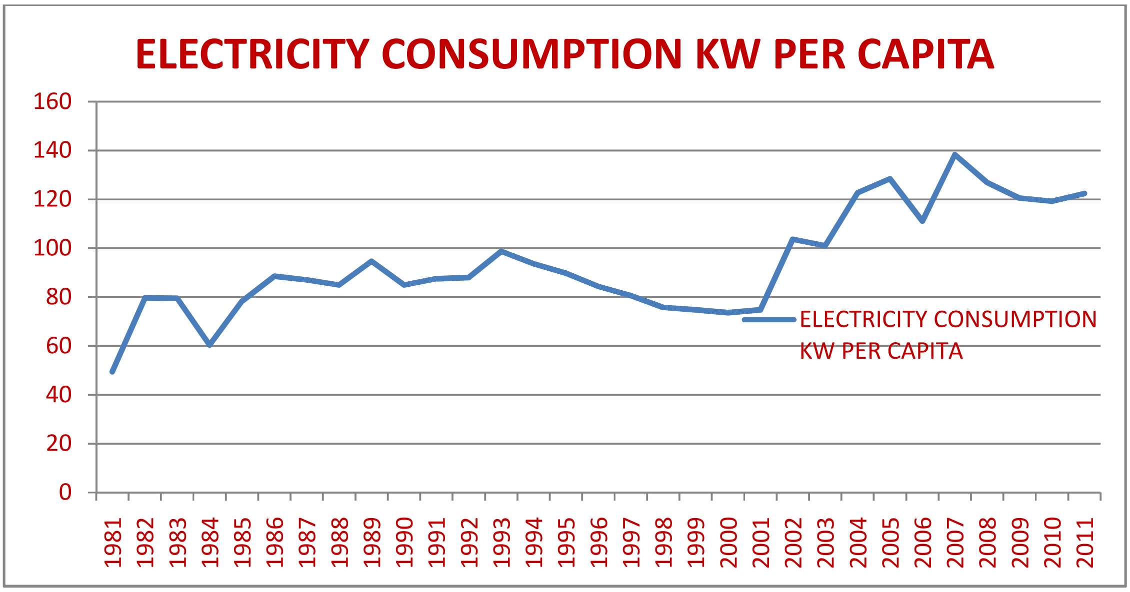
Fig 4.3 **Labour Participation Rate (% of Total Population ages 15+)**



Source: Author; WDI 2012

Labour participation rate is used in the study to proxy Labour. The chart above depicts the rate of participation of the people above 15 years that are engage in productive activities and contribute to the generation of GDP. The chart depicts that the participation rate is falling, this might not be unconnected to the fact that as the population is growing geometrically and there are few jobs available to be taken up, hence continuous dwindling of the rate in Nigeria. This fact can easily be substantiated by the high rate of unemployment in Nigeria. The labour participation rate fell from almost 60% in 1980 to 55 % and 54.5% in 2003 and 2004 respectively. As at the last year of study the labour participation rate has been increasing this might be resulting from the action by both the federal government and various state governments to alleviate poverty and reduce the alarming rate of unemployment in Nigeria.

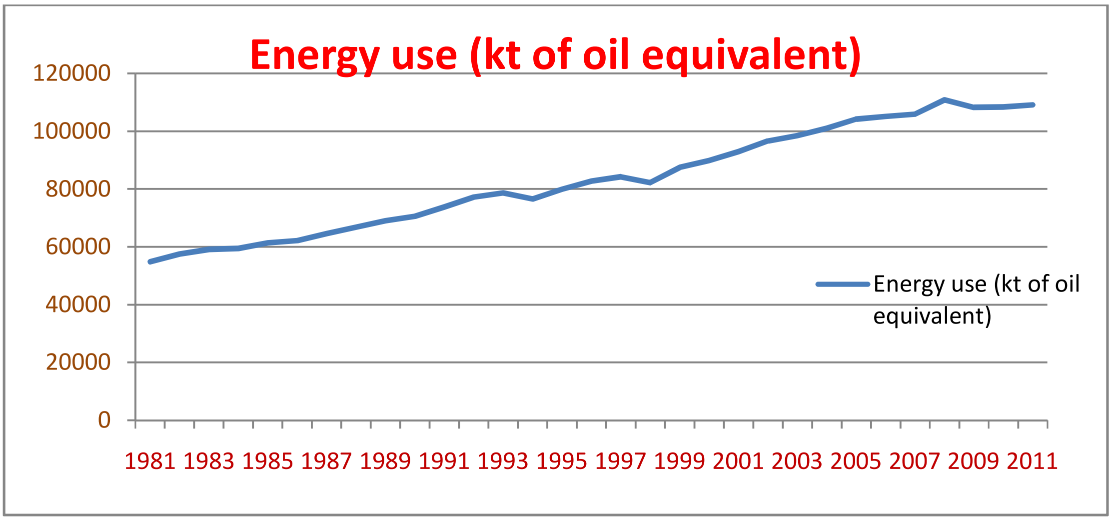
Fig 4.4 Electricity Consumption KW per Capita in Nigeria.



Source: Author; WDI 2012.

Electricity consumption per capita in Nigeria is nothing to write home about as indicated in the table that per capita consumption of electricity is 49.48KW in 1981 and it increased substantially in 1982 to 79.64 KW in 1982. It also fall to 60KW in 1984, from then it started rising within the range of 84.99 KW and 94.68 KW between 1986 and 1990 this may be due to the deregulation of the sector during the Structural Adjustment Programme in 1986. From the year 1990 to 1995 there was substantial increment in the electricity consumption as the country consumed between the range of 84.9 and 98.74 KW, this might be as a result of addition to the existing more power plants having realised the needs to improve the electricity consumption in Nigeria. The table indicates that there is decrease in the consumption rate of 84.41KW in 1996 to73.645KW in 2000; this may be due to the fact that power plant installation cannot be felt instantaneously, because Obasanjo's administration embarked on electricity project to revamp the sector. From 2002 to 2008, the electricity consumption per capital increased drastically between 103.66 KW and 138.33 KW per capita as this may depict the effect of the partial success of Obasanjo's administration restructure of the sector despite such huge budgetary allocation to the sector. It is unfortunate to observe that nothing or little has been achieved since the 2005 power sector reform Act which was promulgated to efficiently supply the needs of Nigeria in electricity term despite the recent hand-over and unbundling programme to private Distribution and generation company in November 2013; though, it is too early to be expecting the dividend of such programme in such a complex, highly-capital-demanding and sensitive sector.

