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Electricity Consumption and Economic Growth in Nigeria: An Empirical Analysis

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Abstract
This paper empirically examined the impact of electricity consumption oneconomic growth in Nigeria with the application of the Augmented Dickey-Fullertest statistics, Johansen Cointegration techniques and the Error Correction Mechanism on a multiple log linear regression framework.The economic and electricity annual time series data on Real Gross Domestic Product (RGDP)and Electricity Price (ELEP) were obtained from Central Bank of Nigeria Statistical Bulletins (2019) while Electricity Consumption (ELEC), Electricity Generation (ELEG) and Electricity Lossesin transmission and distribution(ELEL)were sourced from Index Mundi by US Energy Information Administration (2013) and Index Mundi by CIA World Fact Book (2019).The Augmented Dickey-Fuller test statistics results showed that all the variables (RGDP, ELEC, ELEG and ELEL) were stationary at first difference I(1) except electricity price (ELEP) which was stationary at level I(0), while the Johansen unrestricted cointegration rank test results showed the existence of a unique long run relationship between RGDP, ELEC, ELEG, ELEP and ELEL, as both Trace and Max-Eigen statistics revealed twocointegrating equations respectively. The empirical results from the short run error correction model showed that the entire explanatory economic and electricity variables in the estimation met their expected signs except Electricity Losses in transmission and distribution. The empirical results also revealed that electricity consumption, electricity generation and electricity price haddirect and significant impact on real gross domestic productin Nigeria.This means that 1 per cent increase inELEC, ELEG and ELEP, increases real gross domestic productin Nigeria by 60, 44 and 14 per cent respectively. Electricity Losses in transmission and distribution also had negative effect on the real gross domestic product in Nigeria. This implies that 1 per cent increase in electricity losses in transmission and distribution reduced real gross domestic product in Nigeria by 29 per cent approximately.The error correction mechanism (ECM) results which was -0.700952 was statistically significant and had the appropriate sign. It suggested however, that there was a high adjustment process in the practice of the power sector since the speed of adjustment is 70.1 per cent approximately. Finally, the Diagnostic and stability tests confirmed the robustness of the model over time. The studytherefore, recommended that the Nigerian Electricity Regulatory Commission (NERC) should strengthen policy on electricity generation of power to meet up with the increasing demand for electricity so as to sustain production and economic growth in Nigeria.

Keywords: Electricity Consumption, Electricity Generation,Electricity Losses and Electricity Price.

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I. Introduction

Electricity consumption simply means total electricity used by the economic agents of an economy at a particular period of time [1]. Electricity consumption is one of the key drivers of growth and development of all economies. It serves as an important input that can enhance the productive activities in almost all the sectors of the economy. However, the recent energy crises, increase in prices of crude oil, climate change and the ever-growing emission of carbon into the atmosphere have led to a great debate on the relationship between electricity consumption and economic growth [2]; [3]. Nigeria is one of the countries in the World that has found extremely difficult to provide adequate electricity for its timing population. Since independence in 1960, power sector has performed below par as about 80 million Nigerians do not have access to any form of electricity in their homes despite the various reforms in the sector [4].

Generally, the major sources of electricity generation include Wind, Solar generating stations, Thermal, and Hydro. The electricity generation method varies based on the type of energy to be used. For instance, the generation of electricity via combustion demands the use of coal and natural gas utilization. So also, the renewable energies such as rotation energy by wind, sunlight, and rotating water wheel by running water are directly converted into electricity. In Nigeria, steam gas turbines and hydro plants are the two major energy mix for generating electricity at different ports such as Shiroro, Sapele, Kainji, Jebba, etc[5].

Nigeria started generating its electricity in 1896, and the Nigerian Electricity Supply Company (NESCO), introduced in 1929 was the pioneer utility company after 22 years of operation, the Electric Corporation of Nigeria (ECN) succeeded NESCO in 1951. ECN acquired both the assets and functions of NESCO. In 1962, the Nigeria Dams Authority (NDA) became a partner to the ECN to assist in the development of hydropower. ECN and NDA later formed a merger in 1972 which led to the emergence of the National Electric Power Authority (NEPA). Probably due to inefficiency and little or no funding, NEPA was later privatized and subsequently called the Power Holding Company of Nigeria (PHCN). With the reform in the sector in 2005, the Nigerian Electricity Regulatory Commission (NERC) became the chief regulator of the sector with 11 ElectricityDistribution Companies (Abuja Electricity Distribution Company Plc, Benin Electricity Distribution Company Plc, Eko Electricity Distribution Company Plc, Enugu Electricity Distribution Company Plc,Ibadan Electricity Distribution Company Plc, Ikeja Electricity Distribution Company Plc, Jos Electricity Distribution Company Plc, Kaduna Electricity Distribution Company Plc, Kano Electricity Distribution Company Plc, Port Harcourt Electricity Distribution Company Plc and Yola Electricity Distribution Company Plc) and 60 per cent of the company's shares were now owned by private investors. The function of the electricity transmission was however returned by the government, the sector was further reformed in 2013 but little or no progress was achieved in terms of electricity generation and distribution as the country could only generate about 3,5000MW which is a far cry from what is expected to meet the demand of about 180 million Nigerians. On December 18, 2017 the sector achieved a peak power generation of 5,222MW[6].

Energy is an indispensable force driving all economic activities. It is on this note that George-Anokwuru and Ekpenyong[7] stressed in their study that the positive multiplier effect of constant power supply cannot be over emphasized. A meaningful economic growth takes place in an economy when adequate supply and demand for energy is present. One of the most desired power is direction is electricity. Hence an impressive performance of Gross Domestic Product (GDP) is driven by the effective supply and consumption of electricity. As a key component of national sector, energy electricity is a major source of advancement and improvement in the standard of living of the people by stimulating other sectors like health, education, agriculture, commerce, transportation and industries. Some of the electricity generation stations were built in the 1970's and are still being operated without major revalidation. Also, until very recently; electricity generation, production and distribution has been an exclusive preserve of the poorly managed government monopoly under National Electric Power Authority (NEPA) and later Power Holdings Company Nigeria (PHCN).

Nigeria has experienced problems in the area of power generation, transmission and distribution. The extent of this is underlined by the fact that Nigeria is the largest purchaser of standby electricity generating plants in the world. The inefficiency as well as inadequate facilities to boost electricity supply in the face of increasing population new and electronic based technologies, vast geographical landscape and an increasing business environment all combines to create electricity supply problems, While the demand for electricity is on the increase, supply tends to be falling. It is significant to note that any shock in the energy sector affects the level of productivity, profitability, income and employment opportunity and this is inadvertently link with national security, citizen safety, social order and health of the people who live in Nigeria. The poor or near absence of physical infrastructure was also identified as a major problem [7].

Power instability in Nigeria has been a thing of major concern despite huge investments that the past and present administration has spent in the quest for stabilization of power in the country. This instability and epileptic power supply in the country has affected all the sectors of the economy including small and medium scale enterprises, commerce and industries, revenue generation in Nigeria. Adeyemi [8] concluded that the issue of electricity (power) availability needs to be taken as a vocal point in development planning.That is, the modern technologies needed to drive and sustain economic growth and development are strictly tied to the use of energy. This is a function ofadequate supply and distribution of energy, most especially electricity supply. This study therefore becomes imperative toempirically analyze the impact of electricity consumption on economic growth in Nigeria using annual time series data from 1981 to 2019. The study is subdivided into five sections. Section one is the introduction, while section two and three focuses on literature review and research methods. Section four deals with data presentation, analysis and discussion of results, andSection five presents the concluding remarks and recommendations.

