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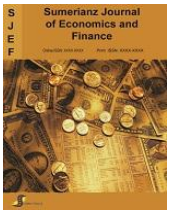

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Electricity Generation and National Development in Nigeria: The Perspective of Auto-Regression Distribution Lag (ARDL) Bond Test Analysis

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Abstract

Electricity generation is an enormous challenge facing African largest and most populous economy as it affects national and socioeconomic development of the Nigerian state. Electricity is regarded as a propelling force behind economic activities, rural /community development and viewed as an economic tool for maintaining and expanding capital stock, poverty alleviation and production capacity of an economy. Most existing studies on electricity and national development relationships on Nigerian economy mainly concentrated on electricity consumption and not electricity generation. Besides, their findings were inconclusive. Therefore, this study examined the relationship between electricity generation and national development Nigeria from the period of 1981 – 2016. The study employed Auto regression distributed lag (ARDL) bound test which was found to be the most appropriate to establish the short-run and long-run relationship since there was fractionally integrated variables. That is, variables at different level of integration (but not at I (2) level). The study revealed that electricity generation negatively affected national development both in the long and short run periods. The consequence of electricity generation effects on national development was negative; thus, it served as a disincentive to productivity, economic activity and national development, also, lack of adequate generation capacity have significantly impacted on the cost of living, production, doing business in Nigeria and even the cost of governance. The study concluded that electricity generation has significantly impacted negatively on productivity and national development of the Nigerian economy over the years. The policy implication of these findings is that electricity generation sufficiency drive of the Nigerian government has to be geared up, continued to be investment friendly and electricity generation mix should be adopted by way of having more varieties of electricity energy generation sources that can actuate industrialization, enhance the desired national development for the Nigerian economy in the nearest future.

Keywords: National development; Electricity generation; Socioeconomic development; Economic growth.

1. Introduction

The prosperity of a nation is central to the long-term national development and economic sustainability. Electricity generation is seen as one of the drivers of development in any economy of the world particularly in the less developed countries, Nigeria inclusive. In this paper, notably, national development and economic growth will be used interchangeably because economic growth is essential and a component of long-term strategic planning for national development .About a decade ago, The Economist labelled Africa as "the hopeless continent" (Zhang, 2014). This was as a result of the continuous institutional and structural failure, degenerating standard of living, despairs in governance, despotism, corruption, poverty and retarded growth of the African economies. Profound changes have taken place since then. Africa's economies are consistently growing faster than those of almost any other regions of the world. Nigeria a shining example of these Africa's hopeful economies, Oke and Sulaiman (2012) emphasized this. However, there are lots of challenges holding Nigeria back of her potentials of being an energy hub and a preferred destination for investors and ultimately a major investment hub in Africa.

Nigeria, an oil-rich economy, has been hobbled by political instability, corruption, inadequate infrastructure, and poor macroeconomic management. Nigeria's former military rulers failed to diversify the economy away from its overdependence on crude oil, which provides about 90% of foreign exchange earnings and about 80% of budgetary revenue (Forbes, 2011). The Nigerian economic growth indicator GDP was worth $568.4billion US dollars in 2014 and it contracted to $481billion in 2015. That is about -18% contractions from previous year. However, private domestic investment from these periods increased from $8.6billion in 2014 and $8.9billion in 2015. The 2015 GDP value of Nigeria represents 0.65 percent of the world economy according to the World Bank and Central bank of Nigeria. Over the past 30 years, the value of the Nigerian economic growth indicator has fluctuated between $481billion in 2015 and $28.8billion in 1985, reaching an all-time high of $568.5billion in 2014 and a record low of $15.7billion in 1993. The economy of Nigeria increased by 54% in 2010 from $169.4billion in 2009 to $369billion the highest growth rate ever recorded. The highest contraction was -86% in 1993 and such contraction repeated itself in 1998 (-12%), 2009 (-23%) and 2015 (-18%). The Nigerian private domestic investment contribution to GDP have been less than 1% from 1985- 2009.

In Nigeria and other developing countries, electricity generation serves as the pillar of wealth creation evident by being the nucleus of operations and engine of growth and development for all sectors of the economy (Emeka,

2010). The output of the electricity sector usually consolidate the activities of the other sectors which provide essential services to direct the production activities in agriculture, manufacturing, mining, commerce etc. Electricity plays an essential role in an economy on both demand and supply. On the demand side, electricity is one of the products a consumer decides to buy to maximize his or her utility. On the supply side, electricity is a key factor of production in addition to capital, labour and materials and is seen to play a vital role in the economic and social development of countries, being a key factor in increasing economic wealth, investment potential and living standards. Electricity is the most common form of energy usage in this part of the world. In addition, electricity has also proven to be a more reliable source of energy and very cost effective means of energy usage in sub-Saharan Africa (Enu, 2014). It plays a very important role in the national, socio-economic and technological development of every nation.

1.1. Statement of the Problem

Economic development continues to be a key macroeconomic concept of interest among most researchers and policy makers around the globe (Abaidoo, 2011). The upholding interest in this macroeconomic indicator comes from its pivotal role in impacting other integral segment of an economy. Hence, the understanding of the dynamics responsible for economic development and the factors which impact this development continues to evolve as economic boundaries continue to fade in the face of increasing shift towards integrated global economy and electricity is the nucleus of operations and subsequently the engine of growth and development for all sector of a nation.

However, there are various problems hindering the electricity sector in sub-Saharan Africa. The current electricity generation in Nigeria and in most part of Africa relies solely on essentially two resources-natural gas and hydro, where they are vulnerable to sabotage and adverse weather conditions. According to Morimoto and Hope (2011), adequate and reliable electricity is a major input for achieving socio-economic development. Also, Thisday News, Feb 22 2015, in its report noted that an inadequate eletricity supply restricts socio-economic activities to basic human needs, limits national development and adversely affects quality of life. Nigeria with over 180 million populations, the country's electricity generation capacity now stands at 3,587 megawatts but required about 14,000 megawatts daily according to the International energy agency (IEA). Nevertheless, inadequate and unreliable electricity generation remains a major constraint to future national prosperity and development. The relationship between electricity energy and nation's growth and development has been examined thoroughly since the pioneer work of Kraft and Kraft (1978). Also, worth noting, most of the studies done on electricity and national development have only concentrated on the relationship between electricity consumption and national development see (Abaidoo, 2015; Akomolafe and Danladi, 2014; Enu and Havi, 2014; Enu, 2014; Gelo, 2009; Ogundipe and Apapa, 2013; Oyaromade *et al.*, 2014). On the other hand, only a few studies considered the relationship between electricity generation and national development and they were found to be inconclusive see (Onyeisi *et al.*, 2016; Saibu, 2012).