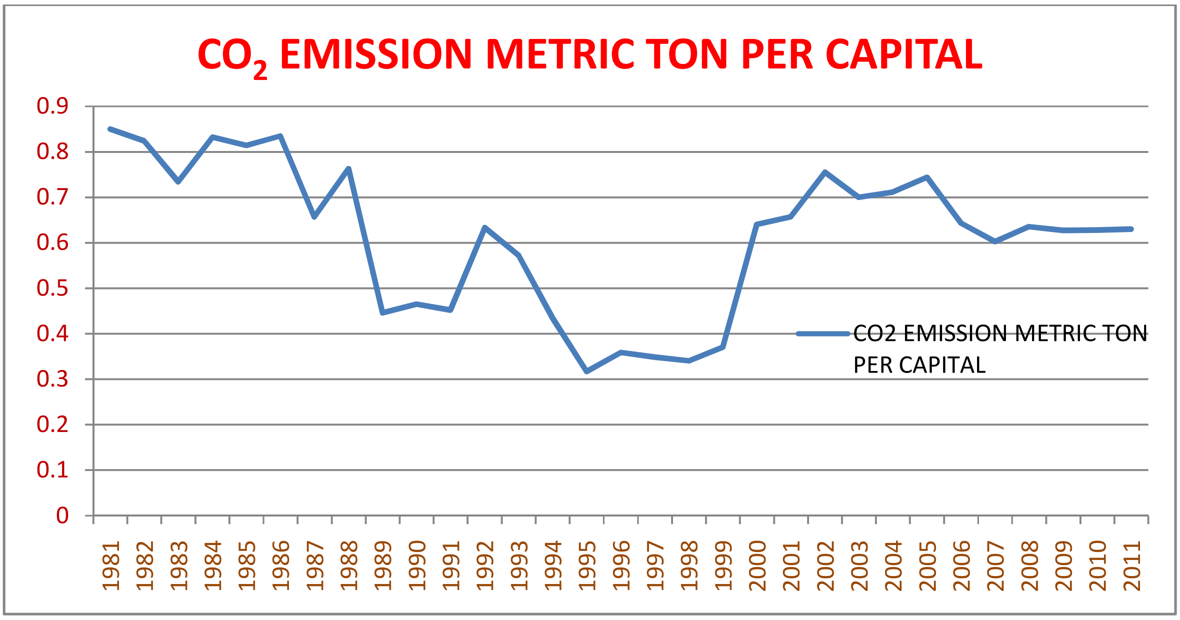
Fig4.5 Energy Use (Kt of oil Equivalent)



Source: Author; WDI 2012

The table presents the energy use Kt of oil equivalent which depicts the trend in the pattern of energy usage in Nigeria. It is shown that from 1981 to 1990 the range of usage was between 54861.932 and 69132.285 Kt of oil equivalent which give the average energy use 62582.82 Kt of oil equivalent over the 10 years. The average energy use between 1991 and 2000 is 81305.77 Kt of oil equivalent. The year 1994 and 1998 recorded a sharp decrease in the rate of energy use in Nigeria. The consistent in the rate of the energy use continued in the following decade, while there was a sharp increase in the year 2008 on the energy use in the country. This might be connected with the reduction in the oil (fuel) price during the President Yaradua 7-point agenda. The energy used between 2001 and 2011 has the average value of 123090.8 Kt of oil equivalent. It is shown that from the base year value of energy use which was 62145.445 Kt of oil equivalent to the current year of observation 2011 with energy use value of 109155.32 Kt of oil equivalent; it is important to note that there is significant improvement in energy use over the three decade period as indicated by the chart.

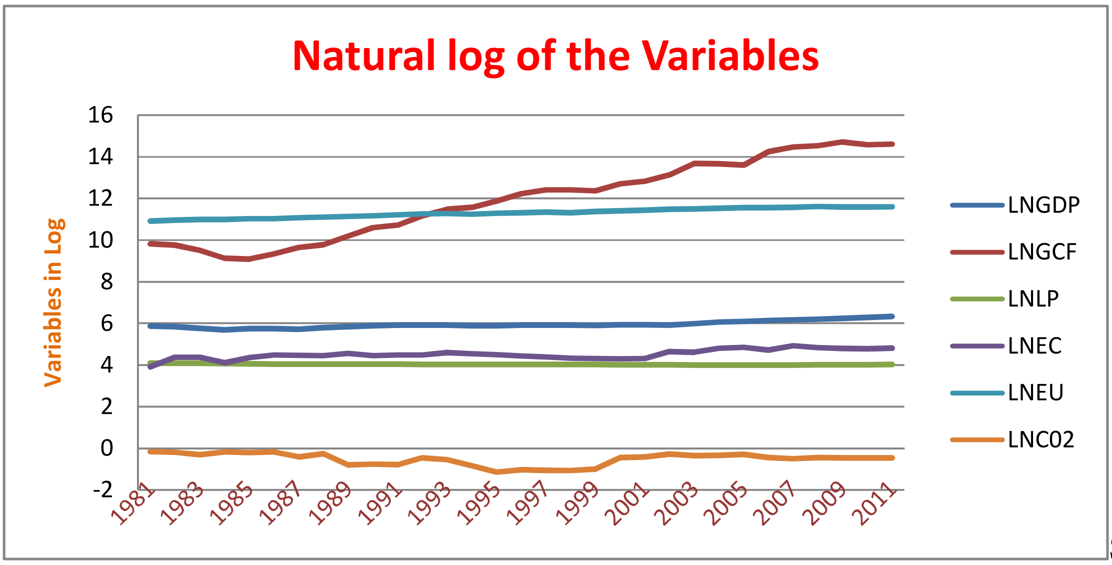
Fig 4.6. Carbon Emission measured in Metric ton Per capita



Source: Author; WDI 2012

The table indicates that the emission of $C0_2$ in 1981 was very high as the nation recorded 0.8499 metric ton per capital and fall slightly to 0.734 in 1983, the following three years also recorded the increment of emission to the tune of 0.835 metric ton per capital in 1986.The emission fell from 0.65 metric ton to 0.4525 in 1991; it rose slightly in 1992 and 1993 to the tune of 0.5724 metric ton per capita. The emission decreased from 0.434 metric ton per capita in 1994 to 0.37 metric ton per capita in 1999. The high rate of emission from 2000 to 2005 was as if no emission control measured was put in place. The carbon emission from 2006 to 2011 is still higher relative to the emission experienced between the year 1995 and 1999. The average carbon emission for the last six years of study between 2006 and 2011 was 0.62798. The various emission control put in place by the various governments in Nigeria has not yielded any positive impact.