II. Literature Review

2.1 Conceptual Issues

Electricity is the flow of electrical power or charge. It is a secondary energy source which means that we get it from the conversion of other sources of energy like coal, natural gas, oil. Nuclear power and other natural sources, which are called primary sources. The energy sources of electricity can be renewable or non-renewable but electricity itself is neither renewable nor non-renewable. Electricity is a basic part of nature and it is one of our most widely used form of energy. Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. According to Energy Networks Association (ENA) the physical process of electricity supply is divided into three broad stages namely: generation, transmission and distribution. Power generation, transmission and distribution involve flow of currents with heat losses in conductors. These losses can be reduced through better design, construction and maintenance. In addition to this physical aspect, there is a commercial overlay involving the trading of electricity between generators and retailers or in some circumstances, generators and large electricity users. Electrical power is now the backbone of modern industries. Every day, we use electricity to do many jobs for us from lighting and transportation, communications, powering of computers, library automation cum usage of internet facilities etc[9].

Electricity plays a very important role in the socio-economic and technological development of every nation. 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. It is widely accepted that there is a strong correlation between socio-economic development and the availability of electricity [10].

Electricity consumption simply means total electricity used by the economic agents of an economy at a particular time [1]. However, the rate of electricity accessibility in Nigeria is about 45%, of which electricity supply and consumption are largely dominated by the urban region of the country. The 80% of the total electricity demand in Nigeria is made up of electricity consumption from commercial sectors and the residential of the economy, while electricity consumption from industrial, special tariff sectors and street lighting covered the remaining 20% of the total electricity demand in Nigeria [5].

The determinants of electricity consumption are well documented in the energy literature. Many studies have emphasized the importance of electricity prices, income, trade openness, population growth and FDI as major factors that influence electricity consumption [11]; [12]. However, the argument is that technological improvement through innovation enables energy efficiency of electricity using appliances and products which would lead to lower energy consumption.Electricity consumption-growth literature has evolved into four distinct hypotheses about the effect of electricity conservation on the causal relationship between electricity consumption and economic growth [13]. The first hypothesis states that electricity conservation policies design to reduce electricity consumption and waste have little effect on economic growth. The second argues that electricity conservation policies stunt economic growth. The third establishes that electricity conservation policies have no effect on growth, while the fourth states that electricity conservation policies impact economic growth positively[14].

Over the past two decades, electricity prices have been highly subsidized for consumers in Nigeria. Because of this, investment in the power sector has not been competitive, leaving the economy with a capacity deficient power sector. The country loses approximately $13bn yearly on imported captive generating plants used for self-generation [15].Some previous research provided evidence in support of the electricity led growth hypothesis see Orhewere[16] and Iyke[17], for the neutrality hypothesis see Mustapha and Fagge [18] while other studies supported the feedback hypothesis between electricity consumption and economic growth [19]. There is a wide gap between electricity supply and its consumption in Nigeria. For many years, the power sector has been facing enormous challenges regarding its generation, distribution and consumption. These problems has weakened the industrialization process, and significantly undermined the effort to achieve sustained economic growth, increased competitiveness of domestic industries at both regional and global markets, and employment generation in the country [20].

However, concerning the figures obtained from the Nigeria Bureau of Statistics, about 25% of the 12,522MW installed capacity gets to the end-users as a result of operational inefficiency and other systemic challenges. Presently, about 4,022.42MW of electricity is generated out of over 12,000MW installation capacity of our generation stations. The energy source for rural areas of the country is majorly constituted by the usage of solid biomass, such as fuel wood[21].

Apart from the inability of the country to generate the required amount of electricity for its ever-growing population, there is a large quantity that is lost between the generation units and the final units of consumption. Akomolafe and Danladi [22] shows that less than 40% of the population has access to electricity and the power sector suffers from high energy losses (3035%) which caused a low collection rate of money owed to the power supplier. As a result, a lot of our domestic industries have now been shut down and many are unable to operate at their optimum capacity. These constraints also posed other fundamental infrastructures deaths in the country. World Bank [23] reported that the inability to meet the domestic and industrial needs for electricity has affected the growth potentials of Nigeria. Several measures and policies have been set to boost the electricity sector. In 2012, the Nigerian National Electric Power Authority (NEPA) was privatized in order to improve electricity supply and strengthen the sector performance. Iyke[2] reported that the demand for electricity in Nigeria was projected to increase from 5,746 megawatts in 2005 to nearly 297,900 megawatts by the end of 2030. So the power sector has to increase the supply of electricity by approximately 11,686 megawatts each year to match this projection.

Adequate access to reliable, quality and affordable power is crucial to national economic growth. The Nigerian power industry performance track records and statistics are dismal and appalling. The power supply is characterized by low accessibility, epileptic and poor transmission. The socioeconomic activities in Nigeria have been grossly impacted negatively by insufficient power supply. Yet the huge energy potential available in the country are insignificantly tapped [24]. In 2016, it was reported that only about 58% of Nigeria's population have access to the national electricity grid and in this percentage, only about 30% of its current requirements are met [25].

The power sector in sub-Saharan Africa (SSA), is in a pathetic state, despite several interventions. The most populous country in the region, Nigeria, is severely affected. The challenges that trail the power sector in Nigeria, seem as they were two decades ago and have deepened in some areas. Before divestiture of Power Holding Company of Nigeria (PHCN) by the federal government in 2013, PHCN was solely mandated to construct and engineer power generating units; maintain and service power grids; operate dams and manage water for power generation, flood control and navigations; resettle; maintain control, protections and communications equipment; maintain scheduling; and analyzed security and post contingency. The Power Holding Company of Nigeria[24].They added that the running of the power sector has been lacking in professionalism since inception of the Electricity Corporation of Nigeria (ECN) to National Electric Power Authority (NEPA) to Power Holding Company of Nigeria (PHCN) to date. The national grid system is characterized by poor workmanship; poor quality materials; poor standards by foreign and local contractors; cable theft; power theft by consumers; vandalization of pipelines and transformers; court disputes and protests; and much more.

Power is needed to drive industrial machines for the manufacturing of different products, as a result, it contributes, significantly, to national economic growth. The power required to stimulate socioeconomic activity in Nigeria, is grossly inadequate, consequently, there is high rate of unemployment, poverty, high cost of production and services, etc. Power consumption per capita, is a yardstick for measuring the quality of life and development of a country or region [26]. However, there is an addition to this benchmark in the contemporary energy world, prompted by attributes of modern energy supply [27]. In the contemporary world, the consumption per capita of clean, adequate, affordable and sustainable power is a yardstick for measuring the quality of life and development of a country or region.

The x-rays of the past and present power situation in Nigeria was examined by Ebhota and Tabakov[24] with the determinants of the amount of power demanded and the several interventions in the Nigerian power supply. The study reported that population, industry, transportation, agriculture, and commercial services are the main determinants of energy demand in Nigeria. Their results revealed that population interconnects all other factors. Industrial, transportation and residential sectors consume the most energy in Nigeria. Industrialization, urbanization and the general economic wellbeing of Nigeria depend largely on effective power supply. This study concludes that effective power supply relies on careful and logical handling of these critical power technical activities – power generation; efficient power transmission to users; efficient power distribution to the users; reasonable level of domestic power equipment manufacturing infrastructure; management of population growth; and national power infrastructural development planning and enabling policy for power sector investments.

