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Electricity Generation, Transmission and Distribution for Sustainable Economic Development in Nigeria

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Abstract—*Electricity is vital and inevitable to our daily and day to day activities, as it lighting our environment, powers our homes, schools, hospitals, offices, businesses, and aid industrialization, It is a known phenomena that the economic growth of a nation depends on its electricity generation. The objective of this research is to evaluate the extent to which increase in capital expenditure on power sector will lead to increase of GDP in the economy as well as to examine the effect of installed and generation capacity on the level of power consumption for sustainable economic development in Nigeria. Given the expected result of this study, the researcher generated two sets of hypothesis H0.1: -Government capital investment on power supply has no impact in economic development of Nigeria. H1.1: -Government capital investment in power supply has impact in economic development of Nigeria. In line with the formulated hypothesis the researcher employed econometric techniques for this analysis. Multiple linear regressions are formulated along with simple linear model. The study proved a positive relationship in both models that 100% increase in power supply via government capital expenditure, the installed and generation capacity, will lead to 79.78% and 159% in both GDP and Power consumption in the economy respectively. The researcher concluded his work by identifying several causes of inadequate power supply in Nigeria and argued that the precarious situation has serious negative implication on the economic development sustainability of the country. Sustainable energy development in Nigeria is the Key to the stability of the country, in terms of a viable economy, social order and political stability. The issue of revamping the power sector for a rapid economic development in the country cannot be over emphasized. The researcher made some recommendations, that Government investment at any level of play in the Electricity Market should not be based on politics or quota system but strictly on integrity, competence and professionalism.*

1. INTRODUCTION

Electricity plays a very important role in the economic and technological development of every nation. Without it, the dream of any country to become a develop nation will only be a mirage. The electricity demand in Nigeria far outstrips supply and supply is epileptic in nature[1].

The history of electricity in Nigeria dates back to 1896 when electricity was first introduce in Lagos, fifteen years after its introduction in England[2]. Despite the fact that its existence in the country is over a century, its development has been at a slow rate. In 1950 a central body was established by the legislative council, which transferred electricity supply and development to the care of the central body called the Electricity Corporation of Nigeria (ECN). Other bodies like Native Authority and Nigerian Electricity Supply Company (NESCO) has license to produce electricity in some locations in Nigeria. There was another body known as Niger Dam Authority (NDA) established by an act of parliament. The authority was responsible for the construction and maintenance of Dams and other work on River Niger and elsewhere generating electricity by means of water power, improving and promoting fish brines and irrigation. The energy produced by NDA was sold to Electricity Corporation of Nigeria for distribution and sales at utility voltages[3]. The construction of the first phase of Kanji hydroelectric station started, and was concluded between 1968 and 1970 simultaneously, in 1958; studies were conducted by ECN for the construction of Jebba hydroelectric station, which was commissioned in 1986.

1.1 OBJECTIVE OF THE STUDY

The main objective is to examine the extent to which electricity supply is able to trigger sustainable economic development in Nigeria. The specific objectives are:

To evaluate the extent to which increase in capital expenditure on power sector will lead to increase of GDP in the economy.

To examine the effect of installed and generation capacity on the level of power consumption for sustainable economic development in Nigeria.

To identify the challenges in the power sector and suggest measures of solving them.

1.2 RESEACH QUESTIONS

What is the state of power generation, transmission and distribution in Nigeria?

To what extent has the federal government of Nigeria invested in the power sector to make it effective for sustainable economic development?

How can the new owners of the power sectors tackle the countries power problem?

1.4 RESEARCH HYPOTHESIS

Given the expected result of this study, it is appropriate to generate two sets of hypothesis which will be tested:

H0.1: -Government capital investment on power supply has no impact in economic development of Nigeria.

H1.1: -Government capital investment in power supply has impact in economic development of Nigeria.

H0.2: -The available power supply (i.e. installed and generation capacity) does not encourage high power consumption for economic development.