Fig 4.7 LOGARITHMS OF THE VARIABLES



Source: Author computation

The above chart depicts the natural logarithm of the variables of study over the years. LNGDP denotes the natural log of the GDP per capita to proxy economic growth, LNLP denotes natural log of Labour participation rate to proxy Labour, LNEC denotes natural log of Energy consumption variables, LNEU denotes natural log of Energy use in Kt of oil equivalent and the $LNC0_2$ denotes the natural log of the Carbon Emission ($C0_2$). The effect of these natural logarithms is observable as it smoothing the trends of the variables unlike when they were in bare values.

Table 4.1: Summary Statistics of the Variables

	PCGDP	GCF	LP	EC	EU	$C0_2$
Observations	31	31	31	31	31	31
Mean	386.2097	566476.1	56.53581	93.67220	83225.11	0.613740
Median	366.4613	204047.6	56.40000	88.04744	82266.02	0.635555
Std. Dev.	69.80295	784970.2	1.438754	21.22733	17995.77	0.163433
Maximum	561.9044	2442704.	59.90000	138.3314	110872.4	0.849933
Minimum	293.5969	8799.480	54.60000	49.48188	54861.93	0.317386
Skewness	1.065255	1.332524	0.919520	0.333792	0.061695	-0.390287
Kurtosis	3.248912	3.226740	3.239208	2.518023	1.687822	2.018106

Source: author computation

PCGDP - GDP Per Capita Constant 2000 US Dollar

GCF - Gross Capita Formation

LP - Labor Participation Rate, total (% of total population ages 15+)

EC - Electricity Power Consumption (KW Per Capita)

EU - Energy Use Kt of oil Equivalent

$C0_2$ - Carbon Emission (Metric Ton Per Capita)

The information in the above table shows the summary statistics of the variables of study. Mean, median and standard deviation of per capital GDP were found to be 386.21, 366.46 and 69.80 respectively with minimum value of 293.5969 and maximum value of $561.9044. These values were actually low compare to other developing countries like NICs and Asian Tigers. The similar statistics for Electricity Consumption were found to be 96.67KW, 88.05KW and 21.22KW respectively with minimum value of 49.48KW and maximum value of 138.33KW. The figures for this are outrageously low and this is due to poor electricity supply in the country which has forced people to source for other means of electricity consumption. Energy Use Kt of oil equivalent statistics is moderate at 83225.11kt, 8266.02Kt and 17995.77kt with minimum value of 54861.03 Kt and maximum value of 110872.4 Kt. The duo of electricity consumption and energy use is expected to promote economic growth as they serve as the mechanism for fuelling the engine of growth but our observations from this analysis does not support the expectation. The environmental effect of this energy consumption through the emission of Carbon ($C0_2$) which is detrimental to environment and lethal to the human resources that is an agent of economic growth is also looked at. The mean, median and standard deviation of the carbon emission recorded 0.61374Mt, 0.6355Mt and0.1634Mt respectively with minimum value of 0.3173Mt and maximum value of 0.8499 Mt. The quantity of emission is quite large and capable of having negative impact on the productivity of the human resource and environmental resources. Since the goal of environmental sustainability has been vigorously pursued as enshrined in the Millennium Development Goal signed by 189 members country of United Nation in Washington on September 2000, drastic efforts has been taken to salvage the environment from the menace of this carbon emission but Nigeria's effort is far below what is expected of country of such population that is witnessing emission from almost all the sectors like residential, transport, manufacturing, commercial and ultimately gas spillage by various oil and gas company in its territory.

4.2 Econometrics Analysis of the Study

Due to the properties of most time series, it is important to carry out the Unit root test on the series in the Vector Autoregressive (VAR) model. If the series are stationary, the results obtained from the VAR model are valid. However, if the series are non stationary, it is important to conduct Cointegration test to verify whether the time series are cointegrated or not. The Johansen Cointegration test has been found to be reliable and it is adopted in this study. If the Johansen Cointegration test indicates the existence of long run equilibrium in the model, then the VAR model gives the long run causality in the equation of the model. Correspondingly, the short run dynamics of the model are captured with the Vector Error Correction Model which implies the short run adjustment.

4.2.1 Test for Stationarity

This section presents the Unit root test conducted on the variables. As the first step, to diagnose the stationarity status of the variables in order to determine the appropriate test and estimation model to employ. Augmented Dickey- Fuller (ADF) test is used. According to Gujarati and porter (2009), it is conducted by augmenting the following:

Table 4.2: Unit Root test applied to variables

Variables	ADF TEST Critical Values	ADF Test Statistic	Prob- Values	Decision Rules
LNGDP	1% -3.679322	-3.596894	0.0122	I(1)
	5% -2.967767			
LNGCF	1% -3.711457	-4.048571	0.0045	I(1)
	5% -2.981038			
LNLP	1% -3.679322	-4.258945	0.0024	I(1)
	5% -2.967767			
LNEC	1% -3.679322	-7.680077	0.0000	I(1)

	5%	-2.967767			
LNEU	1%	-3.679322	-5.944886	0.0000	I(1)
	5%	-2.967767			
$LNC0_2$	1%	-3.679322	-5.610601	0.0001	I(1)
	5%	-2.967767			

The unit root test conducted on the variables, the variables found to be non stationary at level. A further test of stationarity by first level of difference shows the variables attained stationarity. LNGCF, LNLP, LNEC and $LNC0_2$ attained the stationarity by first level of differencing at one percent level of significance and LNGDP is at five percent level of significance. Consequentially, rejection of the null hypotheses of the presence of unit root in the variables at the level of first difference for all the variables. The results of this test necessitate the performance of Cointegration test in order to confirm the existence of long run associationship among the variables.