2.2 Theoretical Literature

Review of the theoretical literature on the relationship between electricity consumption and economic growth was conducted to include: a) the endogenous growth theory or the neoclassical growth theory, b) the demand for energy growth leads hypothesis, c) the mixed companies' hypothesis and d) energy consumption growth hypothesis

2.2.1 The Endogenous Growth Theory or the Neoclassical Growth Theory

The neoclassical growth theory emphasized that economic growth results from increasing returns to the use of labour and capital holding technological advancement momentarily constant. The neoclassical production function of Cobb-Gouglas (1928) expressed the technical relationship between given level of output and a given quantity of physical input, that a change in output ia as a result of variation in the physical inputs. This production function has only two factors inputs in production but with the emergence of empirical evidence identifying electricity as an independent factor of production [28].

The theory states that if a firm or an economy which invests in capital (physical) and skilled workers adapts a new technology outlay for production, then productivity will be more effective. This will further leads to a shift in the production function and this can also lead to an increasing returns to investment rather than decreasing returns to investment. This implies that technology is endogenous to production system. The basic assumption of the theory is that labour and capital contributes to the long-run growth rate of an economy. In other words, physical capital and skills of labour are the two vital factors of production [9].

Endogenous growth theory describe economic growth which is generated by factors within the production process such as economies of scale, increasing return or induced technological changes, government policies, political stability, market distortions, human capital etc., can significantly affect economic growth as opposed to exogenous factors such as increase in population. Endogenous growth theory is a widely used growth model in providing a systematic investigation of the government policies and programmes. The exogenous growth theory, also known as the neo-classical growth theory as reported by Robert Solow in 1956, which is the centre piece of the standard neoclassical growth model developed by Solow is an aggregate production function of the form:

$$Y_t = f(K_t, L_t, A_t) \qquad (1)$$

According to Solow [29] Y represent output, K equals capital, L is labour and A is an index of technology or efficiency while t represent time trend. Solow posits that f has the usual neoclassical properties; in particular, it is characterized by constant returns to scale, decreasing returns to each input, and a positive and constant elasticity of substitution. The fundamental dynamic equation of the model relates the evolution of the capital stock to a constant rate of saving and a constant rate of depreciation. Labour and the level of technology grow at exogenous exponential rates. This model assumes that countries use their resources efficiently and that there are diminishing returns to capital as labour increases. From these two premises, the neo-classical model makes three important predictions; first, increasing capital relatives to labour creates economic growth, since people can be more productive given more capital. Second, poor countries with less capital per person will grow faster because each investment in capital will produce a higher return than rich countries with ample capital. Third, because of diminishing returns to capital, economies will eventually reach a point at which no new increase in capital will create economic growth. This point is called a steady state. If there were no technological progress, growth in this model would eventually come to a halt. However, the formulation of the model is chosen so as to allow increases in efficiency to offset the diminishing returns to capital. In endogenous growth theory, the growth rate depended on one variable: the rate of return on capital [30].

2.2.2 The Demand for Energy Growth Leads Hypothesis

The demand for energy leads to economic growth. It is true that consumption is derived from demand. That is whatever is consumed must have been demanded. Birol[31] argued that demand for energy has surged and in that respect, the unrelenting increase has helped fuelled global economic growth. Yu and Choi [32] carried out a research on the Philippines and found that there is a positive relationship between energy consumption and economic growth. They went further to define that relationship as a unidirectional one where economic growth served as the dependent variable and energy consumption was the independent variable. Asafu-Adjaye[33] carried out the same research on Singapore and Indonesia respectively and found out the same unidirectional causality effect of Energy consumption and Economic growth. There are other economic findings which are contrary to the Energy - GDP causality relationship. Yu and Choi [32] carried out a verification study on the causality relationship between energy consumption and economic growth and found out that the causality ran in an opposite direction, from economic growth to energy consumption.

The positive relationship between electricity and economic growth has been justified by some authors as being consistent. Many economists agree that there is a strong correlation between electricity use and economic development. Morimoto and Hope [34] have discovered, using Pearson correlation coefficient that economic growth and energy consumption in Sri Lankaare highly correlated. Odularu and Okonkwo[35] reported that Breshin (2004) said that electricity is vital for driving growth in the energy, manufacturing and social sector. He went further to say that a parallel (positive) growth trend existed between electricity demand and gross domestic product (GDP). According to Simpson [36]it is electricity rather than Steam engine, which is driving the developing industries in modern Africa. By implication, He re-emphasizes the fact that electricity drives economic growth. An increase in electricity consumption leads to economic growth in a developing nation like Nigeria.

Odularu and Okonkwo[35] article investigates the relationship between energy consumption and the Nigerian economy using energy sources crude oil, electricity and coal with the application of co-integration technique, the results derived infer that there exists a positive relationship between current period energy consumption and economic growth. The implication of the study is that increased energy consumption is a strong determinant of economic growth having an implicit effect in lagged periods and both an implicit and explicit effect on the present period in Nigeria. Thus, it is pertinent that this sector should be given more relevance even by exploiting the opportunities laden in the sector to increase economic growth

Sanchis[37] stated that electricity as an industry is responsible for a great deal of output. She went on to say that electricity had effects not only on factors of production but also on the impact it had on capital accumulation. Alam[28] agreed that there is a departure from neoclassical economics which include only capital, labour and technology as factors of production to one which now includes energy as a factor of production. He went further to say that energy drives the work that converts raw materials into finished products in the manufacturing process. Sanchis [37] added that increase in the electricity production will avoid the paralyzation of the industrial production. Increased industrial production will eventually increase output. Thus, this implies that electricity production should become an economic policy high-priority objective which should be urgently responded to. Energy efficiency is also called 'efficient energy use'. It is not just about reducing utility bills of energy. It also involves boosting revenue through greater productivity. Energy efficiency is an indispensable component of any effort to improve electricity productivity. Classical economists did not recognize energy as a factor of production in the production process and neither did the Neoclassical. Today, economists like Alam [28] found out in his work on 'Economic Growth with Energy' that not only does energy serve as a factor of production; it also acts as a booster to growth of a nation.

2.2.3 The Mixed Companies Hypothesis

The mixed companies' hypothesis is also known as public-private partnerships (PPP) theory. Investments in infrastructure, although historically dominated by public intervention, are increasingly managed through public-private partnerships (PPP) [38]. Furthermore, the recent economic and financial crisis and the limitations of public resources brought about renewed interest in PPP [39]. Most authors have pointed out that this alternative governance model allows to mitigate the negative consequences of market failure when providing public services at the local level [40]; [41].

The creation of mixed ownership companies allows to channel the private sector's skills and resources into state-owned enterprises, thus generating benefits in terms of efficiency. Several authors have proved that mixed ownership companies have much better performance indicators than enterprises fully owned by the state [42]. Furthermore, Garrone, Grilli and Rousseau [43] analyzed a sample of multi utilities and proved that there is a relationship between cost reduction and the presence of private shareholders. Similarly, Menozzi and Vannoni[44] have analyzed a sample of companies operating in the gas, water, and electricity sectors and shown that the main performance indicators improve in mixed ownership utilities.

As for investment incentives are concerned, since in mixed public private ownership companies no stakeholder has veto power, both types of innovation (those aimed at reducing costs and those aimed at improving quality) are expected to be carried out. In literature, there are few studies comparing state-owned enterprises and private companies in terms of propensity to invest [41]. One of these few studies was carried out by Schmitz [45] and showed that mixed companies tend to offer better incentives in terms of cost reduction than fully state-owned enterprises and, at the same time, encourage quality improvement to a greater extent than fully private companies.

