



## Effects of Electricity Demand on Economic Growth in Nigeria

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**Abstract.** The study examined the effects of electricity demand on economic growth over a period of year 2000 to 2022. The objective is to examine the extent to which electricity demand has positively impacted the economic growth. The study utilized the covariance, multi-regression error correction model and Durbin-watson test. The study concluded that there is positive impact of electricity demand on economic growth in Nigeria. The results also show long and short run positive and significant correlation between electricity demand and real gross domestic production, electricity access and RGDP, electricity production from oil, gas and coal and RGDP. This study therefore recommends investment at private and public levels should be encouraged to increase electricity supply to meet with the customers' rising electricity demands. Finally, government should enforce law directing private operators in distribution electricity to provide prepaid metering system to public institutions, private institutions and the remaining households of the country.

**Keywords:** Economic growth, Electric power Consumption, Electricity access, Electricity demand, Electricity production

### 1. Introduction

Electricity is an important element for the development of any economy. It is impossible to operate a factory, run a shop, grow crops or deliver goods to consumers without using some form of energy supply. Most economic activities of human being revolve around the electricity. More importantly, electricity has proved to be an important factor that drives technical progress, social life and economy of any nation. Besides capital and labour, electricity is considered as a third important

production factor of any nation's economy (Nkalo & Agwu, 2019; Adebisi, Alenoghena & Charles 2023). Electricity is mandatorily required in production, making it an essential factor that generally determines the productivity of any firm. Electricity is the run of electrical charge or electrical power through cable; it's a secondary source of energy produced from the conversion of other energy sources such as fossils fuels, solar energy, nuclear power, coal and other natural sources of energy which are called primary sources (International Energy Agency, 2016).

Electricity power is not freely obtainable in nature; therefore, it must be produced by transforming other major sources of energy; mainly from renewable energy, non-renewable energy and fossil fuels. Renewable and nonrenewable energy sources can be used as primary energy sources to produce useful energy such as heat or used to produce secondary energy sources such as electricity (Chinedu, Daniel & Ezekwe 2019). There are five main renewable energy sources which are solar energy (from the sun), geothermal energy (from heat inside the earth), wind energy, biomass (from plants) and hydropower (from flowing water). Most of the energy consumed in the Nigeria is from nonrenewable energy sources like petroleum products, hydrocarbon gas liquids, natural gas, coal, nuclear energy. Crude oil and coal are known as fossil fuels. However, fossil fuels remained the leading source for electricity generation in the world and indeed Nigeria. In 2020, fossil fuels generated 61% of the world's electricity power used by consumers, down from 66% in 2015 (Energy Information Administration, 2020).

Nigeria generates electricity through the thermal and hydro energy sources. However, the major source of electricity generation in the country comes from

fossil fuels especially gas which accounted for about 81% with the remaining percentages of electricity is generated from hydropower and other sources of energy (Yakubu, Chindo & Bala 2022). Nigeria's average electricity power generation is 4,000 Megawatts though, sometimes the generation hit the 5,000MW with usually an average of 3,000MW being distributed to electricity consumers across the country (Yakubu, Chindo & Bala 2022). The fluctuation in power generation and transmission was largely due to infrastructural deficits in the country's electricity value chain. Stakeholders in the power sector believed that the current electricity power capacity in the country is increasingly inadequate to cater for the power needs of the Nigeria's growing population (Nigerian Electricity Regulatory Commission, 2020).

An economy's production and consumption of electricity are basic indicators of its size and level of development. Expanding the supply of electricity to meet the growing consumers' demand is one of the great challenges facing developing countries like Nigeria. Modern societies are becoming increasingly dependent on reliable and secure electricity supplies to underpin economic growth and community prosperity. Furthermore, access to electricity is particularly crucial to human development as electricity is, in practice, indispensable for certain basic activities, such as lighting, refrigeration and the running of household appliances, and cannot easily be replaced by other forms of energy. Individuals' demand of electricity is one of the most clear and undistorted indication of a country's energy poverty status. Electricity demand is increasingly at the forefront of governments' preoccupations, especially in Nigeria. As a consequence, a lot of rural electrification programs and national electrification agencies have been created to monitor more accurately the needs and the status of rural development and electrification. Use of electricity is important in improving people's standard of living.