4.2.2 Cointegration Test

There are number of methods for testing cointegration, the Johansen test for cointegration has been found more reliable. Hence, the study used the Johansen test for cointegration.

Table 4.3: Presentation of Johansen Test of Cointegration

Hypotheses: Number of Cointegrating Equations	Eigen Value	Trace Statistic	0.05 Critical Value	Probability Value
0*	0.987644	251.5592	95.75366	0.0000
1*	0.848764	128.5377	69.81889	0.0000
2*	0.699388	75.64812	47.85613	0.0000
3*	0.635473	41.99395	29.79707	0.0012
4	0.327331	13.73758	15.49471	0.0904
5	0.089832	2.635534	3.841466	0.1045

Source: computed by author; see appendix

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinn-Haug-Michelis (1999) p-values

The cointegration table above indicates 4 cointegration equations at the 0.05 level.

TABLE 4.3 presents the Johansen cointegration test, using the trace statistics with respect to the probability value. Considering the null hypothesis that there is none cointegrated equation which is rejected on the basis of p-value which is 0.0000 and less than 0.01 levels. Hence rejection of the null hypothesis that there is none cointegrated equation. The second hypothesis that at most 1 equation is cointegrated is rejected on the basis of the p-value which is 0.0000 less than 0.01 levels. The third hypothesis is rejected on the same basis of the p-value of 0.0000 which is also less than 0.01 levels. The fourth hypothesis of at most 4 is cointegrated is also rejected because of its p-value of 0.0012. The other two hypotheses cannot be rejected because their p-value is greater than 0.05 level which are 0.0904 and 0.1045 for at most 4 and 5 respectively; hence the acceptance of null hypotheses. As a result of these, there are 4 cointegrated equations at the 0.05 level. The implication of this is that there is long run relationship or associationship among the variables; consequentially, this necessitates the use of restricted VAR i.e. Vector Error Correction Model.

4.2.3: Vector Error Correction Analysis

Presentation of the Result: Vector Error Correction Analysis Estimated values of the coefficient for equation 3.16:

$LNGDP_t = 0.021560 + 0.030199LNGDP_{t-2} + 0.046602LNGCF_{t-2} - 1.091860LNLP_{t-2} - 0.053216LNEC_{t-2} - 1.030529LNEU_{t-2} - 0.127500LNC_02_{t-2} - 0.171342\ ecm_{1t-1} + e_{1t}$ Eq.

4.2.4 Long Run Causality Test

Furthermore, LNGDP error correction equation was chosen to test and confirm the long run causality as reflected in table 4.5 below, the C(1) is 1-period lag residual of the cointegrating equation, the C(1) is negative as expected, and it is significant with the prob. Value of 0.0185 which is less than 0.05 level. The rule is that if the error correction term is negative and significant i.e. the prob. Value 0.0185 is less than 0.05. Hence, there is long run causality from the explanatory variables to LNGDP.

Table 4.5 Presentation of VECM Causality Model

Dependent variable: LNGDP	Included observations: 28 after adjustments

Error Correction Equation: D(LNGDP) = C(1)*(LNGDP(-1) - 0.34155154323*LNEU(-1) - 0.132797521463*LNC02(-1) - 2.1413308161) + C(2)*(LNGCF(-1) - 9.32688930983*LNEU(-1) + 0.524450280312*LNC02(-1) + 93.9055993337) + C(3)*(LNLP(-1) + 0.121160813325*LNEU(-1) + 0.0170238259257*LNC02(-1) - 5.39310395666) + C(4)*(LNEC(-1) - 0.664214983577*LNEU(-1) - 0.764380946913*LNC02(-1) + 2.56483264283) + C(5)*D(LNGDP(-1)) + C(6)*D(LNGDP(-2)) + C(7)*D(LNGCF(-1)) + C(8)*D(LNGCF(-2)) + C(9)*D(LNLP(-1)) + C(10)*D(LNLP(-2)) + C(11)*D(LNEC(-1)) + C(12)*D(LNEC(-2)) + C(13)*D(LNEU(-1)) + C(14)*D(LNEU(-2)) + C(15)*D(LNC02(-1)) + C(16)*D(LNC02(-2)) + C(17)				
	Coefficient	Std. Error	t.-statistic	Prob.
C(1)	-0.217929	1.133758	-0.192219	0.0185
C(2)	-0.171342	0.062300	-2.750295	0.0189
R-squared	0.660754			
Log likelihood	69.83057			
F-statistic	1.339053			
Prob(F-statistic)	0.316564			
Durbin-Watson stat	1.946300			

Source: author; see appendix 4.4

4.2.5 Short Run Causality Test

To check the short run causality between the LNGDP and other variables like LNEU and $LNC0_2$ the study employed the Wald test by using chi- square value of Wald statistics to check the short run causality from LNEU, and $LNC0_2$ to LNGDP.

Short run causality from LNEU and $LNC0_2$ to LNGDP

1) Null hypothesis :C(13)=C(14)=0 there is no short run causality from LNEU of Lag 2 to LNGDP
2) Null hypothesis: C(15)=C(16)=0 there is no short run causality from $LNC0_2$ OF lag 2 to LNGDP

Table 4.6: PRESENTATION OF WALD TEST RESULT

H0: C(13)=C(14)=0		
Test statistic	Value	Probability
Chi-square	1.824477	0.4016
H0: C(15)=C(16)=0		

Test statistic	Value	Probability
Chi-square	4.063943	0.1311

Source: author; see appendix 4.6

C (13) = C (14) = 0 this hypothesis implies that LNEU of lag 2 cannot influence LNGDP in the short run. Considering the Chi square with prob. value of 0.4016 which is greater than 0.05 levels, hence we accept the null hypothesis that there is no short run causality from LNEU to LNGDP.