2.2.4 Energy Consumption Growth Hypothesis

For more robust theoretical literature Azami and Almasi [46] reported that conventional Energy–growth Nexus in OPEC Countries considering energy as a general unit, numerous studies have investigated the relationship between energy consumption and economic growth. Ozturkand Acaravci [47] reviewed the existing literature and provided four testable hypotheses, namely: a) the growth hypothesis, b) the conservation hypothesis, c) the feedback hypothesis and d) the neutrality hypothesis.

The growth hypothesis stressed on the existence of a one-way causal relationship from energy consumption to economic growth and the vital role of energy in increasing economic growth, either directly or as a complement input for labor and capital. This hypothesis suggests the dependence of economy on energy and considers energy as a prerequisite for economic growth. In this case, lack of adequate energy supply may restrict economic growth and results in a poor economic condition [48]; [49].

The other hypothesis is **the conservation hypothesis** which holds that increasing economic growth will increase energy consumption. In the conservation hypothesis, it is hypothesized that there is one-way causal relationship from economic growth to energy consumption which indicates lower dependence of economy on energy. Thus, energy saving policies such as reducing and eliminating energy subsidies, reducing greenhouse gas emissions, taking measures to increase energy efficiency, along with demand management and reducing energy consumptionpolicies, and avoiding energy wastes can be implemented without leaving adverse effects on economic growth [50]; [51]; [52].

The feedback hypothesis suggested that energy consumption and economic growth are interdependent and complementary. According to this hypothesis, there is a bidirectional causal relationship between energy consumption and economic growth. The internal relationship between energy and economic growth also indicates that energy saving policies may reduce economic growth. Besides, changes in economic growth can change the level of energy consumption as well [53]; [54].

The Neutrality hypothesis reflected the negligible and insignificant role that energy plays in the economic growth process. Based on this hypothesis, there is no causal relationship between economic growth and energy consumption. Therefore, policies to increase (decrease) energy consumption will not increase (decrease) economic growth [47].

2.3 Empirical Literature

Noor and Siddiqi [55] employed cointegration and ordinary least square techniques in theexamination of the relationship between per capita energy consumption and per capita gross domestic product (GDP) in Nigeria from 1971to 2006. The cointegration result shows a strong long run relationship between variables in the model. The long run estimated equation shows a negative relationship between the per capita energy consumption and per capita GDP, while the causality test reveals a unidirectional causality running from GDP to EC in the short run.

Orhewere and Machame[56] reports a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Unidirectional causality from gas consumption to GDP in the short-run and bi-directional causality between the variable in the long-run was also reported. A unidirectional causality from oil consumption to GDP is found in the long-run. However, in the short run, no causality was found in either direction between oil consumption and GDP.

Dantama, Umar, Abdullahi, Nasiru [57] examined the impact of energy consumption on economic growth in Nigeria over the period 1980-2010 using the autoregressive distributed lag (ARDL) approach to co-integration analysis. The results indicate a long-run relationship between economic growth and energy consumption variables exist. Both petroleum consumption and electricity consumption are statistically significant on economic growth but coal consumption is statistically insignificant. Also, the speed of adjustment in the estimated model is relatively high and containsthe expected significant and negative sign.

Adegbemi, Adegbemi, Olalekan and Babatunde [58] evaluated the causal nexus between energy consumption and Nigeria's economic growth for the period of 1975 to 2010 using secondary time-series data with the application of cointegration and ordinary least square techniques. Co-integration results showed a long run relationship among the variables. The result showed that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. The empirical results reveal that petroleum, electricity and the aggregate energy consumption have significant and positive relationship with economic growth in Nigeria. Therefore, the study recommended that government should encourage a level-playing field for all energy forms available in the country by diversifying its power-generation portfolio. Also, the government should continue to collaborate with the private sector within the context of public-private-partnership (PPP) to further exploit the opportunities in the sector in order to increase economic growth.Ogundipe [19] examined the relationship between electricity consumption and economic growth in Nigeria using the Johansen and Juselius Co-integration technique based on the Cobb-Douglas growth model covering the period 1980-2008. He found that the variables are cointegrated in the long run. The result also shows evidence of bi-directional causal relationship between electricity consumption and economic growth. He recommends periodic replacement of worn-out equipment in order to drastically curtail transmission power losses and strengthen the effectiveness of energy generating agencies.

Adeyemi [8] examined the relationship between electricity consumption and economic growth in Nigeria using the Johansen and Juselius Co-integration technique based on the Cobb-Douglas growth model covering the period 1980-2008. The results of the Johansen and Juseliuscointegation, and the Vector Error Correction Modelling showed the existence of a unique co-integrating relationship among the variables in the model with the indicator of electricity consumption impacting significantly on growth. Also, the results of the Pairwise Granger Causality test shows an evidence of bi-directional causal relationship between electricity consumption and economic growth. They recommended that there is the need to strengthen the effectiveness of energy generating agencies by ensuring periodic replacement of worn-out equipment in order to drastically curtail transmission power losses.Orhewere [16] investigated the relationship between electricity consumption and economic growth in Nigeria using the Johansen cointegration over the period 19702005. They found long run cointegration relationship among the variables and a unidirectional causality running from total electricity consumption to GDP both in the short and long-run. The study suggests that large supply of electricity can ensure a higher level of economic growth in the country.

Akomolafe and Danladi [22] investigated the relationship between electricity consumption and economic growth in Nigeria using a multivariate system over the period covering 1990-2011. The Johansen cointegration test shows a long run relationship between electricity consumption and economic growth. The result of the Granger causality test shows unidirectional causality from electricity consumption to real gross domestic product. There is also unidirectional causality from capital formation to real gross domestic product. The study suggests capital formation's contribution to the economy is relatively determined by the adequate electricity in Nigeria.Iyke [17] examined the dynamic causal linkages between electricity consumption and economic growth in Nigeria within a trivariate VECM, for the period 1971-2012. The results showed that there is a distinct causal flow from electricity consumption to economic growth both in the short run and in the long run. This finding supports the electricity-led growth hypothesis, as documented in the literature. The paper urges policy-makers in Nigeria to implement policies which enhance the generation of electricity in order to engineer economic growth. Appropriate monetary policies must also be put in place, in order to moderate inflation, thus enhancing growth.

An economic evaluation of the electricity generation was carried out by Ijeoma[15] with the aim of analyzing the various power generation options for Nigeria, using an economic cost-benefit analysis approach to estimate the cost of various options that were explored in Nigeria, and computes the consumers' willingness to pay for electricity (taking into account the high level of self-generation presently in the country. The results showed that the Nigerian economy realized a net benefit of $4.9 billion, in present value terms, if the country embarks on hydro power investment as replacement for the current shortages. If solar PV is chosen, the economy could realize a net benefit of $21.1 billion in present value terms. If open cycle gas as replacement, the economy could benefit a net present value of $25.6 billion, and if the country goes for combined cycle gas plant, the economy could benefit $29.3 billion in net present value terms. These results are sensitized for different prices of fuel over the period of analysis covered in this study. He concluded that there is a strong evidence that the country stands to benefit from any amount of electricity supplied through the national grid as a replacement for the self-generation.

Rasheed, Adagunodo and Bamidele[59] investigated the relationship between total energy consumption and economic growth in Nigeria using Granger Causality. The two variables of the study are energy consumption and real GDP were found to exhibit unit root property, i.e. non-stationary. The study finds no clear relationship between energy consumption and economic growth. Real GDP was found not to cause energy consumption while energy consumption was also found not to cause real GDP. As astounding as this result may be, it portends potential policy implications for the economy including the need to implement policies that link energy consumption with growth generating activities.