In Nigeria economy, growth in electricity demand and use are closely related to growth in the modern sectors - industry, motorized transport, and urban areas - but energy use also reflects economic factor (such as the relative price of energy). The high price and shortage of supply of electricity have always negatively influenced productivity and firms' profit. Yakubu et al (2022) asserts that electricity power, consumer price index and economic growth are positively related. The implication is that when there is a high efficiency of electricity supply, the running cost of the firms is drastically reduced, leading to higher electricity demand, higher electricity

consumption, and consequently higher profitability, higher productivity and growth in the economy.

Over the past decades, studies on electricity and economic growth have been extensively carried out (e.g Adebisi et al 2023, Awad & Yossof 2016, Khobai, Mugano & Roux 2017, Yakubu et al 2022). On the other hand, the result of the causal relationship between electricity demand and economic growth still unknown and required scholarly attention. Therefore, this study considered electricity demand side, access and electricity production from oil, gas and coal sources including the already studied consumption side. The main objective of this study is to find out the impact of electricity demand on economic growth in Nigeria for the period of 2000 to 2022 using Multi-regression Error Correction model.

## 2. Empirical Review

The connection between electricity and economic growth has attracted the attention of various scholars. The subject under review is a fundamental issue that should be subjected to thorough review of related empirical studies so as to understand the positions of the concerned scholars and researchers on this subject matter and to establish the gap inbuilt in the previous related research.

Stern, Burke and Bruns (2017) reviewed the macroeconomic perspective of electricity access and use and their casual effects on economic growth with focus on Sub-Saharan Africa. The finding revealed that electricity use and access are strongly correlated with economic development. A similar study by Nkalo and Agwu (2019) reviewed the impact of electricity supply on economic growth in Nigeria. The study revealed that lack of access to electricity in some parts of Nigeria affects development and impinge negatively on the economic growth. Khobai, Mugano and Roux (2017) investigated the causal relationship between electricity supply and economic growth in South Africa using annual data covering the period between 1985 and 2014. The parameters were estimated using the Vector Error Correction Model to determine if the variables could cause each other. The outcome of the tests showed that electricity prices, trade openness, employment and capital Granger-cause economic growth and electricity supply. Yakubu et al (2022) investigated the impact of electricity power on the economic growth in Nigeria using annual data from 1981 to 2019. The study employed Autoregressive Distributed Lag (ARDL) bounds test for cointegration of variables through Augmented

Dickey-Fuller test (ADF) and Phillip Perron (PP) unit root tests. The result of the study revealed that, electricity power is statistically positive and has significant impact on the economic growth in both the long run and the short run.

A recent study by Adebisi et al (2023) investigated the impact of energy supply on economic growth in Nigeria between 1971 and 2020. The study employed Autoregressive Distributed Lag (ARDL) model with Bounds Testing for cointegration approach to examine the extent to which energy supply impacted the productive sectors of the economy. The finding revealed a long-run relationship between the electricity supplied through hydropower, oil and gas and economic growth. The findings of some studies (Adebisi, et al. 2023, Nkalo & Agwu 2019) suggest that electricity supply has positive impact on the economic growth).