C (15) = C (16) = 0 this hypothesis implies that $LNC0_2$ of lag 2 cannot influence LNGDP in the short run. Considering the chi square with prob. value of 0.1311 which is greater than 0.05 levels, hence we accept the null hypothesis that there is no short run causality from $LNC0_2$ to LNGDP. Conclusion is that there is no short run causality from carbon emission ($LNC0_2$) to economic growth (LNGDP)

4.3 Granger Causality Test

It is documented by Gujarati and Porter (2009) that regression analysis is about the dependence of one variable on the other variables, it doesn't necessarily imply causation. The test assumes that the information relevant to the predictions of the respective variable, LGDP, LNEC, LNEU and LNC02 is contained on time series data on these variables. The test involves the estimation of the following pair of regressions:

$LNGDP_t = \sum \alpha_i LNEC_{t-i} + \sum \beta_I LNGDP_{t-i} + u_{1t}$

$LNEC_t = \sum \lambda_i LNEC_{t-i} + \sum \delta_I LNGDP_{t-i} + u_{2t}$

This is applied to others variables of study i.e. LNEU, $LNC0_2$.

The critical *F*-value is 2.47 (for 6 and 25 df) at 5 percent level, against which the tabulated or estimated F-statistics would be compared. If tabulated f-stat is greater than critical f-stat the study reject the Null Hypothesis and if tabulated f-stat is lesser than critical f-stat the study accept the Null Hypothesis.

The study distinguished four cases:

1. Unidirectional causality from one variable to the other.

2. Feedback or bilateral causality between the variables
3. Independent (Neutrality) causality of the variables

Table 4.7 Presentation of Granger Causality

Models & hypotheses	f- stat	Decision
H0: LNGDP doesn't Granger cause LNEC & LNEC doesn't Granger cause LNGD		
LNGDP vs LNEC	2.87820	LNGDP ↔ LNEC
LNEC vs LNGDP	2.81781	
Critical f –stat (6 & 25 df) at 0.05 level	2.47	Feedback Causality
H0: LNGDP doesn't Granger cause LNEU & LNEU doesn't Granger cause LNGDP		
LNGDP vs LNEU	2.09904	LNGDP ≠ LNEU
LNEU vs LNGDP	0.22132	
Critical f-stat (6 & 25 df) at 0.05 level	2.47	Neutrality causality
H0: LNGDP doesn't Granger cause $LNC0_2$ & $LNC0_2$ doesn't Granger cause LNGDP		
LNGDP vs $LNC0_2$	0.12159	LNGDP ≠ $LNC0_2$
LNC02 vs LNGDP	2.08231	
Critical f-stat (6 & 25 df) at 0.05 level	2.47	Neutrality causality
H0: LNEC doesn't Granger cause $LNC0_2$ & $LNC0_2$ doesn't Granger cause LNEC		
LNEC vs $LNC0_2$	0.46056	$LNC0_2$ →LNEC
$LNC0_2$ vs LNEC	4.12516	
Critical f-stat (6 & 25 df) at 0.05 level	2.47	Unidirectional causality
H0: LNEU doesn't Granger cause $LNC0_2$ & LNC02 doesn't Granger cause LNC02		
LNEU vs $LNC0_2$	2.51594	LNEU → $LNC0_2$
$LNC0_2$ vs LNEU	0.83977	
Critical f-stat (6& 25 df) at 0.05 level	2.47	Unidirectional causality

Source: author: see appendix 4.7

4.3.1 Analysis of the Granger Causality

1) H_0: LNGDP doesn't Granger cause LNEC

LNEC doesn't not granger cause LNGDP

The table shows that estimated F-stat which are 2.87820 and 2.81781 are greater than the critical f-stat of 2.47 at 0.05 level, hence rejection of the null hypotheses and acceptance of alternative hypotheses that LNGDP granger cause LNEC and LNEC granger cause LNGDP respectively. This is feedback hypothesis which implies that electricity consumption granger causes Economic Growth and Economic Growth granger causes Electricity Consumption. Therefore, electricity consumption has significant effect on economic growth and Economic growth also has significant effect on Electricity Consumption (Feedback Hypothesis)

2) H_0: LNGDP doesn't Granger cause LNEU

LNEC doesn't not granger cause LNGDP

The table shows that estimated F-stat which are 2.09904 and 0.22132 are less than the critical f-stat of 2.47 at 0.05 level, hence acceptance of the Null hypotheses and rejection of Alternative hypotheses that LNGDP granger cause LNEU and LNEU granger cause LNGDP. This is Neutrality hypothesis which imply that energy use in oil equivalent is not causing economic growth and economic growth plays neutral role to energy use. Therefore, energy use doesn't have significant impact on economic growth and vice versa (Neutrality hypothesis)

3) H_0: LNGDP doesn't Granger cause $LNC0_2$

$LNC0_2$ doesn't not granger cause LNGDP

The table shows that estimated F-stat which are 0.12159 and 2.08231 are less than critical f-stat of 2.47 at 0.05 level, hence acceptance of the Null hypotheses and rejection of Alternative hypotheses that LNGDP granger cause $LNC0_2$ and $LNC0_2$ granger cause LNGDP. This is Neutrality hypothesis which implies that economic growth (LNGDP) is not causing carbon emission ($LNC0_2$) and carbon emission doesn't granger cause economic growth. Therefore, Carbon emission has no significant impact on economic growth and vice versa. In other words economic growth can be pursued without degradation of environment (Conservative hypothesis).

4) H0: LNEC doesn't Granger cause $LNC0_2$

$LNC0_2$ doesn't not granger cause LNEC

The table shows that estimated F-stat are 0.46056 and 4.12516. The estimated f- stat 0.46056 is less than the critical f-stat of 2.47 at 0.05 level, hence acceptance of the null hypotheses that LNEC doesn't granger cause $LNC0_2$. Meanwhile, estimated f-stat of 4.12516 is greater than the critical f-stat of 2.47 at 0.05 level hence, rejection of the null hypothesis that $LNC0_2$ doesn't granger cause LNEC. This is unidirectional hypothesis which implies that electricity consumption doesn't granger cause carbon emission ($C0_2$). Therefore, electricity consumption (LNEC) doesn't significantly cause carbon emission. (Neutrality Hypothesis)

5) H0: LNEU doesn't Granger cause $LNC0_2$

$LNC0_2$ doesn't not granger cause LNEU

The table shows that estimated F-stat are 2.51594 and 0.83977. The estimated f-stat 2.51594 is greater than the critical f-stat of 2.47 at 0.05 level, hence rejection of the null hypothesis and acceptance of alternative hypothesis that LNEU does granger cause $LNC0_2$. Meanwhile, estimated f-stat of 0.83977 is less than the critical f-stat of 2.47 at 0.05 level hence, acceptance of the null hypothesis that $LNC0_2$ doesn't granger cause LNEU. This is unidirectional hypothesis which implies that energy use cause carbon emission. (Unidirectional causality)

4.3.2 The Discussion of the Granger Causality

The granger causality result in the above table shows the direction of causality between the variables in a pair wise. It tells us how the current behaviour of a variable can influence change in another. From the table above the direction of causality is based on the estimated F-stat as compared with critical f-stat at 5 percent significant level.