Iyke [2]reexamined the dynamic linkage between electricity consumption and economic growth relationship in Nigeria using a trivariate VECM over the period 1971-2011. Including inflation rate in the analysis, the results supports both linear and nonlinear cointegration relationship between the variables. The results also show a unidirectional causality running from electricity consumption to economic growth in both the short run and in the long run which supports the electricity-led growth hypothesis. He recommends the appropriate monetary policies that would moderate inflation in order to enhance economic growth in the country.

Mustapha and Fagge [18] used VAR model approach to examine the relationship between energy consumption and economic growth in Nigeria's with data from 1980 to 2011. By including the variables labour and capital in their analysis, they found that there is no causality relationship between energy consumption and economic growth. Their results of the impulse response and variance decomposition analysis shows that capital and labour are more important in affecting output growth compared to energy consumption.

Okorie and Manu [60]appraised the relationship between electricity consumption and economic growth in Nigeria for the period of 1980 to 2014. The study employed the Johansen co-integration and VAR-based techniques. The results of the Johansen co-integration test revealed that long run relationship exists among the variables. The results showed that in the long run, electricity consumption has a similar movement with economic growth, following the positivity hypothesis. The Granger causality test revealed that there is a unidirectional causal relationship between electricity consumption and economic growth. They recommended that the industries increase daily generation of power to meet up with the increasing demand for power, more plant stations should be built, and the alternatives to power supply by PHCN should be made more competitive so as to increase productions and the output of the economy as a whole.

Ogundipe, Akinyemi and Ogundipe[61] submitted from the VECM analysis that the economic development is negatively affected by electricity use. So also, the study found a causality nexus among the two variables in the short-run. Also using VECM granger causality test approach were Ogbonna, Idenyi and Attamah [62] on a study power generation capacity and economic growth in Nigeria and submitted that there is a long-run nexus between the two variables (i.e. real GDP and power generation capacity) in Nigeria.

Akinbola, Zekeri andIdowu [63] investigated power sector and its impacts on industrialization of businesses in Nigeria using the Johansen Co-Integration technique to determine the long-run relationship among some macroeconomic variables that includes the industrial component of real gross domestic product, explicitly chosen using explanatory variables. The independent variables includes electricity consumption, electricity production (Kwh), growth rate of labour force, real gross fixed capital formation and telephone lines per hundred population and their impact on industrial component of real GDP. Annual time series data on these variables from 1981 to 2010 were collected from the Central Bank of Nigeria Statistical Bulletin, the World Bank and United Nations Statistics. Augmented Dickey Fuller (ADF) and Phillip-Perron(PP)tests were employed to test the order of integration of the variables.Thestudy also performed a Vector Error Correction Model-VECM tocorrectpossible disequilibrium caused inthe short-run relationships. The empirical results showed that an increase in electricity consumption lead to an increase in industrial output,thus the industry contribution to real Gross Domestic Product in the longrun. However, contrary to theoretical expectation, electricity production which is a result of existing government policies exerts a negative impact on industrial output in the longrun affected the businessviability.

Egbichi, Abuh, Okafor, Godwin and Adedoyin[64] empirically examined the dynamic impact of energy consumption on the growth of Nigeria economy between 1986 and 2016 using symmetrical autoregressive distributed lag model approach. Findings from the study revealed that electricity consumption has not had a significant impact on the growth of the Nigerian economy. It showed that due to fluctuations in electricity supply, the growth of Nigerian economy has been on the decline. However, petroleum consumption was discovered to have a significant impact on economic growth in Nigeria; while gas consumption was discovered to have no significant impact on the growth of Nigeria economy. This was attributed to gas flaring activities and other environmental abuses that had caused major Niger-delta crisis and attendant consequences like pipeline vandalization and hostage taking. The study therefore recommended that government should undertake a cogent approach towards reforming the electricity supply sector as its paramount for the country's quest for industrialization.

Ajibola,Isiaka, Nnoli and Abimbola [65] examined the impact of electricity supply on economic diversification in Nigeria, using time series data from 1981 to 2016. The study employed descriptive analysis and Autoregressive Distributed Lag (ARDL) techniques. The result from the Bounds co-integration test showed the presence of a long-run relationship among the variables. The short run (ARDL) model results indicated a positive insignificant relationship between electricity supply and economic diversification in Nigeria. The findings of the study revealed that the electricity supply had not played a fundamental role in enhancing economic diversification in Nigeria. The study therefore, recommended that for Nigeria to drive economic diversification through electricity supply, the government should fix the electricity supply problem which can be achieved by short-term action to reduce technical faults through maintenance of the transmission and distribution infrastructure or long-term interventions to expand generating capacity.

Sabiu and Sa'ada[3] examined the relationship between electricity consumption and economic growth in Nigeria using the Autoregressive Distributed Lagged (ARDL) approach on quarterly time series data for economic growth and some selected variables electricity consumption, electricity supply, electricity loss and inflation rates. Their results indicated positive and significant influence of electricity consumption on economic growth in both the short run and long run. Other variables except inflation rates showed insignificant contribution to economic growth in the long run. The result of the causality test also supports the electricity-led growth hypothesis in Nigeria. The findings suggested that increase in electricity consumption will contributes to economic growth in the country. It is recommended that electricity consumption should be considered when forecasting and making economic growth policies in Nigeria.

George-Anokwuru and Ekpenyong[7] empirically studied electricity and economic growth in Nigeria from 1971 to 2018. Having the dependent variable as GDP, and independent variables are electricity consumption, electricity generation, and electricity transmission and distribution losses. Their results showed that there is a positive relationship between electricity consumption and economic growth. Electricity generation also have a negative relationship with economic growth, while electricity distribution and losses have a negative relationship with economic growth in Nigeria. They recommended amongst others that government should ensure that energy generated in the country stays in the country and that electricity generation should be backed up with optimal production and utilization. There should be budgetary allocation into research and development in this sector so that innovation can be fostered.

Onayemi, Olomola, Alege and Onayemi [66] examined the stimulation of foreign direct investment (FDI) inflows through constant electricity power supply for economic growth in Nigeria, by engaging time series data sourced from the world development indicators (WDI) for the period 1986-2017 and employed the Autoregressive distribution lag econometric approach to co-integration. The gross domestic product growth rate per capita was the proxy for economic growth and the dependent variable, while the independent variables include FDI, labour force participation rate, gross fixed capital formation and electricity power supply. Their results showed that in the long-run, increased FDI inflows, gross fixed capital formation, electricity power supply, have the potency of increasing economic growth by 30%, 20% and 6%, respectively. They recommended that there should be constant electricity power supply to keep pace with productivity for efficient economic growth in Nigeria.

Idogun[9] empirical analysis of the nexus between electricity consumption and manufacturing sector performance in Nigeria using Autoregressive Distributed Lag (ARDL) techniques on annual time series data from 1981 to 2017 onmanufacturing sector output, electricity consumption, electricity generation, electricity price proxied by consumer price index, carbon emission, exchange rate and commercial bank credit to the manufacturing sector. The results revealed that manufacturing sector electricity consumption, electricity and generation, electricity price had inverse and significant effect on the growth of Nigeria manufacturing sector while commercial bank credit to the manufacturing sector had had direct and significant effect on the growth of manufacturing sector in Nigeria. Furthermore, the finding indicated that the cumulative sum (CUSUM) and cumulative sum of squares (CUSUM Q) of the residuals showed that the ARDL model was stable. The study recommended that more electric power supply should be generated by the government and electricity generation company to take care of the electric power demand by the manufacturing sector.