H1.2: -The available power supply (i.e. installed and generation capacity) encourage high power consumption for economic development.

2. LITERATURE REVIEW

The theoretical basis for establishing electricity outage cost is that there is welfare loss when there is electric power failure. Three major methods have been advanced and applied in estimating the measurable costs of electricity outage in general and in particular (International Atomic Energy Agency, 1984). These methods are production factor analysis, economic welfare analysis and empirical analysis or customer surveys.

The production factor approach assumes that outage cost is equal to the ratio of an economic index (output-value added by manufacturing, gross domestic, or factor of production-wages) to input such as electrical energy consumed (kwh) over the same period as the economic index. Also this method assumes homogenous output for each industry. The international Atomic Energy Agency (IAEA) reported on outage cost estimate in the range of $0.50-$1.5 per kWh. The high cost was attributed to low electricity consumption in the denominator of the factor analysis method rather than a high financial loss in the numerator of the equation. Munasinghe (1990)[4] stated that the use of the assumption of proportionality between output and electricity consumption implied in the method may not be justified.

The second approach proposed in the literature is base on welfare maximization. Under this approach consumer's surplus, that is, the amount of electricity consumers could have consumed if there were no electricity outages are estimated using the consumer's long-term demand curve for electricity. Advantages of the method include its theoretical underpinning on welfare theory, ease of use given long-term demand elasticity for electricity and its ability to capture factors affecting consumer's willingness to pay. One of the stated shortcomings is the assumption that willingness to pay for electricity outage not actually experienced by consumer. Also, the use of long-term demand elasticity to estimate short-term impact of electricity outage cost may underestimate the actual cost of the electricity disruption.

The final method uses customer survey returns to estimate outage cost. Customer survey has the advantage of measuring outage cost from information necessary to answer the specific concerns of the researcher. Munasinghe (1990) pointed out that survey methods are effective when used in situation where actual electricity outages have being experienced as in Nigerian case. He cited studies conducted by Sanhvi (1982, 1983), Anderson and Taylor (1986), Woo and Train (1988), which showed that customers with actual and recent outage experience valued electricity higher than hypothetical customers without electricity outage experience.

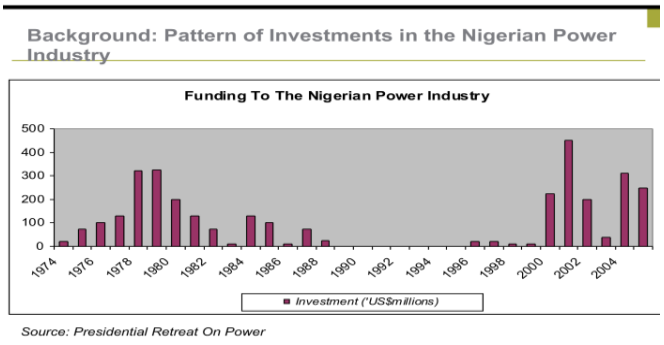

Chart 1: Indicates pattern of investment in the Nigerian Power Industry

Source: Presidential Retreat On Power

Table 1: Shows the ranking of some countries based on their GDP as well as their population and power generation.

Country	Rank GDP	GDP	Power Generation (Billions Kwh)	Rank	Population Size	Rank
USA	1	16.72 trillion	4.099 trillion	2	318,892,103 (July 2014)	4
China	3	13.39 trillion	5.398 trillion	1	1,355,692,576 (July 2014	1
Japan	5	4.729 trillion	936.2 billion	5	127,103,388 July 2014	11
India	4	4.99 trillion	871 billion	6	1,236,344,631 July 2014	2
Germany	6	3.227 trillion	526 billion	10	80,996,685 July 2014	18