Giving the identified knowledge gaps, the broad objective of the study is to investigate the dynamic relationship between electricity generation and national development in Nigeria. More so, subject to the findings of this study, it can provide the necessary recommendations to the Nigerian government on electricity energy generation, investment, national development, rural/community advancement, and sustainable economic prosperity in the future.

2. Literature Review

The concern of research analysts on electricity generation and is its impacts on national development which is conceptualized from varying dimensions. First and foremost, from the elementary literature, National development includes full-growth and expansion of industries, agriculture, education, social and cultural institutions. More so, it implies development of a nation as a whole. National development is economic growth plus institutional and structural changes, changes in social and cultural as well as economic and qualitative as well as quantitative. In same vein, National development is simply the total effect of all citizen forces and addition to the stock of physical, human resources, knowledge and skill.

In understanding the relationship between energy more specifically electricity and national development, economic growth is essential and a component of long-term strategic planning for national development. Economic growth can be defined as sustained growth of full-employment and real national product. Growth further means that an ever increasing quantity of goods and services is available to meet the economy's needs. According to Parkin (2003), economic growth is the expansion of production possibilities that results from capital accumulation and technological change.

However, identifying the relationship between electricity generation and economic growth is difficult given the complex underlying behavioral and structural mechanisms, especially technology, market liberalization, and sustainable development (Gang *et al.*, 2015). Electricity energy is a key infrastructural element for national development. It is a multitalented 'energy currency' that underpins a wide range of products and services that improves the quality of life, increase worker productivity and encourage entrepreneurial activity in an economy (Adom, 2011).

Across most African and developing economies, access to reliable and affordable energy is problematic. Africa's electricity energy sector is dominated by a few countries, namely South Africa in Southern Africa, Egypt, Tunisia and Morocco in North Africa and Nigeria in West Africa. The northern and southern regions alone provide 82% of Africa's power generation (Kalitsi, 2003).

2.1. An Overview of the Nigerian Electricity Sector

The electricity demand in Nigeria far outstrips the supply and the supply is epileptic in nature. The country is faced with acute electricity problems, which is hindering its development notwithstanding the availability of vast natural resources in the country (Okoligwe and Ihugba, 2014). It is widely accepted that there is a strong correlation between socio economic development and the availability of electricity. The history of electricity in Nigeria dates back to 1896 when electricity was first produced in Lagos, fifteen years after its introduction in England. Despite the fact that its existence in the country is over a century, its development has been at a slow rate. In 1950, a central body was established by the legislative council, which transferred electricity supply and development to the care of the central body known as the Electricity Corporation of Nigeria, now defunct. Other bodies like Native Authorities and Nigeria Electricity Supply Company (NESCO) have licenses to generate electricity in some locations in Nigeria. There was another body known as Niger Dams Authority (NDA) established by an act of parliament.

The Electricity Corporation of Nigeria (ECN) was established in 1951, while the first 132KV line was constructed in 1962, linking Ijora Power Station to Ibadan Power Station. The Niger Dams Authority (NDA) was established in 1962 with a mandate to develop the hydropower potentials of the country. However, ECN and NDA were merged in 1972 to form the National Electric Power Authority (NEPA). In 1998, NEPA ceased to have an exclusive monopoly over electricity generation, transmission, distribution and sales. Kainji Hydro Power Station located in Niger State along the River Niger is the first Hydro Power Station in the country. Electricity production by source in Nigeria was 61.90% fossil fuel, 38.10% hydro, 0% nuclear and 0% others. The Energy Commission of Nigeria (ECN) was established by Act No. 62 of 1979, as amended by Act No. 32 of 1988 and Act No. 19 of 1989, with the statutory mandate for the strategic planning and co-ordination of national policies in the field of energy in all its ramifications. By this mandate, the ECN is the government organ empowered to carry out overall energy sector planning and policy co-ordination. As part of its contribution to the resolution of the problems of the electricity sector along the line of its mandate, the ECN has been collaborating with the International Atomic Energy Agency (IAEA) under an IAEA regional project titled "Sustainable Energy Development for Sub-Saharan Africa (RAF/0/016)" As part of the restructuring, the Electric Power Sector Reform Act 2005 was enacted. Subsequently, the defunct NEPA was known as Power Holding Company of Nigeria (PHCN). The reform act paved way for the unbundling of NEPA into 18 companies: 6 generating companies, 1 Transmission Company and 11 distributing companies. The generating companies are made up of 2 hydro and 4 thermal (gas based) stations. Of recent, PHCN has an installed capacity of about 6000MW through a number of hydro (Kainji, Jebba, Shiroro), and thermal stations (Egbin, Ughelli, Afam, Sapele). The transmission voltage levels are 330KV for the grid transmission; 132KV for the sub-transmission lines, whilst the 33KV, 11KV and lower voltages constitute the distribution networks. The System normal frequency is 50Hz. Most of these electricity plants in country are underutilized or not functioning (Enebeli, 2010).