Adegoriola and Agbanuji [5] investigated the impact of electricity consumption on Nigerian economy between 1986 and 2018 using the Autoregressive Distributed Lag Model on Electricity consumption (ELC), Cost of fuel/gas (CFG) and Economic growth rate (GDPR). The stationarity test results showed that GDPR and CFG were stationary at level I(0) while ELC became stationary at first difference I(1), while the ARDL results confirmed that both ELC and GDPR are positively and significantly correlated in the short-run but in the long-run, ELC impacted negatively and insignificantly on economic growth in Nigeria, while CFG exerts positive but insignificant impact on economic growth. The study therefore, recommended that measures be taken towards electricity conservation to enhance efficient consumption of electricity towards increasing economic growth in Nigeria. The government should enact policies in the sector towards availability of electricity considering the negative influence that electricity consumption has on economic growth in the long-run.

III. Research Methods

3.1 Theoretical Framework

The Endogenous Growth Theory or the Neoclassical Growth Theory

The framework of this study assumes a standard neoclassical production function which premise on changes in quantities of factors of production account for growth. The neo-classical model is based on the Cobb-Douglas production function and is given as:

$$Y = f(A_t, K_t, L_t) \qquad (2)$$

The neoclassical growth theory states that the changes in quantities of factor inputs in production (capital and labour) account for growth of output [29]. Where: Y = Aggregate real output, K = Capital, L = Labour force, A = Level of technology and t = time dimension.

3.2 Model Specifications

Some of the variables used in this model were identified in the literature. The specification by Adeyemi [8]was adapted and his model is presented as follows:

$$GDP = f(KAP, LAB, ELEC) \qquad (3)$$

$$\log GDP_t = \beta_0 + \beta_1 \log KAP_t + \beta_2 \log LABt + \beta_3 \log ELECt + \mathcal{E}_t \qquad (4)$$

Where: GDP_trepresents Gross Domestic product, ELE_t is the electricity consumption (Kilowatt per hour), LAB_t is total labor force, KAP_t is the stock of capital and ε_t is the white noise term and theapriori expectation areβ_1,β_2,β_3 >0.

The current study modified equation 4 by using Real Gross Domestic Product (GDP) to capture economic growth and also includeElectricity Generation (ELEG); Electricity Price (ELEP) proxied by Consumer Price Index and Electricity Lossesin Transmission and Distribution(ELEL). The reason for the modification of equation 4to include these variables (RGDP,ELEG, ELEP and ELEL) in the current model specification is to empirically capture the impact of Electricity Consumption and Economic Growth in Nigeria.

$$RGDP_t = f(ELEC_t, ELEG_t, ELEL_t, ELEP_t) \qquad (5)$$

The log linear form of Equation 5 is expressed more specifically for the purpose of statistical test as:

$$\ln RGDP_t = \beta_0 + \beta_1 InELEC_t + \beta_2 InELEG_t + \beta_3 InELEL_t + \beta_4 InELEP_t + U_{t.} \qquad (6)$$

(Apriori expectation β_1,β_2,$\beta_3$and β_4>0).

Where,lnRGDP = log of real gross domestic product,InELEC = log of electricity consumption,InELEG = log of electricity generation, InELEL = log of electricity lossesin transmission and distribution,InELEP = log of electricity price proxy by Consumer Price Index (CPI),U_t = Disturbance term or error term, β_0 = Intercept, β_1–β_4 = Coefficient of the independent variables and t is the time trend. The error correction specification of equation 6 is presented as equations 7:

$$\Delta InRGDP_t = \beta_0 + \beta_1 \Delta InELEC_t + \beta_2 \Delta InELEG_t + \beta_3 \Delta InELEL_t + \beta_4 \Delta InELEP + \beta_8 ECM_{t-1} + U_t \qquad (7)$$

The ECM in equation 7 is the error correction mechanism which indicates the speed of adjustment to equilibrium whenever disequilibrium occurs in the cooperative society.

3.3 Sources of Data and Variables Description

The economic and electricity annual time series data from 1981 to 2019used in this study were obtained from secondary sources. Specifically, data for Real Gross Domestic Product (RGDP) and Electricity Price (ELEP) were obtained from Central Bank of Nigeria Statistical Bulletins [67]while Electricity Consumption (ELEC), Electricity Generation (ELEG) and Electricity Loss ELEL were sourced from Index Mundi by US Energy Information Administration [68] and Index Mundi by CIA World Fact book [69]. Below are the description of the variables:

GDP at Constant Basic Prices (otherwise known as the Real GDP) equals GDP at Constant Market Prices less indirect taxes net of subsidies. Gross Domestic Product (GDP) is the monetary value of goods and services produced in an economy during a period of time irrespective of the nationality of the people who produced the goods and services. Real gross domestic product is a measure of economic growth of a country and it is calculated without making deductions for depreciation. Its unit of measurement is in Billions of Naira.

Electricity Consumption(ELEC)is the aggregate amount of power supply by the electricity distribution companies and consumed in Nigeria in billion kilowatt-hour (billion KWh).This consists of total electricity generated annually plus imports and minus exports, expressed in kilowatt-hours.

Electricity Generation(ELEG) is the total annual electricity generated expressed in billion kilowatt-hour (billion KWh)**. ELEG** is the total amount ofelectric power generated in Nigeria from sources of primary energy in kilowatt-hour for a period of one year. For utilities in the electric power industry, it is the storage prior to its delivery to the end users (transmission and distribution).

Electricity Losses (ELEL)is the discrepancy between the amount of electricity generated and/or imported and the amount consumed and/or exported. This discrepancy is accounted for as loss in transmission and distribution. **ELEL** is the total losses to electricity production which is the total number of billion kilowatt-hour generated by power plants separated into electricity plants and CHP plants. It include losses in transmission between sources of supply and points ofdistribution and in the distribution to consumers including pilferage.

Electricity Price (ELEP) is the total tariff class of the customers of electricity distribution companies in Nigeria. This tariff class include residential, commercial, industrial, special and street lights. The summation of these tariff classes equals electricity price in Nigeria. This is the rate at which the electricity consumed is sold to the users or consumers. Electricity Price is proxied in this study by Consumer Price Index (CPI). This measured the changes in the cost to the average consumer of acquiring a basket of goods and service that may be fixed or changed at specified intervals such as yearly.

3.4 Method of Data Analysis

This study used the Augmented Dickey-Fullertest statistics, Johansen Cointegration techniques and the Error Correction Mechanism (ECM)on a multiple regression framework. These techniques used in analyzing the data collected for this research are basically statistical and econometric in nature. The Augmented Dickey-Fuller test statistics was used to determine thestationarity of the selected economic and electricity variables. Statistical theory requires that variables be stationary before the application of standard econometric techniques. This was done in order to avoid spurious (misleading) results.

The Johansen Cointegrationtest was also employed to determine the existence or otherwise of a long run relationship among the variables in the models. The error correction model was thereafter estimated to determine the speed of adjustment to long run equilibrium. Diagnostic and stability tests were also conducted to confirm the robustness of the model.

IV. Data Presentation, Analysis and Discussion of Results

The economic and electricity time series data used in this analysis are in Appendix A.

4.1. Unit Root Test Results

Prior to the estimation of ECM, a unit root test was conducted on the selected economic and electricity Indicators (Real Gross Domestic Product (RGDP), Electricity Consumption (ELEC), Electricity Generation (ELEG), Electricity Losses (ELEL) and Electricity Price (ELEP) using the Augmented Dickey-Fuller test statistics to determine their stationarity status. The results of the Augmented Dickey-Fuller unit root test statistics are displayed in Table 1.