Furthermore, Awad and Yossof (2016) examined the link between electricity production and economic growth and employment between 1980 and 2013 in Sudan. The work used energy generation since it is what is generated that is supplied. Their work employed cointegration and Wald causality test methods. The cointegration test showed that the variables have a long-run relationship and a bi-directional causality between energy generation and economic growth. The results imply that even in the short run, a decrease in electricity supply leads to a fall in economic growth and vice versa. Therefore, policy design is to strengthen the existing electricity generation policy to boost economic growth. Gbadebo and Okonkwo, (2009) investigated the relationship between energy consumption and the Nigerian economy from the period of 1970 to 2005. The energy sources used to test for this relationship were crude oil, electricity and coal. By applying the co-integration technique, the results derived infer that there exists a positive relationship between current period energy consumption and economic growth. With the exception of coal which was positive, a negative relationship was noted for lagged values of energy consumption and economic growth.

Enu and Havi (2014) carried a study aiming at examining the extent to which electricity consumption influences economic growth in Ghana. The study employed Augmented Dickey- Fuller test, Co-integration test, Vector Error Correction Model and Granger Causality test. The study revealed that, in the long term, a hundred percent increase in electricity power consumption will cause real gross domestic product per capita to increase by approximately fifty two percent. However, in the short run, electricity consumption negatively affects

real gross domestic product per capita. The study again revealed that unidirectional causality run from electricity consumption to economic growth meaning that any policy actions taken to affect the smooth consumption of electricity in Ghana will definitely affect her gross domestic product per capita.

### 3. Methodology

This study made use of within-subject research design which enables us to measure the main and interaction effect and relationship between dependence variable and explanatory variables using time-series secondary data. To empirically examine the impact of electricity demand on the economic growth in Nigeria, the researchers subjected the secondary data collected to multiple regression test statistics, error correction model and Durbin-watson test. To investigate how electricity demand could affect economic growth in Nigeria, a number of variables were taken into consideration, the variables consist electricity demand, electric power consumption (kwh per capita), access to electricity (% of population), electricity production from oil, gas and coal sources (% of total) and Real Gross Domestic Product (RGDP) for the period of 2000-2022. All the variables were sourced from World Bank database, Central Bank of Nigeria, International Energy Agency (IEA) statistics and Organisation for Economic Co-operation and Development (OECD) for various years.

#### Model Specification

This study is anchored on the Yakubu et al (2022) who examine the impact of electricity power on economic growth using Nigeria's data. Therefore, the model is presented in a functional form below:

$$RGDP = F(ED, EConsp, AE, EP) \text{ -----} \\ \text{-----}(1)$$

Where,

ED = Electricity demand (Independent variable)

EConsp = Electric power consumption (Independent variable)

AE = Access to electricity (Independent variable)

EP = Electricity production from oil, gas and coal (Independent variable)

RGDP = Real Gross Domestic Product (Dependent variable)

In a linear function, it is represented as follows:

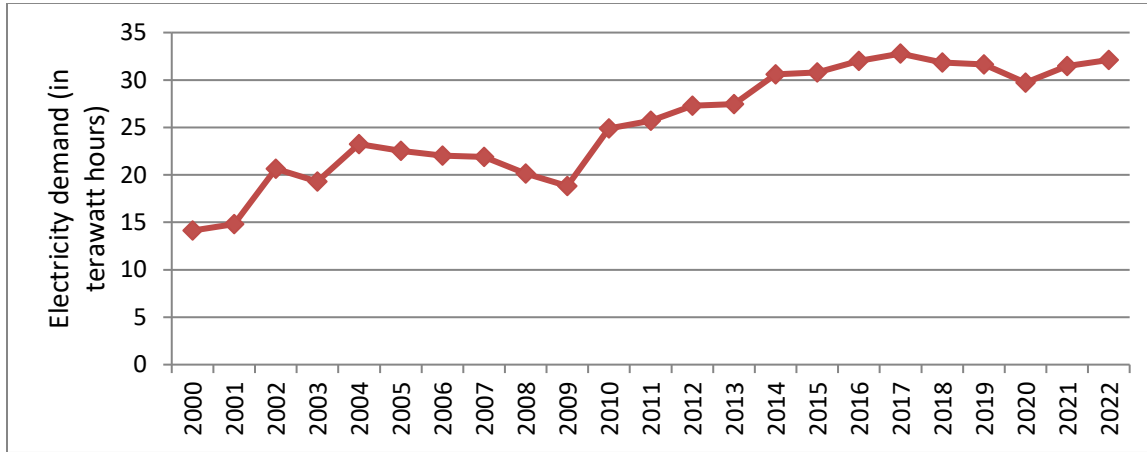
$$RGDP = \beta_0 + \beta_1 ED + \beta_2 EConsp + \beta_3 AE + \beta_4 EP \\ + Ut \text{ .....} (2)$$