2.2. Review of Empirical Literature

Adjei (2016), analyzed the effect of electricity energy production/generation on the GDP Per Capita growth in Ghana using world Bank Data, spanning from the year 1971-2013, examined both the long-run effects and the short-run dynamics, investigated the speed of adjustment to the long run equilibrium and also explored the direction of causality. The co-Integration methodology was used, where the fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS), and the vector error correction model (VECM) were estimated. The study found a positive and significant relationship between electricity production and GDP per capita growth rate in Ghana in the long run estimates and revealed a faster speed of adjustment back to the long-run equilibrium, when there is any disturbance. The study also showed a unidirectional causal relationship running from GDP growth to electricity generation

Onyeisi *et al.* (2016), concluded in their study when examining the impact of power generation capacity on economic growth in Nigeria from 1980 - 2015. In the model specified, Real Gross Domestic Product was a function of Power generation capacity in Kilowatt, Gross capital formation and Unemployment. With the use of co integration test, vector error correction mechanism and granger causality. The result found an insignificant long run relationship exists between power generation and economic growth. This means that the result of this finding can be relied upon in taking long run policy decision indicating an insignificant relationship with economic growth and development. The study concluded that there is no causality between power generation capacity and economic growth and development in Nigeria within the study period. The study therefore, recommended that for the development of the economy and improvement in power generation capacity, government must ensure transparency in the overall implementation of power sector policy and its attendant reform agenda.

Gang *et al.* (2015), focused on understanding the relationship between economic rebalancing, nation development and electricity which they found essential for power systems planning for Chinese national development. Their study used 20 years of provincial data on gross domestic product (GDP) and electricity supply and demand to examine the relationship between these factors. It was observed a higher effect of electricity consumption in the richest provinces in Chinese economy, as the electricity supply saturates and the economy develops and moves to a more service-based economy. The study also examined more carefully the relationship between electricity use and economic development, as China transitions to a new growth phase that is likely to be less energy and resource intensive. The results of their study suggest that policymakers and power system planners in China should seriously re-evaluate energy demand projections and the need for new generation capacity to avoid over-investment that could lead to stranded generation assets.

Bildirici (2013) investigated the relationship between electricity and economic growth by using Autoregressive Distributed Lag (ARDL) bounds testing approach and vector error-correction models (VECM) in Cameroon, Cote D'Ivoire, Congo, Ethiopia, Gabon, Ghana, Guatemala, Kenya, Senegal, Togo and Zambia for period 1970-2010, the ARDL results show that there was a co-integration relation between electricity consumption and economic growth in ten of the eleven countries. The study forward revealed the causality analysis reports that growth hypothesis exists in Cameron, Congo Rep., Ethiopia, Kenya and Mozambique and the conservation hypothesis in Senegal and Zambia. For Gabon, Ghana and Guatemala, and there exists a bi-directional causality between economic growth and electricity supply and demand.

According to Saibu (2012) in his work on the relationship between energy resource, domestic investment and economic growth in Nigeria. The study employed the use of co-integration and vector error correction model (VECM). It therefore concluded that there exist a long-run equilibrium relationship between energy resource, domestic investment and economic growth. This implied that economic growth and domestic investment will possibly yield the desired result as expected in the long-run if energy growth is achieved.

Adom (2011) Research into the electricity-economic growth nexus has important implications for energy conservation measures and environmental policy. The Toda and Yomamoto Granger Causality test was used to carry out the test of causality between electricity consumption and economic growth from 1971 to 2008. The results obtained herein revealed that there exists a unidirectional causality running from economic growth to electricity supply. Thus, data on Ghana supports the Growth-led-Energy Hypothesis. The results imply that electricity conservation measures are a viable option for Ghana.

Igbinovia and Osayi (2010), analyzed electricity generation and demand trend in Nigeria from 1973 to 2007 the study made used of data's collected from the country's monopolized vertically operated utility National Electric Power Authority (NEPA) now called Power Holding Company of Nigeria (PHCN) and from population census bureau was analyzed using mathematical models to determine power systems parameters. In the study it was noted that electric power generation boosted and improved electric energy available for economy during the years, the power generated is still below 4500Mw for the estimated population of above 160Million people. The study further showed and submitted that the so much desired improvement in the nation gross domestic and gross national product's cannot be given definite value comparable with other nations in the world, hence from the saying that energy and knowledge rules the world the trend of energy growth compared with economic, coupled with our level of industrialization, the nation cannot be said to be a developed nation.

Ghosh (2009), assessed the relationship between electricity supply, employment and economic growth (real GDP) for India within a multivariate framework using autoregressive distributed lag (ARDL) bounds testing approach of co-integration. A long-run equilibrium relationship was established among these variables for the time span 1971 to 2006. The study further established long- and short-run Granger causality running from real GDP and electricity supply to employment without any feedback effect. The study concluded that the absence of causality running from electricity supply to real GDP implies that electricity demand and supply side measures can be adopted to reduce the wastage of electricity, which would not affect future national development of India.

Stern and Cutler (2004), the concluded that the theoretical and empirical evidence indicates that energy use and economic growth is tightly coupled with energy availability playing a key role in enabling growth. A time series analysis use in their work ''Energy and Economic Growth'' which focused on the United State shows that energy and GDP co-integrate and energy granger causes GDP. Additionally, Stern (2000) investigated the time series properties of economic growth weighted energy, labor, and capital series on the United States economy, estimating a dynamic co-integration model using the Johansen methodology. The co-integration analysis showed that energy is significant in explaining GDP. It also showed that there is co-integration in a relationship including GDP, capital, labor, and energy. The multivariate analysis shows that energy Granger causes economic growth (GDP) either uni-directionally or possibly through a mutually causative relationship depending on which version of the model is used.

2.3. Summary of the Review of Empirical Literatures on Electricity Generation and Economic Growth

Table-1.

Author (year)	Data period	Country	Topic	Methodology	Result finding	Gap in literature
Onyeisi *et al.* (2016)	1980-2015	Nigeria	Power generation capacity and economic growth	Granger Causality and Co-integration test	No causality between power generation and economic growth. There was insignificant relationship between power generation and national development	The application of Granger causality test and co-integration was not enough and result was inconclusive. This present study will apply ARDL bounds test, which provides optimal estimates of the co-integration.
Adjei (2016)	1971-2013	Ghana	A dynamic estimation of electricity	Co-integration test, FMOLS and Vector error correction (VEC)	The study found a positive and significant relationship between electricity production, national development	This present study will focus on Nigeria economy.