Table 1: Unit Root Test Results

Variable	Level	First Difference	Order of Integration
RGDP	0.351647 (0.9780)	-3.468298 (0.0031)	1(1)
ELEC	-0.321495 (0.9122)	-7.501661 (0.0000)	1(1)
ELEG	-0.386837 (0.9014)	-8.258998 (0.0000)	1(1)
ELEL	-2.698202 (0.0837)	-6.770493 (0.0000)	1(1)
ELEP	4.357209 (0.0043)	6.512694 (0.0000)	1(0)
5% C.V	5% = -2.941145	5% = -2.943427	

Source: Author Regression Output from EViews 9.

Note: i. Pro-value are reported in parenthesis, ii. The Augmented Dickey-Fuller statistics are compared to 5 per cent critical value (C.V).

The results of the Augmented Dickey-Fuller test statistics in Table 1 showed that all the selected variables (RGDP,ELEC, ELEG and ELEL) were stationary at first difference I(1) except electricity price (ELEP) which was stationary at level I(0). This implies that the hypothesis of non-stationarity is rejected for all the variables at level and first difference respectively.

4.2 Cointegration Test using the Johansen Methodology

The results of the Unrestricted Cointegration Rank test for the model is presented in Table 2. Starting with the null hypothesis that there are no cointegrating vector (r = 0) in the model.

Table 2: Unrestricted Cointegration Rank Test result for model.

Hypothesised No. of CE(s)	Trace Stat.	Critical Value (0.05)	Prob**	Hypothesised No. of CE(s)	Max-Eigen Stat.	Critical Value (0.05)	Prob**
None *	93.89100	69.81889	0.0002	None *	39.93272	33.87687	0.0084
At most 1 *	53.95829	47.85613	0.0120	At most 1 *	30.43559	27.58434	0.0209
At most 2	23.52270	29.79707	0.2213	At most 2	14.41873	21.13162	0.3317
At most 3	9.103971	15.49471	0.3558	At most 3	8.620498	14.26460	0.3191
At most 4	0.483473	3.841466	0.4869	At most 4	0.483473	3.841466	0.4869

Source: Author Unrestricted Cointegration Rank Test Output from EViews 9.

Date: 10/10/20 Time: 05:10
Sample (adjusted): 1983 2019
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: RGDP ELEC ELEG ELEL ELEP
Lags interval (in first differences): 1 to 1

Note: i. r represents number of cointegrating vectors. ii. Both Trace and Max Eigenvalue tests indicates 2cointegrating equations respectively at the 0.05 level. iii. ***denotes rejection of the hypothesis at the 0.05 level and iv. **** Mackinnon-Haug-Michelis (1999) p-values.

4.3 Short-run Error Correction Representation

The results of the short-run error correction representation for the model is reported in Table 3.

Table 3: Short-run Error Correction Representation for the Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.270221	0.339556	3.740829	0.0007
D(InELEC)	0.602583	0.174608	3.451064	0.0016
D(InELEG)	0.441488	0.181937	2.426593	0.0211
D(InELEL)	-0.285221	1.141109	-0.249951	0.6042
D(InELEP)	0.142469	0.034687	4.107274	0.0002
ECM(-1)	-0.700952	0.130936	-5.353386	0.0000

Source: Author Regression Output from EViews 9.

Dependent Variable: D(InRGDP)
Method: Least Squares
Date: 10/17/20 Time: 05:19
Sample (adjusted): 1982 2019
Included observations: 38 after adjustments

The short run error correction mechanism results presented in Table 3 showed that the entire explanatory economic and electricity variables in the estimation met their expected signs except Electricity Losses in transmission and distribution. The empirical results also revealed that electricity consumption (ELEC) had a direct and significant impact on real gross domestic product (RGDP) in Nigeria for the sample period. This means that 1 per cent increase in the electricity consumptionincreasedreal gross domestic product in Nigeria by 60 per cent approximately.This finding supports the work of Adegoriola and Agbanuji [60].

The results further revealed that electricity generation (ELEG) contributed positively to the real gross domestic product (RGDP) in Nigeria. Thus, 1 per cent change in electricity generation increasedreal gross domestic product (RGDP) in Nigeria by 44 per centapproximately.This result is consistent with the previous studies ofOgbonna, Idenyi and Attamah [62].

The results also revealed that the Electricity Losses (ELEL) in transmission and distribution had negative effect on the real gross domestic product (RGDP) in Nigeria. This implies that 1 per cent increase in the Electricity Lossesin transmission and distribution reduced real gross domestic product (RGDP) in Nigeria by 29 per cent approximately.This result agreed with the previous empirical analysis ofSabiu and Sa'ada[3].

Electricity price(ELEP) in the empirical estimation also showed a direct and significant impact on real gross domestic product (RGDP) in Nigeria, and 1 per cent increase in electricity price raised the real gross domestic product by 0.14 per centapproximately.This is consistent with previous work of Idogun[9].

Finally, The error correction mechanism ecm(-) of -0.700952is statistically significant and have the appropriate sign . It suggest however, that there is a very high adjustment process in the activities of the power sector in Nigeria since the speed of adjustment to the longrun equilibrium is 70.1per cent approximately.

4.4 Diagnostic Test

To confirm the robustness of the model, a diagnostic test was performed as shown in Table 4.

Table 4: Key Regression and Diagnostic Statistics for Model

R-squared	0.921504	Mean dependent var	8.767101
Adjusted R-squared	0.914145	S.D. dependent var	9.845809
S.E. of regression	2.436821	Akaike info criterion	17.65715
Sum squared resid	190.0192	Schwarz criterion	17.91572
Log likelihood	-81.02669	Hannan-Quinn criter.	17.74915
F-statistic	125.2218	Durbin-Watson stat	2.108546
Prob(F-statistic)	0.000000		

Source: Author Regression Output from EViews 9.

The coefficient of determination R^2 indicates that 92 per cent of the total variation of the Net Profit after Charges of the real gross domestic productin Nigeria is jointly explained by electricity consumption, electricity generation, electricity losses and electricity price. The Akaikeinformation criterion, Schwarz criterion and Hannan-Quinn criterion show that the model is correctly specified. F statistic measuring the joint significant of all regressors in the model is statistically significant at the 5 per cent level. Durbin-Watson statistic is 2.108546. This implies absence of autocorrelation among the explanatory variables.

4.4. Stability Test

Stability test was performed for the model using cumulative sum (CUSUM) and cumulative sum of square (CUSUM Q) of recursive residuals as shown in figures 1 and 2 respectively. The existence of parameter instability is established for the model if the cumulative sum of the residual goes outside the area between the critical (straight bounded upper and lower) lines.