From the first hypothesis, it is shown that there is bi-directional causality (feedback causality) between the Per capita GDP and Electricity Consumption. The implication of this is that electricity consumption causes per capita GDP in the long run and per capita GDP also cause electricity consumption. Any attempt to increase electricity consumption would have positive effect on economic growth and vice versa. So, it is needful of Nigeria Governments to improve the electricity supply of the nation at the competitive tariff rate in order to roll the engine of economy. This conclusion is made having acknowledged the fact that electricity consumption in

Nigeria is not contributing much to the carbon ($C0_2$) emission as indicated in the table above that $LNC0_2$ only granger cause electricity consumption while electricity consumption doesn't granger cause LNC02. This is evidence from the facts that Nigeria can generate electricity from hydro source and other renewable electricity sources that are not powered by fossil resources (thermal).

The table above revealed that there is independent causality between LNGDP (Economic growth proxy) and LNEU (energy use in oil equivalent). The implication of this is that energy use (LNEU) in Nigeria is not granger causing economic growth (LNGDP) and economic growth (LNGDP) doesn't granger cause energy use (LNEU) in Nigeria. This fact might seems unrealistic , but critical consideration of Nigeria case will reveal that existence of crude oil that should have been economic blessing has been seen as economic problems and epicenter of our corrupt leaders in Nigeria to the extent of neglecting other sectors that are capable of promoting economic growth in Nigeria.

It is indicated from the above table that there is unidirectional causality running from energy use (LNEU) to carbon emission ($LNC0_2$); hence, in order to protect our threatening environment it is needful of the country to reduce energy use (fossil) in oil equivalent as its not contributing meaningfully to the economic growth of Nigeria. The table shows that there is independent causality from economic growth (LNGDP) to carbon emission and vice versa.

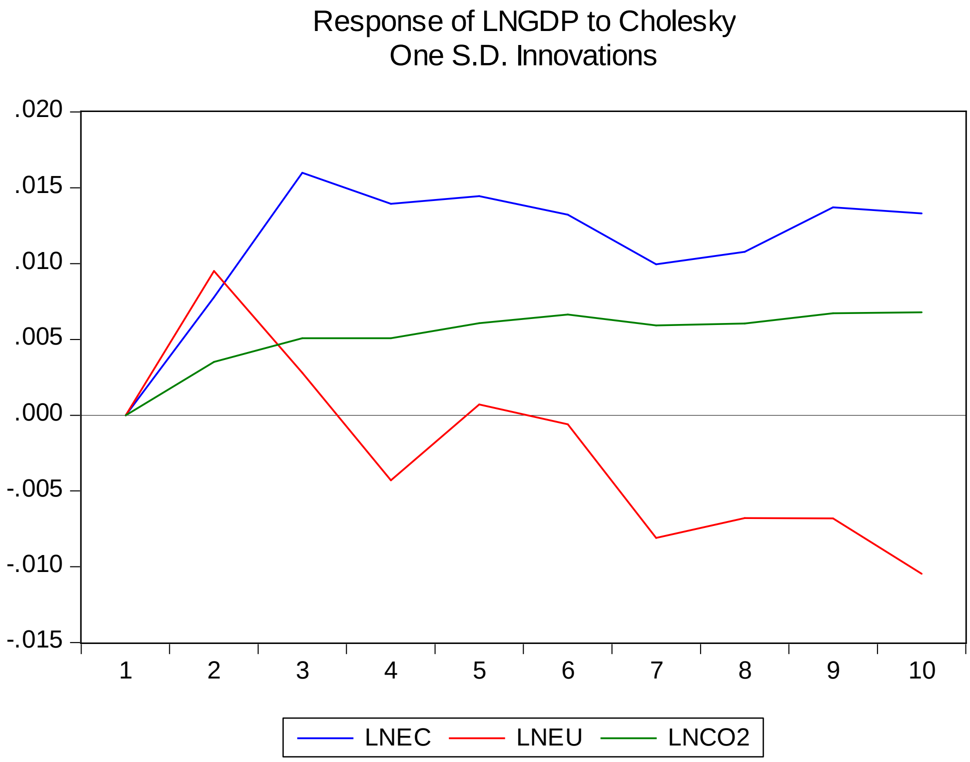
The result of the study analysed so far actually conformed with the empirical study by Presely and Babette (2012) study on Liberia, Soytas and Ramazan (2007) study on Turkey and Wolde – Rufael (2005) study on 19 African countries and 8 of the countries experienced bidirectional hypothesis between electricity consumption and economic growth as witness in Nigeria. It is worthwhile to point out that other similar studies have the mixed and conflicting evidence with respect to energy consumption, electricity consumption and environmental degradation. This divergent can be attributed to different factors e.g. variable choices, estimation techniques, time frame with quantity and quality of data used and developmental stage of different economies.

4.4: Impulse Response Analysis

On the basis of Vector Auto-Regression (VAR) model impulse response function is used to trace the response path of an endogenous variable (Economic growth) proxy by (RGDP) to a change in one of the innovations. This function determines the dynamic interplay between the variable and observe the adjustment speed in the system. The fig. 9 below reflects the response of LNGDP (Economic Growth) to shocks from the variables under study. It is reveals that Economic growth respond largely in positive region to shock from electricity, this is highly conform to the result obtain from the Granger causality analysis. This has policy implication that if there is improvement in supply and consumption of electricity will have significant impact on the economic growth in Nigeria. It is indicated that energy use in oil equivalent has negative relation or impact to the Economic growth. This is an indication of the condition prevailing in Nigeria whereby the revenue from the sector is always diverted for personal coffer, level of corruption in the sector, which is the reason why this is having negative relationship and impact to the economic growth.