			production and economic growth		and economic growth.	
Gang *et al.* (2015)	1990-2009	China	Economic rebalancing and electricity production demand.	ARDL bounds test	The study established a relationship between national development and electricity supply and demand.	The study was done on a developed economy. This present study will focus on the Nigerian economy, a developing economy.
Bildirici (2013)	1970-2010	14 selected African economies	The relationship between economic growth and electricity consumption	ARDL bound test, VECM and Granger causality	The result showed that there was a co-integration relation between electricity consumption and national development in ten of the eleven countries. Also, a bi-directional causality.	This present study will only focus on Nigeria economy and the variables to be considered are electricity generation, national development and private domestic investment.
Ogundipe and Apapa (2013)	1981-2010	Nigeria	Electricity consumption and economic growth in Nigeria.	Co-integration with cob-Douglas model	Electricity consumption impacted significant on economic growth.	This present study will be considering electricity energy generation, private domestic investment and economic growth and will employ the use of ARDL bound test.
Saibu (2012)	1970-2010	Nigeria	Energy resources, domestic investment and economic growth	Co-integration and Vector error correction model (VECM)	It was revealed that existed a long-run equilibrium relationship between energy resources, domestic investment and economic growth.	The study made use of oil production as a variable to capture energy resource. This present study will make use of electricity generation (production) as a variable to capture energy generation.
Adom (2011)	1971-2008	Ghana	Electricity consumption and economic growth nexus.	Granger causality	The study revealed a uni-directional causality running from economic growth to electricity generation.	The application of granger causality alone is not enough for this kind of study. This present study will focus on Nigeria and will employ more estimation techniques suitable.
Igbinovia and Osayi (2010)	1973-2007	Nigeria	A case study of electric energy generated and demand trend.	Descriptive statistic and Mathematical model.	The study noted that electric power generation was boosted and there was improved electric energy available during the years reviewed. The desired improvement in national development can only be achieved by developing the electricity generation capacity	This present study will make use of ARDL Bound test econometric techniques of analysis.
Ghosh (2009)	1971-2006	India	Electricity supply, employment and real GDP.	ARDL bound test	The finding showed a long-run equilibrium relationship between electricity supply and real GDP (economic growth) and a bi-directional causality runs from real GDP to electricity supply.	The study was conducted with 2006 data. The present study's timeframe ending is 2016 and it's focuses on Nigeria economy.
Stern and Cutler (2004)	1970-2000	USA	Energy and economic growth	Ordinary linear regression and Granger causality	Energy and economic growth have a significant relationship	The timeframe of 2002 compare to timeframe of present study of 2016 and Nigerian economy

3. Theoretical Framework

The Romer's Endogenous growth model as represented with the technological homogeneous production function takes the form of a production function just like that of Cobb-Douglas, as it assumed a function of homogeneous of degree one (1) in all its inputs.

Hence, the basic production function, according to Romer is:

$$Y = AK^{\alpha+ß} L^{1-\alpha} \quad (1)$$

It is assumed that the value of 'A' does not increase with the passage of time, rather it remains fixed.

$Y = [AL^{1-\alpha} K^{\alpha+ß}]$ (Recall equation 3.1)

A stable economy will occur when Y/Y and L/L, K/K will be constant. In the presence of constancy of K/K, the Y/K will also remain constant. If the ratio remains constant, the output will also remain constant as; K/K=Y/Y=g (a constant growth rate). The labor growth rate (n) is assumed constant also, then 'n' = L/L, inserted into above equation.

$$\text{The } \dot{Y}/Y \text{ will be as: } \frac{\dot{Y}}{Y} = [AL^{1-\alpha} K^{\alpha+ß}] \left[(\alpha+ß) \frac{K}{K} + n(1-\alpha) \right] / [AL^{1-\alpha} K^{\alpha+ß}] \quad (2)$$

As $g = \dot{Y}/Y$ and $g = \dot{K}/K$, then, therefore we have this

$\dot{Y}/Y = (\alpha+ß)(\dot{K}/K) + (1-\alpha)n \equiv g = (\alpha+ß)g + (1-\alpha)n$

As is assumed, 'g' shows the rate of growth of output and 'n'represents growth of population. Hence, in the absence of technological progress the per capita growth rate will be zero. Romer's growth model which includes the externalities of capital, will make ß = 0. As a result, the per capita growth rate, i.e., g - n > 0, and Y/L, i.e., per capita output will be increasing.

3.1. The Model

This study adopts the Romer's Endogenous growth model as represented with the technological homogeneous production function as used by Paul Romer in his growth theory by introducing the electricity generation to investigate the relationship between economic growths (nation development) in Nigeria. The endogenous growth incorporated electricity energy as an explicit factor of production in an endogenous growth model and concluded that the rate of growth depends negatively on the rate of growth of real energy prices. Modeling for the relationship between electricity generation and economic growth (national development) relationship follows directly from the Romer's endogenous theoretical model. To include Energy resource (Energy generation) in the growth model, it is assumed that a fixed amount of electricity generation is available to the economy in each production period and it is therefore assumed that output is produced according to the below function;

$$Y = AK^{\alpha+ß} L^{1-\alpha} \quad (3)$$

As 'A' represent the index of exogenous technology which multiplied the production output function. 'K' represents physical capital stock and 'L' represents the labour stock. According to Romer's the production function exhibits increasing returns in the production output that is output doubles when inputs factors are doubled. Similarly, the next equation can be modified as;

$$\Delta Y = \Delta AK^{\alpha+ß} L^{1-\alpha} \quad (4)$$

In other words, ΔY the rate of output growth can be determined by the rate of growth in 'A, K, and L'. If more capital is invested in new technology then technology increases by a larger amount. That is ΔA is greater. Since, endogenous growth incorporated electricity as an explicit factor of production and technology is assumed by Romer as a non-rival input and non-excludable so is electricity generation (EG), and then ;

$$\Delta A = EG \quad (5)$$

The change in capital stock overtime is investment (PI). That is;

$$\Delta K/K = PI \quad (6)$$

According to the mainstream and endogenous economists 'L' represents the labour stock. That is labour force (LF) otherwise known as Human capital.

$$L = LF \quad (7)$$

Putting all these in simple linear form by incorporating equations (5), (6) and (7) into equation (4), so as to accommodate energy generation, private domestic investment and labour force influence on output growth (national development).

$$\Delta Y = \alpha_0 + ß_1 EG + ß_2 PI + ß_3 LF \quad (8)$$

$$\Delta Y/Y = \text{Output Growth (RGDP)} \quad (9)$$

Also, with the modification from the work of Saibu (2012) who studied Energy resources, Domestic investment and Economic growth in Nigeria and adopted his model from an endogenous growth model. The model for his study was stated as below;

$$RGDP = \bullet_0 + \bullet_1 ENR_i + \bullet_2 Z_i \quad (10)$$

Where RGDP = Economic growth (which depends directly on both human and physical capital investment, ENR = Energy resource and Z = vector of other explanatory variables (foreign direct investment, investment in human capital e.t.c.