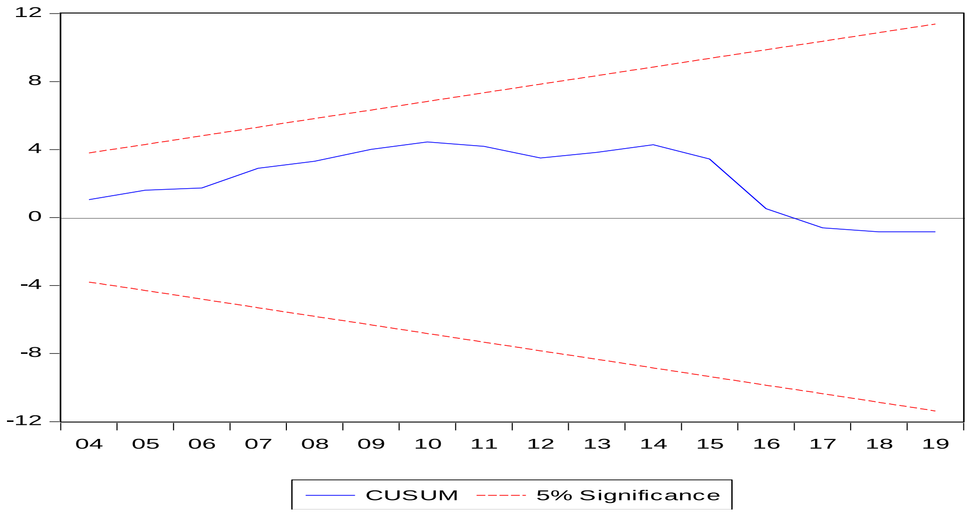

Figure 1 Plot of Cumulative Sum of Recursive Residuals

From figure 2 and 3, it was observed that the model at 5 per cent level of significance, CUSUM and CUSUM Q were both stable because the observed bound lied between the upper and lower limit. In conclusion, at 5 per cent critical value both CUSUM and CUSUM Q explain the stability of the model overtime.

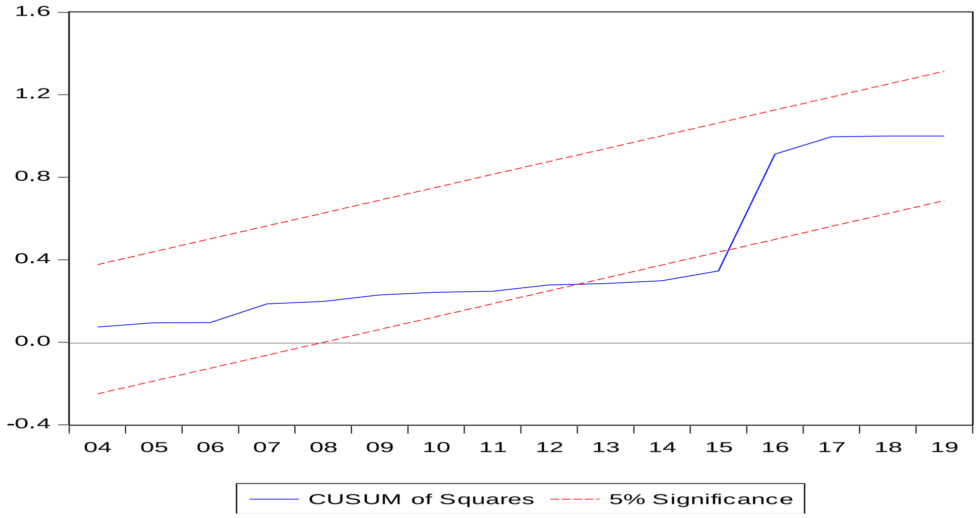

Figure 2 Cumulative Sum of Square of Recursive Residuals

V. Concluding Remarks

In reviewing the impact of electricity consumption on economic growth in Nigeria between 1981 and 2019, one can deduce from the findings that the direct and significant impact of Electricity Consumption (ELEC), Electricity Generation (ELEG) and Electricity Price (ELEP) on Real Gross Domestic Product (RGDP) is as a result of the heavy consumption of the electricity supplied by customers of the electricity distribution companies in Nigeria. The results of the Augmented Dickey-Fuller test statistics showed that all the selected variables (RGDP,ELEC, ELEG and ELEL) were stationary at first difference I(1) except electricity price (ELEP) which was stationary at level I(0), while the error correction mechanism ecm(-) of 70.1 per cent approximatelyshowed a very high adjustment process in the activities of the power sector in Nigeria since the speed of adjustment to the longrun equilibrium is above 50 per cent. It is also a confirmation that indeed electricity consumption, electricity generation, electricity losses, electricity price and the real gross domestic product in Nigeria are cointegrated. It was also revealed that at 5 per cent critical value both CUSUM and CUSUM Q explain the stability of the model overtime.

Based on the empirical findings of the study, the following recommendations were made:

a) The Nigerian Electricity Regulatory Commission (NERC) should strengthen policy on electricity generation of power to meet up with the increasing demand for electricity so as to sustain production and economic growth in Nigeria.

b) Government should urgently fix the electricity generation problem in the country,by overhauling and replacement of worn-out equipment’s, maintenance of the transmission and distribution infrastructure. This will help to drastically curtail transmission and distribution of electricity losses in Nigeria.

c) Electricity consumption should be considered when forecasting and making economic growth policies in Nigeria, since it has positive and significant impact on real growth domestic product in Nigeria.

d) Government should deepened policy onelectricity price reduction and electricity conservation to enhance efficient consumption of electricity towards the sustainability of economic growth in Nigeria.

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Appendix A: Economic and Electricity Data for Regression Analysis

Year	RGDP	ELEC	ELEG	ELEL	ELEP
1981	15,258.00	5.70	7.80	2.10	0.49
1982	14,985.08	5.90	8.10	2.20	0.53
1983	13,849.73	6.10	8.30	2.20	0.66
1984	13,779.26	6.00	8.60	2.60	0.77
1985	14,953.91	6.40	9.90	3.50	0.83
1986	15,237.99	8.30	11.00	2.70	0.88
1987	15,263.93	7.30	11.00	3.70	0.98
1988	16,215.37	7.30	11.00	3.70	1.51
1989	17,294.68	8.30	12.00	3.70	2.27
1990	19,305.63	8.00	12.00	4.00	2.44
1991	19,199.06	8.20	14.00	5.80	2.75
1992	19,620.19	8.40	14.00	5.60	3.98
1993	19,927.99	8.30	14.00	5.70	6.26
1994	19,979.12	8.00	15.00	7.00	9.82
1995	20,353.20	7.90	14.00	6.10	16.98
1996	21,177.92	7.60	14.00	6.40	21.95
1997	21,789.10	7.90	15.00	7.10	23.82
1998	22,332.87	8.60	15.00	6.40	26.20
1999	22,449.41	8.40	15.00	6.60	27.93
2000	23,688.28	13.72	14.76	1.04	29.87
2001	25,267.54	17.37	18.70	1.33	35.51
2002	28,957.71	14.77	15.90	1.13	40.08

2003	31,709.45	14.55	15.67	1.22	45.70
2004	35,020.55	14.55	15.67	1.22	52.56
2005	37,474.95	18.43	19.85	1.42	61.95
2006	39,995.50	14.46	15.59	1.13	67.05
2007	42,922.41	17.71	19.06	1.35	70.66
2008	46,012.52	15.85	22.11	6.26	78.84
2009	49,856.10	15.85	22.11	6.26	87.94
2010	54,612.26	19.21	21.92	2.71	100.00
2011	57,511.04	19.21	21.92	2.71	110.84
2012	59,929.89	18.14	20.13	1.99	124.38
2013	63,218.72	17.66	18.81	1.15	134.92
2014	67,152.79	20.38	24.87	4.49	145.80
2015	69,023.93	22.56	25.65	3.09	158.94
2016	67,931.24	24.78	27.27	2.49	183.85
2017	68,490.98	24.00	29.00	5.00	214.23
2018	69,799.94	24.72	29.35	4.63	240.14
2019	71,387.83	24.72	29.35	4.63	269.10

Sources: US Energy Information Administration, (2013); CBN Statistical Bulletin, (2019) and CIA World Factbook (2019).

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