Russia	7	2.553 trillion	1.057 trillion	4	142,470,272 July 2014	10
UK	9	2.387 trillion	365.7 billion	12	67,742,977 July 2014	23
Spain	15	1.389 trillion	276.8 billion	15	47,737,941 July 2014	29
Indonesia	16	1.285 trillion	173.8 billion	23	253,609,643 July 2014	5
Taiwan	21	926.43 billion	252.2 billion	17	23,359,928 July 2014	52
Poland	22	814b	153.4	25	38,346,279 July 2014	35
KSA	20	927b	239.2b	19	27,345,986	47
Thailand	25	673b	173.3b	24	67,741,401	21
South Africa	26	595.1 billion	257.9b	16	48,375,645	28
Malaysia	30	525b	118b	31	30,073,353	44
Nigeria	31	478.5b	24.87b	68	177,155,754	8
Sweden	35	393.8b	148.7b	26	9,723,809 July 2014	91
Philippines	32	454.3b	67.45b	42	107,668,231 July 2014	13
Switzerland	37	371.2b	68.02b	41	8,061,516	96
Ghana	78	90.41b	8.213b	97	25,758,108	49
Sudan	79	89.97b	7.193b	108	35,482,233	37
Brazil	8	2.416 trillion	530.7b	9	202,656,788 July 2014	6
France	10	2.276 trillion	561.2b	8	66,259,012 July 2014	22

Source: www.cia.gov[6]

3.1 CAPITAL EXPENDITURE ON POWER SECTOR AND GDP

Table 2: Shows Nigerian Capital Expenditure on Power sector and GDP:

YEAR	GDP(NB) Y	CAPITAL EXPENDITURE (NB) X
1996	3,157.20	1179.20
1997	3,148.20	1000.00
1998	3,021.90	2700.00
1999	953.20	5500.90
2000	972.20	29543.90
2001	11684.90	78397.00
2002	13318.10	63442.50
2003	15598.80	30587.10
2004	18252.50	54624.00
2005	19439.90	91114.70
2006	20344.40	74710.20
2007	21301.00	100784.40
2008	22132.00	114375.00

Source: Federal Ministry of Power and Steel and CBN statistical bulletin golden jubilee Abuja (2008)[7]

From table 1 above it shows that column one (1) carries the years that makes up the scope of the study from 1996-2008. GDP Y which is the dependent variable is presented in column two (2). Column three (3) displays government capital investment on power X which is the explanatory variable.

3.2 THE INSTALLED AND GENERATION CAPACITY TO INFLUENCE POWER CONSUMPTION

Table 3: Shows Nigerian Power Consumption, Installed Capacity and Generation Capacity

YEAR	POWER CONSUMPTION (MW)	INSTALLED CAPACITY K_1 (MW)	GENERATION CAPACITY K_2 (MW)
1996	1033.30	4548.60	1854.20
1997	1009.60	4548.60	1839..80
1998	972.80	4548.60	1724.90
1999	883.70	5580.00	1859.80
2000	1017.30	5580.00	1738.30
2001	1104.70	6180.00	1689.90
2002	1271.60	6180.00	2237.30
2003	1519.50	6130.00	6180.00
2004	1825.80	6130.00	2763.60
2005	1873.10	6861.60	2779.30
2006	2638.10	7011.60	2638.10
2007	2245.0	7011.60	2623.10
2008	2108.0	7011.60	2108.00

Source: Annual report and financial statement for the year ended 31st December, 2008[8]

From table 2 presented the years that constituted the scope of this study from 1996-2008 in column one (1). Column two (2) presents power consume by industries, residents/ streets and commercial organization which is the dependent variable (Q). Power installed capacity (K_1) is the first explanatory variable in column three (3). Column four (4) carries power generation capacity (K_2) the second explanatory variable.

3.3 INTERPRETATION OF RESULT

Two models are formulated in order to achieve the purpose of this study or research work. We employ simple linear regression[9] and multiple linear regressions[10].

3.4 SIMPLE LINEAR REGRESSION

$$Y = B_0 + B_1 X_1 + U_1$$

Where Y = Gross Domestic Product X_1 = Government Capital Investment or Expenditure in Power, B_0 = Regressor constant constant, B_1 = parameter of the estimate while U_1 = error term.