Thus, the model equation 11 is generally specified below;

$$RGDP = \omega_0 + ß_1 EG + ß_2 PI + ß_3 LF + ß_4 IPD + Z \quad (11)$$

Where; RGDP = Real Gross domestic product (proxy for Economic growth and national development), EG = Energy generation, PI = Private domestic investment, LF = Labour Force and IPD = Implicit price deflator.

Presenting equation 11 in a log linear form in order to covert research data to absolute terms into same numerical structures and to standardize them into relative values, then;

$$\log RGDP_i = \omega_{0i} + ß_{1i}\log EG_i + ß_{2i}\log PI_i + ß_{3i}\log LF_i + ß_{4i}IPD_i + Z_i \quad (12)$$

The ARDL model is expressed as

$$\Delta RGDP_t = \omega_{0i} + \sum_{i=1}^{n} \beta_{1i}\,\Delta RGDP_{t-i} + \sum_{i=0}^{n} \beta_{2i}\Delta\, EG_{t-i} + \sum_{i=0}^{n} \beta_{3i}\Delta\, PI_{t-i} + \sum_{i=0}^{n} \beta_{4i}\Delta\, LF_{t-i}$$

$$+ \sum_{i=0}^{n} \beta_{5i}\Delta\, IPD_{t-i} + \alpha_1 + \alpha_1 RGDP_{t-1} + \alpha_2 EG_{t-1} + \alpha_3 PI + \alpha_4 LF + \alpha_5 IPD + Z_t \quad (13)$$

Where;

$RGDP_i$ = Real Gross domestic product, EG_i = Energy generation, PI_i = Private domestic investment)

LF_i = Labour force, IPD_i = Implicit price deflator, Δ Denotes the first difference operator, Z_i = Stochatic error term, ω_{0i} = Shift/Constant parameters, $ß1_i$, $ß_{2i}$, $ß_{3i}$, and $ß_{4i}$, are parameters co-efficient of the respective independent variables.

3.2. A- Priori Expectataion

The relationship that is expected to exist between the endogenous and exogenous variables in the model based on economics theoretical propositions is shown in what follows.

$$ß1_i > 0,\ ß_{2i} > 0,\ ß_{3i} > 0, \qquad ß_{4i} < 0,$$

The above expression implies that a positive relationship is expected between real gross domestic products (RGDP) a proxy for Economic growth (national development) and its assumed determinants in the Nigerian economy, except for implicit price deflator which is expected to be negative with economic growth.

3.3. Data Type and Sources

The data used are time series secondary data from 1981 to 2016 and it was analyzed for the Nigeria economy. The key variables are realGDP, electricity generation, private domestic investment, labour force and implicit price deflator. Data for these variables are sourced from the International Energy Agency (IEA), World Bank national accounts data file, Central Bank of Nigeria (CBN) statistical bulletin and National Bureau of Statistic (NBS).

3.4. Estimation Techniques

The method of analysis and estimation employed involves the use of trend analysis, Augmented Dickey Fuller for capturing the stationarity of the variables and the use of the Auto-Regressive Distributed lag (ARDL) bounds testing approach.

Trend analysis is based on the premise that economic performance follows an established pattern and that historical data can be used to predict future indicator activity. Trend analysis techniques involve characterizing the historical pattern of an economic variable and then projecting its future path based on past experience. However, forecasting by trend projection is predicated on the assumption that historical relationships will continue into the future.

The Augmented Dickey Fuller unit root test in economic variables plays an important role in determining the co-integration relationship in economic models involving time series data. It determines the order of integration relationships as it is crucial for setting up an econometric model and inference. It helps in verifying the properties of variables and examining whether the variables has a unit root or integrated of the same order prior to the construction of an econometric model.

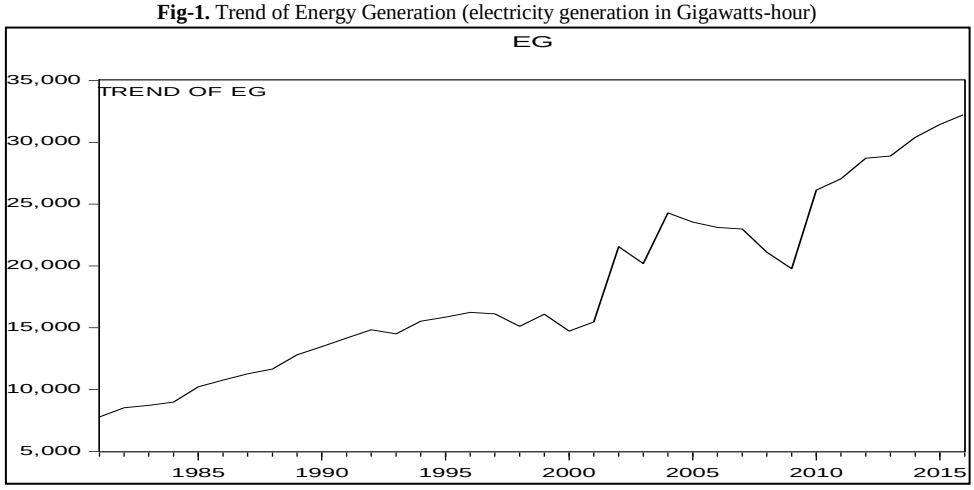
Autoregressive Distributed Lag (ARDL) Bound Test is used to explore the existence of co-integration in a relationship. However, if all variables are stationary, I (0), an Ordinary Least Square (OLS) model is appropriate and for all variables integrated of same order, say I (0), Johansen's method is very suitable. When we have fractionally integrated variables, variables at different levels of integration (but not at I(2) level) or co-integration amongst I(1) variables, the Autoregressive Distributed Lag (ARDL) model is appropriate to run the short-run and long-run relationships (Shin *et al.*, 2014). In analyzing time series of macroeconomic variables, there is need to pay attention to structural changes which come about for reasons such as changes in policy, regime and institutional arrangements as well as a period of economic crisis.