Where:  $\beta_0$  = Constant term,  $\beta_1$  to  $\beta_4$  = Regression coefficient and  $Ut$  = Error Term.

**4. Result and Discussion**

The individual demand for electricity in the country varied annually. The Figure 1 shows the trends of electricity demand in Nigeria from 2000 to 2022 in terawatt hours. In 2014, the amount of electrical energy needed for use by each person in Nigeria peaked at 173 kilowatt hours (Statista 2023). Overall, electricity generating companies in Nigeria recorded an output of over 36,000 gigawatt hours in 2021. As of 2022, the electricity demand in Nigeria amounted

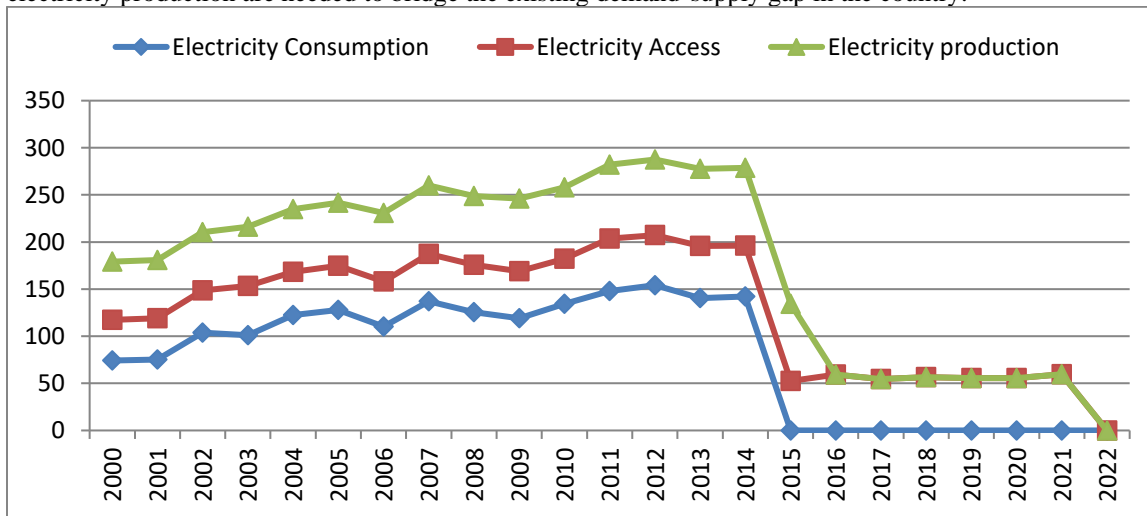
to over 32 terawatt hours. This followed a slight upward trend observed since 2020 (Statista 2023). Furthermore, the demand remained stable between 2002 and 2010 and increased annually afterward until 2017. The fast-growing population of the country can explain the increase. Nevertheless, in 2020, a little more than half of the Nigerian inhabitants were still without electricity. The per capita electricity demand in Nigeria reached 150 kilowatt hours in 2022, which was the same value as the previous year.