It is important to mention that the result of our Impulse Response corroborate with the result of our Granger causality which says that carbon emission doesn't have negative impact on economic growth in the short run as validated by the Short run causality test. Though, there is indication that the two has long run association in the long run as depicted by the long run causality test.

Fig 4.8



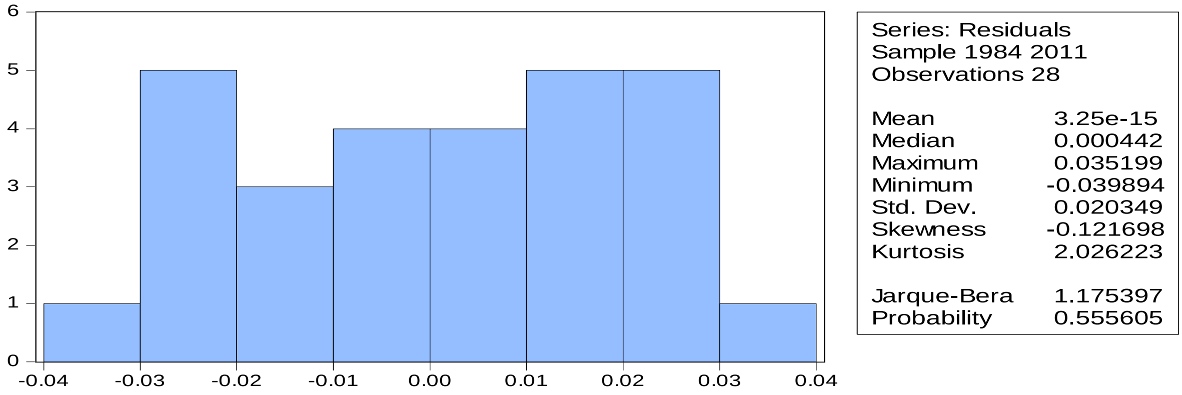
Despite the fact that the electricity plays crucial role in promotion of economic growth, electricity sector in Nigeria has not been properly structured towards the productivity that is capable of boosting the economic growth to the desirable level. The energy used KT of oil equivalent with similar negative relationship with LGDP implies that the energy which could have been used toward the promotion of economic growth has been used for other purpose i.e. to promote the Nigerian political leaders personal fulfilment as can be seen in the recent years that the corruption in the oil sector and the popular oil theft is capable of retarding the growth rate of the GDP. The reasons for these are not far-fetched, when the Government expend huge amount on these sectors (electricity and oil) with the aim of improving the sector's performance on the economic growth and eventually the sectors are not performing due to corruption, oil theft and siphoning the revenue from such sectors to personal coffer, definitely, these will have a negative effect on economic growth as it is clearly revealed by this study. The well-known corrupt practices by the NNPC and the gross failure of our electricity sector where the nation is expending large sum of Dollar without the commensurate productivity to show for this has been having a negative impact on the nation's economic growth potential as vividly depicted by the study at hand.

4.4. Residual Diagnostic Tests

These tests are conducted to determine the efficiency of the model.

4.4.1: Normality Test

Fig. 4.9 Test for Normality of the Residual



H_0: Null hypothesis: Residual is multivariate normal

H_1: Alternative hypothesis: residual is not multivariate normal

Consideration of Jacque-Bera statistic with value 1.175397 and Prob. value of 0.555605 which is greater than 0.05 levels. Hence, we accept the H_0 that the residual is normally distributed. Conclusion is that the residual of the model is normally distributed.

4.4.2. Heteroscedasticity Test

According to Gujarati and Porter (2009), Autoregressive conditional heteroscedasticity (ARCH) may have an autoregressive structure, in that heteroscedasticity may be observed over different periods, hence it is needful to conduct the test for this study.

H_0: there is no ARCH effect

H_1: there is ARCH effect

Observation included: 26	Dependent Variable: RESID^2	H_0: no ARCH effect

F-statistic	0.652871	Prob. F(2,23)	0.5299
Obs* R-squared	1.396760	Prob. Chi-Squared	0.4974

Source: author; see appendix 4.7

From the table above, the Prob. chi-Squared value of 0.4974 which is greater than 0.05 levels, hence we accept the null hypothesis that there is no ARCH effect. This is desirable for the study because it signify that there is no heteroscedasticity problem in the model.

4.4.3: Test for Residual Auto-Correlation

This is the test for serial correlation in the model. The Breusch -Geofrey Serial correlation LM test is used to test the existence of serial correlation in the model.

Breusch-Godfrey Serial Correlation LM Test

Observation included: 28	Dependent Variable: Residuals		H_0: no serial correlation
F-statistic	0.204557	Prob. F(2,9)	0.3866
Obs* R-squared	1.217455	Prob. Chi-Squared	0.5440

Source : author; see appendix 4.7

Null Hypothesis (Ho): there is no serial correlation

From the table, considering the prob. Chi-Square value of 0.5440 which is greater than 0.05 level. And, the decision rule is to accept the Null hypothesis (Ho) if the prob. Value is greater than 0.05; hence acceptance of the null hypothesis which stated above that there is no serial correlation in the model.

Conclusively, the above residual test of the study conducted are all desirable, considering the normality test of the residual, ARCH effect (heteroscedasticity) test and serial correlation test of Breusch-Geofrey. This model can be used for forecasting and other economic purpose as the tests conducted indicated that it is highly reliable.

5 SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATION

5.1 Summary and Findings

This study is borne out of the curiosity to determine the role energy plays in the accomplishment of growth objective in Nigeria, with considerations of adversities attached to its consumption on our environment. The fact that the role of the energy has been downgraded as it merely refers to as 'just an intermediate input' is another reason that justifies the attention being devoted to this study. The study reveals that energy consumption plays significant role in the accomplishment of growth objective most especially electricity without been detrimental to the environment. Consequently, the quest for just concluded power sector reform is necessitated having confirmed the crucial role the energy plays in achievement of economic growth.