4. Empirical Results and Findings

4.1. Trend Analyses of Electricity Generation and Economic Growth (National Development)

The figures show the trend behavior of the key variables of EG (electricity generation) and RGDP (economic growth) in Nigeria over the study periods from 1981-2016.

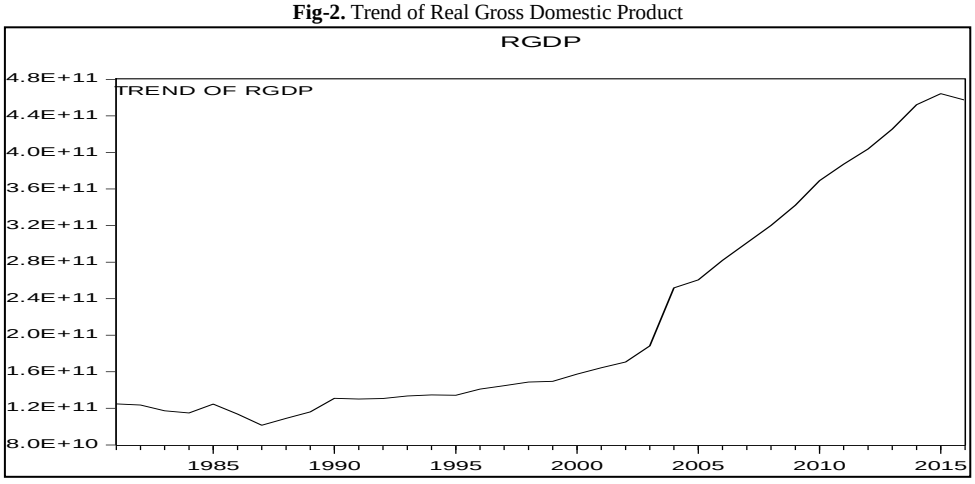
Fig-1. Trend of Energy Generation (electricity generation in Gigawatts-hour)



Sources: Author's construction 2019

From Fig.1, it can be seen that electricity energy generated in Nigeria over the years has been relatively unsteady throughout the study periods through the trend behavior. In spite all the various reforms in the electricity energy sector, the maximum point capacity generation of 32,259 gigawatts a year about 3,682 megawatts daily is still below the average needs of the economy. From 1981 to 1992, the electricity energy generation grew by 90.7%, then experienced its first decline by -2.2% in 1993, which could be as a result of the political and economic instability caused by the crisis of 1993 presidential election, with falls in 1997 and 1998 by -0.8% and -6.6% respectively. There was a reform in year 2000 to restructuring the power sector which unbundled NEPA into seven (7) generating companies, one (1) transmission company and eleven (11) distribution companies and a name changed to PHCN. Little or no significant impact was recorded as growth in generation capacity could not be sustained all through to 2004 with an exception of an upward growth of 64%. Ultimately, in 2013 the unbundling and privatization of electricity generation and distribution was finalized by the President Good luck government and since then, the generation capacity have sluggishly grew on the average of 2.6% yearly from 2013 to 2016.

Fig-2. Trend of Real Gross Domestic Product



Sources: Author's construction 2019

It is obvious from Fig.2 that real gross domestic products was relatively unsteady from 1981-1990, with a minimum point recorded in 1987 of about -22% contraction which could be associated with the failed SAP policy in Nigeria and tensed unstable political atmosphere that put national development and economic prosperity at a disadvantage. In 1991, the economy steeped by -0.7% and since then the real GDP has being on a steady growth path up until 2015.

4.2. Unit Root Test

Table-4.1. Results of Augment Dickey-Fuller (ADF) Unit Root Test

Variables	Augmented Dickey Fuller Test	5% Level Critical Value	Probability Value	Level of Integration
RGDP	-3.585552	-2.951125	0.0114	I(1)
EG	-7120124	-2.951125	0.0000	I(1)
PI	-3448437	-2.951125	0.0160	I(1)
IPD	-6.319853	-2.948404	0.0001	I(0)
LF	-8.296035	-2954021	00020	I(1)

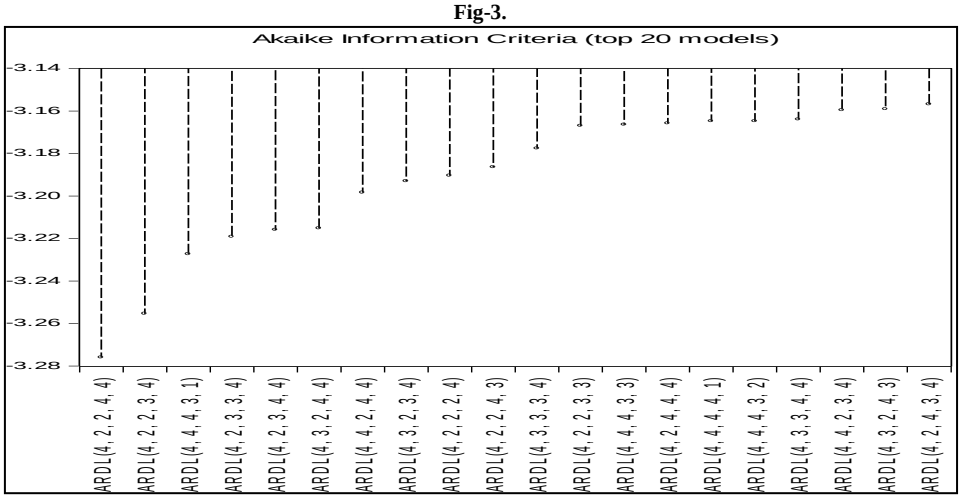
Source: Author's computation using Eviews 10.0

The result of the Augment Dickey-Fuller (ADF) unit root test shown in table 4.1, revealed RGDP (real GDP), EG (electricity generation), PI (private domestic investment) and LF (labour force) were stationary at their first order difference I(1), while IPD (implicit price deflator) was stationary at zero order level I(0). The Augment Dickey-Fuller (ADF) test value was greater than the 5% level of significant critical value in absolute terms. Therefore, it was established that all the variables are integrated of order zero and one respectively. Imperatively, all the unit root test results revealed the integrated levels to be I(1) and I(0) for all the variables in the models and confirmed the absence of I(2) variables or above. The implication of these is that it confirmed the application of Autoregressive Distribution Lag (ARDL) Bound test as the most appropriate method of estimation for the study.