The dependent variable (Y) is regressed against the independent variable X_1 the regain result is shown below:

$Y = 2716.848 + 0.182 (X_1)$

(1871.725) (0.038)

$R^2 = 0.775$

$F_c = 37.961 > F_t = 4.84$

T_c of $B_0 = 1.452 < T_t = 2.201$

T_c of $B_1 = 6.161 . T_t 2.201$

Dubin–Watson d = 0.952

DL = 0.861

DU =1.579

The result shows that there is a positive relationship between GDP and Government Expenditure on Power Sector. This means GDP growth is an increasing function of government capital expenditure.

The intercept (B_1 = MPC) shows on the average other factors that affect GDP apart from capital expenditure that is when capital expenditure is held constant. Thus, this will give us Y = 2716.848 + 0.182 (0) Y+ 2716.848.

Therefore, 2716.248 is on average the proportion of other factors aside capital expenditure that affects the GDP in Nigeria. The category of these factors is poor maintenance culture of existing facilities, corruption on the part of management in the power sector, absence of skilled man power among other factors.

3.5 HYPOTHESIS TESTING

H_0: $b_1 = 0$ government capital investment on power supply has no positive impact on economic development of Nigeria

H_1 : $b_1 = 0$ government capital investment on power supply has positive impact on economic development of Nigeria.

When T_c is greater than T_t, we reject H_0 otherwise accept H_1 and conclude that government capital on power supply has positive impact on economic development of Nigeria.

$T_c = 6.161$, $T_t = 2.201$. Since $6.161 > 2.201$ we reject H_0 and conclude that government capital investment on power has a positive impact on economic development in Nigeria, otherwise accept H_1.

In conclusion on the data analysis of the relationship between government capital investment and the GDP in Nigeria, the idea of this analysis is to verify how more government investment on power leads to increase in GDP. This can be shown using the initial model for prediction. The result of the prediction is very useful in helping government decision making. The model for prediction is shown below.

$Y = 2716.848 + 0.182 (X_1)$

For instance, if the current power supply is 4500mw due to the previous government capital investment on power, what will be the level of GDP in Nigeria?

$Y = 2716.848 + 0.182 (4500) = 2716.848 + 819$

Thus Y = 3535.848

If the government decides to increase capital expenditure to jack up power supply to say 20000mw as stated in the country's vision, what will be the increased in GDP?

$Y = 2716.848 + 0.182 (20000)$

$Y = 2716.848 + 3640$

Thus Y = 6,356.848

Percentage change in power supply due to government capital investment on power sector will be as follows:

$$X = \frac{20000–4500 \times 100}{4500} = 344\%$$

Percentage change in gross domestic product (GDP)

$$Y = \frac{6{,}356.848–3535.848 \times 100}{3535.848}$$

$$Y = \frac{2821 \times 100}{3535.848} = 79.78\%$$

This shows that 344% increase in power supply due to government capital investment on the sector will lead to 79.78% increase in Gross Domestic Product (GDP) in Nigeria.

3.6 THE MULTIPLE REGRESSIONS

The dependent variable (Q) is regressed against the two explanatory variables (k_1) and (k_2). The result is shown below:

$Q = - 1544.352 + 0.501 (K_1) + 0.026 (K_2)$
(657.368) (0.114) (0.090)
$R^2 = 0.687$ 68.7%
$F_C = 10.983$ $F_t = 4.10$
T_c of $b_1 = 4.378$ T_t of $b_1 = 2.228$

T_c of b_2 = T_c of b_2 = 0.285, T_t = 2.228

Dubin–Watson d = 1.11, dl = 0.715 du = 1.816

The result shows that from the base year that make up the scope of this study, power consumption was not influenced by the installed and generating capacity rather it was influenced by other alternative power supply and that is why the value of the intercept B_0 is negative. That is when installed and generation capacity is held constant, the model will give us:

Y = 1544.352 + 0.501 (0) + 0.026 (0)

Y = 1544.325

The standard error of the two slopes (sb_1) and (sb_2) are 0.114, 0.090 respectively.