**Figure 1.** Trend of Electricity Demand (2000-2022)

*Source: Author's compilation 2023*

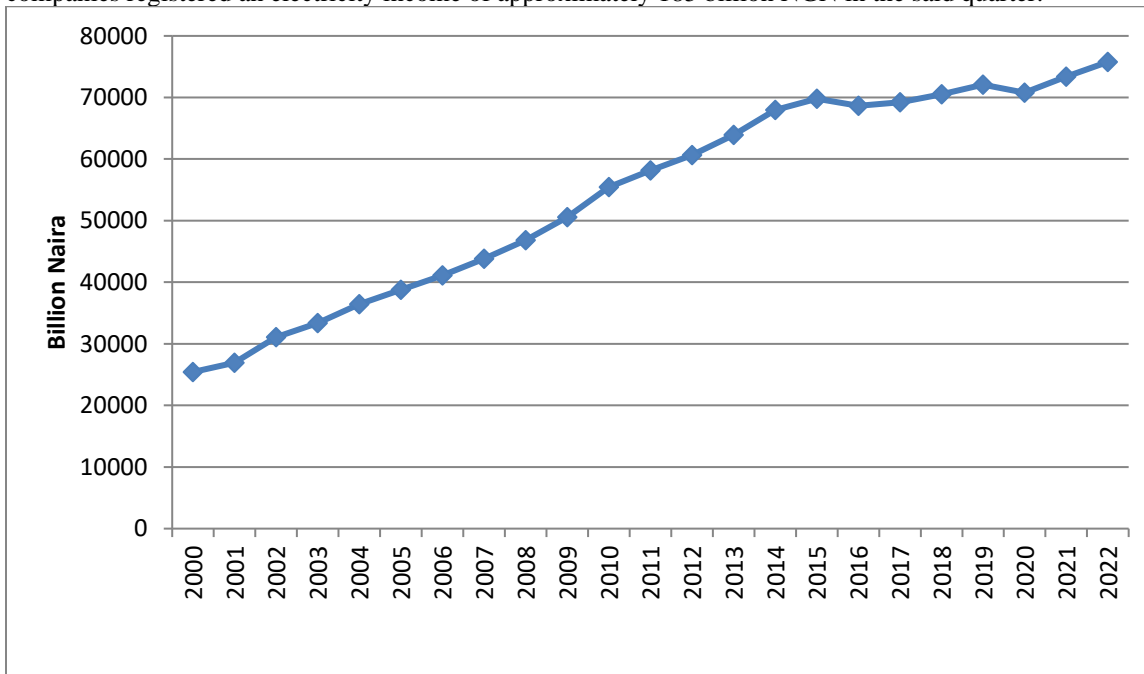
Nigeria is the most populous country in Africa. As of 2020, the nation's population amounted to just over 200 million (Sasu, 2023). To meet the electrical energy needs of individuals in Nigeria, a high volume of production is expected. In 2020, around 35.7 thousand gigawatt hours of electricity were generated. This was very low in comparison to the level of electricity demand, which exceeded 29 terawatt hours in the same year. Moreover, the amount of energy that was supplied reached roughly 35 gigawatt hours in 2020. Visibly, more investments in electricity production are needed to bridge the existing demand-supply gap in the country.