4.3. Auto Regressive Distributed Lag (ARDL) Bounds Test

In the first step of the ARDL analysis is to test for the presence of long-run relationships in the model. However, given that the study employed an annual data, an appropriate lag length is used and the lag length with the lowest AIC or SIC is accepted because the lower the better the result. Therefore, the accepted lag length used for the model was lag 4 because Akaike information Criterion (AIC) of -3.276029 and Schwarz Criterion (SIC) of -2.314140.

Fig-3.



4.3.1. ARDL Bounds Test for Co-Integration

This test established the existence of the long-run relationship in the model dependent variables and its determinants. Then, confirming the existence of the long-run relationship, the ARDL con-integration method is then used to estimate the long-run parameters.

Table-4.2. Results of Bounds Tests for the Existence of Long-run Co-integration

ARDL Bounds Test		
Test Statistic	Value	K
F- Statistic	6.164816	4
Significance	I0 Bound	I1Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.72	5.06

Source: Author's estimation with Eview 10.0.

As shown in Table 4.2, the null hypothesis was rejected at 5% significance level, this is because the calculated F-statistic value of 6.164816 was greater than the upper bound critical value of 4.01 at 5% significance level. Thus, this implied that there is a long-run relationship that existed between realGDP and its determinants and there exist a co-integration between the dependent variable and the determinants. All variables in the model move together in the long-run.

4.3.2. ARDL Co-Integrating and Long-Run Form

Since the previous test established the presence of co-integrated relationship between realGDP with its determinants, the long-run parameters of the ARDL of the model is estimated and the result is presented.

Table-3. Estimated ARDL Long-run Coefficients

ARDL Cointegrating And Long Run Form		
DependentVariable:LRGP		
Selected Model: ARDL(4, 2, 2, 4, 4)		
Sample: 1981 2016		

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEG	-5.546027	4.943424	-1.121900	0.2858
LPI	0.367961	0.365580	1.006513	0.0358
LLF	10.624882	7.650033	1.388868	0.1924
LIPD	-0.634186	0.528877	-1.199118	0.2557
C	-113.855745	94.752698	-1.201610	0.2547

Cointeq = LRGDP = (-5.5460*LEG + 0.3680*LPI + 10.6249*LLF -0.6342 IPD -113.8557)
Source: Author's estimation with Eview 10.0.

The result in Table 3, reveals the long-run relationship of the parameters and the real gross domestic product (RGDP). It is negatively impacted by electricity energy generation (EG) in Nigeria but not significant, as it's being currently experienced, The electric energy crisis in Nigeria as it affects the national development and economic growth is not only from the generation capacity aspect alone but also from other sections of the whole structure of the power sector. This is in line with the findings of Igbinovia and Osayi (2010). The result reveals the long-run relationship of the parameters and the real gross domestic product (RGDP). It is negatively impacted by electricity energy generation (EG) in Nigeria but not significant, as it's being currently experienced, The electric energy crisis in Nigeria as it affects the national development is not only from the generation capacity aspect alone but also from other sections of the whole structure of the power sector. This is in line with the findings of Igbinovia and Osayi (2010).

Furthermore, private domestic investment (PI) impacted positively and significantly on the long-run on real domestic product (RGDP) in the Nigerian economy under the observation period of this study. This confirmed the theoretical behavior of the two variables. The elasticity of private domestic investment showed that economic growth will be responsive by 37% to a percent change in private domestic investment. The domestic investment acted on the accelerator principle to increase output overtime. Thus, this conformed to the empirical findings of Esso (2010) done on ten sub-African economies, Nigeria inclusive. This is in contrasts to findings of Oke and Sulaiman (2012). More so, the implicit price deflator (IPD) demonstrated a negative and insignificant long-run relationship with real gross domestic product (RGDP). A percent change in price index or level of prices of all new domestically produced, final goods and services in the economy could be felt negatively by -63% resistances in consumption or investment patterns. Therefore, the higher the ratio of nominal GDP to real GDP, the lower the performance of the economy will appear. This is also in line with economics criteria as stated by the apriori expectation.

The elasticity of real gross domestic product (RGDP) to a percent change in labour force (LF) is highly elastic but insignificant. This is of the view that growth in population or labour force alone is not significant enough to guarantee economic growth and prosperity, if human capital development and capacity building is not enhanced, because lack of active participation of the labour force has an impact on the local economy, tax base, incomes, investment decisions and other indicators, the more people work and spend money the better the economy.

4.3.3. ARDL Short-Run Relationship and Error Correction Model (ECM)

Confirmatively, having done the long-run co-integrating model estimations, then, the next estimation is the short-run dynamic model relationship among the variables within the ARDL framework.

Table-4. Estimated ARDL Short-Run Error Correction Model (ECM)

Dependent Variable: D(LRGDP)				
Method: Least Squares				
Sample (adjusted): 1982 2016				
Included observations: 35 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.166840	0.040466	4.122969	0.0003
D(LIPD)	-0.174885	0.104182	-1.678646	0.1040
D(LEG)	-0.119112	0.127840	0.931726	0.3592
D(LLF)	-3.642786	1.101814	-3.306173	0.0025
D(LPI)	0.017602	0.043864	0.401273	0.6912
ECM(-1)	-0.130808	0.075482	-0.097876	0.0927
R-squared	0.770078			

Source: Author's estimation with Eview 10.0

The estimated result in Table 4 showed the short-run estimate of real gross domestic product (RGDP) in relations with implicit price deflator (IPD) and electricity generation (EG) to be in line with the long-run relationship that was established between RGDP and these independent variables in Table 3. The relationship was negative, and, the elasticity coefficient values of -0.17 and -0.11 for implicit price deflator (IPD) and energy generation (EG) respectively were perfectly inelastic and as well insignificant. The implications of this is that all through the short-run period to the long-run period the electricity energy generation capacity has impacted negatively on the economic performance of Nigeria over the years.