As a rule when the standard error of the slope is less than half of the numerical value of the slope ($b_1/2$) that is ($b_1/2$) > sb_1, then we conclude that the model is statistically significant. Therefore since, 0.501/2 = 0.25058 and 0.026/2 = 0.013, which means for b_1 0.114<0.2506, we conclude that the model is statistically significant, but for b_2 0.090>0.013 which shows that the model is statistically insignificant.

3.7 HYPOTHESIS TESTING

H_0; b_1 = 0 (this means that there is no relationship between installed and generation capacity with the level of power consumption).

H_1; b_1 = 0 (there is a relationship between installed and generation capacity with the level of power consumption).

When the T_c is greater than T_t we reject the null hypothesis H_0 and conclude that there is relationship between the installed and generation capacity and the level of power consumption in the country.

From the result, T_c = 4.378, T_t = 2.225. Since 4.378 > 2.225 we reject H_0 and conclude that there is a relationship between the installed and generation capacity with the power consumption in the country.

Conclusion on the data analysis of the available power supply (i.e installed and generation capacity) with the level of power consumption in the country.

The aim of this analysis is to evaluate how power consumption can be increased via increased in power supply. This can be shown using initial model from the outcome of the prediction. This is very useful in helping government decision making. The model for prediction is expressed below:

Y = - 1544.352 + 0.501 (k_1) + 0.026 (k_2)

For example if the current installed and generation capacity are 8000mw and 4500mw respectively. What will be the level of power consumption in the country?

Y = 1544.352 + 0.501 (8000) + 0.026 (4500)

Y = 2580.648

If government decides to increase installed and generation capacity to 16000 and 9000 respectively, what will be the increase in power consumption?

Y = - 1544.352 + 0.051 (16000) + 0.026 (9000)
Y = 6705.68
Percentage change in installed and generation capacity:

$$K_1 = \frac{16000–8000 \times 100 = 100\%}{8000}$$

$$K_2 = \frac{9000–4500 \times 100 = 100\%}{4500}$$

Percentage change in power consumption in Nigeria

$$Y = \frac{6705.648–2580.648 \times 100 = 159.8}{2580.648}$$

This shows that 100% increased in both installed and generation capacity will lead to 159.8% increased in power consumption in the economy.

4. CONCLUSION

Focussing exclusively but critically on the power generation, transmission and distribution situation in Nigeria, the research came to acknowledged that in spite of huge amount government committed into the power sector in the country over the past eighteen years (1996-2014), Nigeria with over 170 million population, the generation capacity has been fluctuating given the installed capacity. There was reasonable improvement in the generation in 2003, but after which it began to go down far less than the installed capacity of 7011mw as against 2108.0 mw in 2008. However, a report from PHCN has shown that, Nigeria is presently 3400mw out of 10000mw installed capacity as at 2010[11].

5. RECOMMENDATIONS

I. Government investment at any level of play in the Electricity Market should not be based on politics or quota system but strictly on integrity, competence and professionalism. A complete depoliticises and de-quotalise electricity market system to harness best result possible.
II. Encourage foreign participation based on experience, financial capacity and performance record.

III. Reduce the number of thermal generating plants locations and increase their generating capacity to avoid the complexity of gas pipeline network, reduce risk of vandal and achieve cost savings.
IV. Set up team from relevant ministries to continuously work on building sustainable electricity market in Nigeria that is favourable to the Nation's economic growth.
V. The government should also make some effort to diversify its sources of energy by investing on renewable energy which is environmental friendly and risk free to the society.

6. FUTURE RESEARCH TO BE CARRIED OUT

- Reliable and Efficient Power Supply in Nigeria
- Challenges and prospect of Power Sector in Nigeria
- Nigerian Electricity power Market
- Power Supply and the performance of Small, Medium and Large scale industries in Nigeria
- Potentials of Renewable Energy in Nigeria

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