The study investigated the impact of energy consumption and carbon emission on economic growth in Nigeria between 1981 and 2011. The variables of interest in the study are Economic growth proxy by PCGDP at 2000 constant Dollar, Capital is proxy by Gross Capital Formation, Labour is proxy by Labour Participation Rate (% of total population 15+), Electricity Consumption KW per capita, Energy use (Oil Equivalent) and Carbon (CO_2) Emission (Environmental Impact of Energy Consumption). Restricted Vector Auto-Regressive Model is used to estimate the Long run causality and short run causality. Having confirmed that all variables are stationary at Order of Integral One I(1), Johansen cointegration was conducted and long run relationship is confirmed to exist in the model, long run causality test was also conducted which indicated the existence of long run causality among the variables. Further test known as Wald test was carried out to determine if there is existence of short run causality among the variables, the test indicated that there is no short run causality between PCGDP and Energy use in oil equivalent; and it doesn't exists between PCGDP and CO_2 emission.

The granger causality test indicated that there is bi-directional causality between PCGDP and Electricity consumption; CO_2 emission granger causes Electricity Consumption; Energy use in oil equivalent granger causes CO_2 emission. And finally, there is no causality between PCGDP and Energy use in oil equivalent; more so, CO_2 doesn't granger cause PCGDP. Diagnostic tests on residuals were conducted to determine efficiency and consistency of the model. Serial Correlation test was carried out with the aid of Breusch-Godfrey serial correlation test, and was found that the model is free from serial correlation problem by accepting the null hypothesis of no serial correlation after examining Chi-square statistic of the test. ARCH test was also conducted to test for Heteroscedasticity condition in the Auto Regressive model, the result showed that there is no ARCH effect by examining the Chi-Square statistics. Normality test on residuals indicated that the residuals are normal having considered Jaque Bera statistics and the probability value.

5.2 Conclusion

As a corollary to the above, the result of strong granger causality revealed that energy use (in oil equivalent) is not significant to Nigeria economic growth, meanwhile the study shows that it is the main source of carbon emission (environmental degradation). Furthermore, the study exposed the capability of electricity consumption to move the nation from this undesirable state to better and more desirable state by being able to promote the so called economic growth and socio-economic development. The study captured the present electricity status in Nigeria viz a viz the economic growth which is indicated by the negative coefficient in the VECM analysis. It was emphasized above that the sector has not been properly managed to achieve the growth objectives of the nation. Further consideration of strong granger causality shows electricity's capability to turn the nation's economy around without being detrimental to the environment. This is due to the fact that Water (Hydro), Sunlight, Wind, Tides and Geothermal heat which are (renewable) that can be exploited to generate electricity in Nigeria.

The above empirical investigation brings the study to the conclusion that Nigeria is capable pursuing economic growth objectives at the same time with the environmental sustainability goal. Ultimately, the following triple goals can be achieved:

1) Energy security by not depending mainly on fossil which is non-renewable as the only source of energy, so that future generation can benefit from this diminishable and non-renewable natural resources.
2) Environmental sustainability (green economy) whereby global warming problem can be mitigated to the barest minimum by reducing the consumption of fossil fuel and substituting substantial energy required for economic growth with renewable energy sources thereby reducing the carbon ($C0_2$) emission, hence protecting our threatened environment.

3) Sustainable and inclusive development.

5.4 Recommendations

The unbundling of the PHCN which has been taken over by private operators is a right action in the right direction, the establishment of National Electricity Regulation Commission as institutional framework that is saddled with monitoring and regulation of the sectors is in line with the best practices and the body must be strengthened and made to be independent in decision making as far as this privatization is concern in order to avoid the situation where public monopoly would be turned to private monopoly.

The sector is a promising one, it is capable of bringing success story to Nigeria if it is properly harnessed. In the light of this, Federal government should continue to partner with the private operators in the area of funding as we all know that the project concerns is capital intensive and has a very long gestation period. Hence, Government should go extra-mile to assist the operators in acquisition of loan to finance the project by guarantee the security of loan required by the operators to fund the projects in order for the whole process of unbundling and privatization not to become a ruse.

There are indications as reviewed by the literatures in this study that governments has some energy policies among which it can generate electricity through water (hydro), thermal, wind, geothermal, nuclear. All these sources of energy are environment friendly, hence government should make giant stride towards harnessing these opportunities by establishment of institutions and framework that will focus on the development of this sources to compliment the fossil fuel source in order to have a more sustainable environment that will be good for all to live.

As electricity sector has been identified as crucial to socio-economic development of Nigeria, I strongly recommend the establishment of training institute where our youth can be trained and garnered technical know-how on developing alternative electricity generation means to reduce our concentration on thermal means of electricity supply. This will go a long way in providing job opportunity to our youth and capable of meeting the electricity required by Nigerians estimated as 140,000 MW base on international comparison.

Sound policies framework should be provided, to be followed strictly by the electricity generation and distribution operators to ensure that they do not exploit individual and corporate Nigerians for their own selfish personal interest. The government should ensure the operators provide the appropriate meter for the consumers especially residential and firms to protect them from being over or undercharged in order to make them to be more competitive on their various productive activities.

Having liberalized the sector, government should ensure level playing grounds for other prospective operators, by removing the factors that might constitute hindrances or obstacles to other participants and should desists from making the sector political affairs whereby failed politicians will be allocated business opportunity in the sector to embark on the project so that he or she can recover what he has wasted on political platform at the expense of Nigerians

The fourth cardinal objective provided in the reform programme that states that there will be rural electrification agency and fund, this initiative is a right one if there is political will and dynamic inconsistency will not come to play. Federal government should ensure that electricity is extended to remote rural areas of the country. This will empower rural dwellers economically and made their small scale business to be more viable which can reduce urbanization in the long run.

As regards crude oil issue, the delayed petroleum bill that has been in the process of passing into Act is necessary to curtail the excesses of our political officers that are siphoning the public revenue from crude oil to personal coffer, the unscrupulous nature of the official in NNPC must be mitigated so that the sector will be able to contribute immensely to the growth objective more that it is doing. Government should make a giant effort to check and control the activities of pipeline vandals as this is disrupting supply of oil products adequately.

More policies, laws and institutions should be established to control emission in our nations. It is confirmed in our analysis that energy usage (oil equivalent) is the variable that causes carbon emission; thereby transporters must be controlled and checked by ensuring their vehicles are not emitting toxic carbon in the environment. The issue of gas flaring and oil spillage should be checked, to ensure our environment is suitable for living and our private and investment properties are save from uncontrollable floods.

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