Also, in the short run, the elasticity coefficient value of private domestic investment was positive and insignificant in the short-run. In the long-run the impact of private domestic investment on economic growth was

positively significant. This could mean that firms in Nigeria in the short-run usually operate below full capacity and increasing aggregate demand does not necessarily expand the capital stock as but in the long-run capacity can be fully utilized as a result of expansion in the future and innovations. This was also the submission of Atoyebi *et al.* (2012) in the study done on Nigeria. It also in conformity with the findings of Aurangzeb and Anwar (2012) done on the Pakistani economy.

Also worthy of note, the error correction model (ECM) value is perfectly signed (-0.13) and statistically significant. This implied that any disequilibrium in the system in the short-run as a result of shock to long-run equilibrium relationship can be corrected by the error correction term by 13% speed of adjustment. Hence, the R-square value of 0.770078 indicated a good fit and explained that about 77% systematic variation in real gross domestic product in the short-run was caused by the independent variables in the model.

4.3.4. ARDL Models Diagnostics and Stability Test

Finally, the ARDL estimation model will not be complete if these diagnostic and stability tests are not conducted. These tests are to examine the serial correlation, functional form, normality and heteroscedasticity associated with the study model.

H_O; *Corv* $(Et, E_{t-1}) = 0$

H_1; *Corv* $(E_t, E_{t-1}) \neq 0$

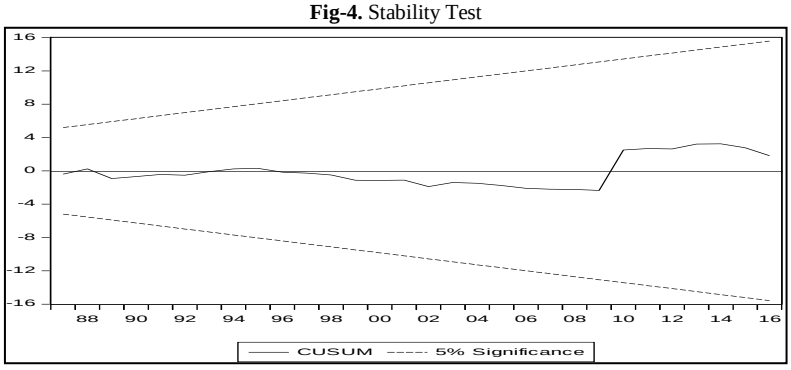
Table-5. Model Diagnostics

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.360626	Prob. F(4,25)	0.8342
Obs*R-squared	1.909338	Prob. Chi-Square(4)	0.7524

Source: Author's estimation with Eview 10.0

From the result in table 5 the test for the presence of serial correlation is tested for ARDL model, the Chi-Square Probability values of 0.7524 for model is greater than 5% so the null hypotheses cannot be rejected but rather be accepted. Therefore, it is concluded that the ARDL model do not suffer from the problem of auto correlation and that error terms in a time series is not transferred from one period to another. That is, errors from one time period 'A' is not correlated or affected with the errors for a subsequent time period 'B'.

Fig-4. Stability Test



Finally, when analyzing the stability of the coefficients for the model of the ARDL, the Cumulative Sum test (CUSUM) was applied and these can be seen in Figures 4. According to Pesaran *et al.* (2001), the stability of the regression coefficients are evaluated by stability test and show whether or not the parameter estimated are stable over time. The CUSUM was plotted against the critical bound of 5% significance level and the plotted trended lines remained within the critical bound of 5% significance level, this implied that the model adopted was a stable one.

5. Conclusions

Conclusively, the dynamic relationship between electricity generations and national development have been examined in this paper and the findings showed that electricity generation capacity is a key determinant of national development, economic growth, prosperity, and domestic investment survival in the Nigerian economy. As it is, private domestic investment has the potential to positively contribute on national development. It implied that private domestic investment can act on the accelerator principle to increase output over time in the Nigerian economy. The development of labour force with requisite skills and training is germane to output-growth, expansion and development, the potential of the labour force is enormous as revealed and all economic actors and agents are to see to the proper utilization of this unutilized resource, lack of active participation of the labour force has negative impacts on economic well-being of a nation. The price index plays an impactful role on consumption and investment patterns in Nigeria economy.

However, all the set objectives of the paper were all achieved and the hypotheses were well tested. Giving the fact that research on electricity energy and national development (economic growth) is still emerging, it is therefore suggested that future studies should endeavor to employ other methodologies or can take into account structural change and regime shifts, so as either validate or refute the findings of this study. Also, comparative studies among the Sub-Saharan African and developing economies should be considered in the future.

Policy Recommendations

Ultimately, having taken into account the findings of the study, these are the policy recommendations.

Electricity generation has significantly impacted negatively on national development in the Nigerian economy over the years, lack of adequate generation capacity have significantly impacted on the cost of living, cost of production, doing business in Nigeria and even the cost of governance, it has served as a disincentive to poverty alleviation, investment, productivity, economic activity, growth and national development. Government and her agents should redesign the energy policy to be investment friendly, taking a key interest on the generation aspect of the electricity energy sector by way of ensuring level playing fields for genuine independent power generating investors and should not play politics with the electricity crisis.

Micro grade electricity generation sources like solar, wind and renewable energy should be invested on, so as to serve as a backup and additional capacity when there is a short fall in gas supply or drop in water level which in often time leads to system failures in existing generation plants. Regardless, Nigeria should start looking in the direction of adopting electricity mix generation plants policy just like the developed economies, European Union, U.S.A, France, Britain, Russia, Japan and even South Africa have started to follow in this direction. This is the future to a sustainable and adequate electricity supply that is needed to propel national development, economic activities, growth and prosperity.

Also, government should put support policy measures in place to neutralize the negative impact of cost reflective electricity price on private investors at large so as to harness the positive impact contribution potential of private domestic investment to enhance the desired national development and growth in the Nigerian economy.

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