**Figure 2.** Trend of Electricity Consumption, Access and Production from oil, gas and coal (2000-2022)

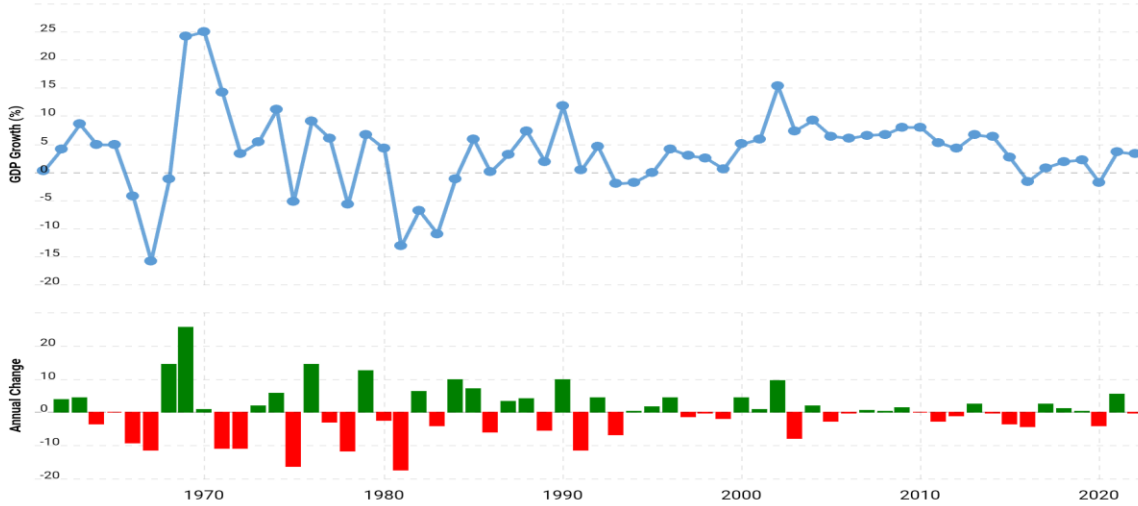
*Source: Author's compilation 2023*

Not everyone in Nigeria is able to obtain electricity for use. In fact, in 2020, slightly over 55 percent of the population had access to electricity. As of 2019, the absence of electricity was most prevalent in rural communities, as only 30 percent of them had access to electrical energy. In contrast, the share reached around 90 percent among the urban population. Moreover, households in the northeast and northwest zones were the most electricity-deprived in the same year. Therefore, it is not surprising that the two regions reported households owning the least number of electrical appliances in the country in 2020. In Nigeria, the residential consumption of electricity is higher than that of industries (Sasu 2023). In 2019, while over 57 terajoules of electricity was consumed by residences, the amount reached below 15 thousand terajoules in terms of industrial consumption. Overall, the amount of electric power consumed per capita was estimated at roughly 161 kilowatt hours in 2022. Indeed, Nigeria economically benefits from electricity distributed and consumed both locally and outside its borders. In 2020, it earned more than 80 million U.S. dollars in revenue from electricity exports. Moreover, as of the second quarter of 2021, Ikeja made the most monetary contribution to the country from electricity distribution. Sasu (2023) reported the revenue collected by electricity distribution companies in Nigeria 2021, by company. As of the second quarter of 2021, the electricity distribution company in Ikeja in Nigeria received over 38.7 billion Nigerian naira (NGN) (roughly 93.2 million U.S. dollars) in revenue. This was against a total bill of 45.81 billion NGN. Moreover, Eko and Abuja contributed 28.6 billion NGN and 27.5 billion NGN to the total electricity revenue, respectively. Overall, the Nigerian electricity companies registered an electricity income of approximately 185 billion NGN in the said quarter.



**Figure 3.** Trends of Real Gross Domestic Product (2000-2022)  
*Source: Author's compilation 2023*

The trends of Real Gross Domestic Product and annual percentage growth rate of GDP for the period of 2000 to 2022 were presented in Figure 3 and 4. The annual percentage growth rate of GDP at market prices was based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. The result shows that Nigeria GDP growth rate for 2022 was 3.25%, a 0.4% decline from 2021 which was 3.65%, a 5.44% increase from 2020 was -1.79%, a 4% decline from 2019 was 2.21%, a 0.29% increase from 2018.



**Figure 4.** GDP Growth Rate and Annual Change (2000-2022)  
**Source:** Author’s compilation 2023

Covariance Analysis of Independent Variables on RGDP  
 Dependent Variable: D(RGDP)  
 Method: Correlation  
 Date: 01/10/23 Time: 15:39  
 Sample (adjusted): 2000-2022

Variable	Mean Stat.	Std.Err	Std. Dev.	Variance	r	p.value
ED	25.474	1.217	5.838	34.083	.940	.000
EConsp.	120.989	6.269	24.282	589.619	.871	.000
AE	51.568	1.034	4.850	23.523	.884	.000
EP	72.358	1.925	7.699	59.286	.973	.000

As shown in covariance analysis table, there was strong positive correlation between electricity demand and real gross domestic product ( $r = .940, p < .01$ ). This is in agreement with Khobai, Mugano and Roux (2017) and Yakubu et al (2022) who in their study revealed that electricity prices, trade openness, electricity supply and electricity power are statistically positive and have significant impact on the economic growth both in the long and short run. The result also shows positive correlation between electric power consumption ( $r = .871, p < .01$ ) and real gross domestic production. This is in corroborated with the study of Enu and Havi (2014) supported that there exists a positive relationship between current period energy consumption and economic growth. Furthermore, the result show strong positive correlation between electricity access ( $r = .884, p < .01$ ) and real gross domestic product. This finding is supported with the study of Stern, Burke and Bruns (2017) who in their finding revealed that electricity use and access are strongly correlated with economic development. Electricity production from oil, gas and coal also has strong positive correlation with real gross domestic product. This finding is in agreement with Gbadebo and Okonkwo, (2009), Awad and Yossif (2016), supported that a long-run relationship and a bi-directional causality between energy generation and economic growth.

**4.1 Empirical Analysis of Multi-regression Error Correction Model**

Dependent Variable: D(RGDP)  
 Method: Least Squares  
 Date: 01/10/23 Time: 15:39  
 Sample (adjusted): 2000-2022

Variables	Coefficient	Std.Error	t-Statistics	Prob.
(Constant)		9326.222	-8.553	.000
ED	.263	317.692	2.480	.033
EConsp.	-.050	66.861	-.420	.683

AE	.103	273.683	1.244	.242
EP	.723	180.983	7.255	.000
<b>R-squared</b>	.978	Mean dependent var	45370.4107	
<b>Adjusted R-squared</b>	.969	S.D. dependent var	13514.87799	
<b>S.E. of regression</b>	2418.85854	Durbin-Watson stat	1.582	
<b>Sum squared resid</b>	58508766.382			
<b>F-statistic</b>	109.263			
<b>Prob(F-statistic)</b>	.000			

Error correction model was carried out to examine parameters estimates. In testing this hypothesis, Electricity Demand (ED), Electric Power Consumption (EConsp.), Access to electricity (AE) and Electricity Production from oil, gas and coal (EP) were regressed against Real Gross Domestic Product (RGDP). The result of the regression analysis was summarized and it shows that the model for the effect of electricity demand on economic growth. The empirical result shows that the coefficient of electricity demand and electricity production from oil, gas and coal have 26% and 72% respectively positive significant effect on Real Gross Domestic Product because observed values of t – statistics was greater than its p-values. The result shows no significant effect of electricity access and electric power consumption on Real Gross Domestic Product. The F–statistical test (109.263) show that the overall regression of the variables was statistically significance at P.value less than 01. The adjusted R-squared (R<sup>2</sup>) is 0.969 indicating that explanatory powers of the variables on economic growth were very high.

**5. Conclusion and Recommendations**

The study concluded that there is impact of electricity demand on economics growth in Nigeria. The empirical result shows that the coefficient of electricity demand has 26% positive significant effect on real gross domestic product, electricity production from oil, gas and coal has 72% positive significant effect on real gross domestic production. Electricity demand together with electric power consumption, electricity access and electricity production from oil, gas and coal have positive correlation with real gross domestic product both in long and short run. This study therefore recommends a sustainable energy policy that will boost electricity production in the country. In addition, more investment at the private and public levels should be encouraged to increase electricity supply to meet with the customers’ rising demands. Electricity users should also be enlightened and educated on how limited electricity supply should be used wisely. Finally, government should enforce law directing private operators in distribution electricity to provide prepaid metering system to

public institutions, private institutions and the remaining households of the country.

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