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A Descriptive Analysis of Nigeria and United State's Energy Consumption and Economic Growth

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ABSTRACT:- Nigeria with a Gross Domestic Product (GDP) of $469.40billionin in 2018 ranked 25th globally has formulated a policy objective in 2009 of becoming one of the twenty strongest economies in the world by 2020 referred to as vision 20:2020. However, empirical evidences have found strong linkages between energy consumption and economic growth; thus, the significance of energy for Nigeria to achieve its policy objective cannot be overemphasized. However, Nigeria's per capita energy consumption in 2018 is 796 kilograms of oil equivalent; however, it is 6,902koe in United States of America (USA) the strongest economy in the world. The aim of this paper is to descriptively demonstrate that sufficient energy is needed for Nigeria's economic growth as energy arguably contributed to economic growth in USA the global leading economy. Data on per capita energy consumption and GDP on Nigeria and USA are collected and descriptively analysed using the lens of optimal resource utilisation theory. Findings indicate that sustainable energy sufficiency was vital in driving economic growth in the USA; therefore, policy makers in Nigeria must provide sufficient and sustainable energy for the country to achieve its policy goal of becoming one of the twenty strongest economies in the world.

KEY WORDS:- Economic growth, Energy Consumption, Gross Domestic Product, Policy

I. INTRODUCTION

The Cambridge English dictionary defined economic growth as denoting an increase in the economy of a country or an area represented by the value of goods and services produced in that country or area [1]). From the perspectives of economics, economic growth is the constant increase in volume of production in a country or an increase in Gross Domestic Product (GDP) being the quantitative indicator of production for a period of one year [2]. It is also regarded in limited sense as an increase in national income per capita; while in a wider sense, it depicts increase in GDP, Gross National Product (GNP) and National Income (NI); thus, national wealth. Therefore, economic growth simply means increase in the size of national economies represented by increase in the macro-economic variable of GDP per capita; the growth could be positive, zero, or negative [3]. However, economic growth is a complex, long-run phenomenon; thus, is subject to such constraints as excessive rise of population, limited resources, inadequate infrastructure, excessive government interventions, institutional and cultural problems and inefficient utilization of resources among others [3]. Despite the constraints, economic growth is obtained by an efficient use of the available resources and by increasing the production capacity of a country. The benefits of a growing economy are enormous including but not limited to redistribution of income which helps in moving people out of poverty, creation of job opportunities, enhancing human development, improvement of health and education and better transformations of societies [4 5]. However, economic growth depends on stable, efficient and active government's structures, policies and programs that will guide and support it [3]. Perhaps, it is in realisation of this, that Nigerian government formulated a policy objective designed to place the country among the twenty strongest economies in the world by the year 2020 referred to as vision 20:2020 [6 7 8].

One crucial variable which although was ignored in early economic growth analyses especially in 1950s and 1960s is energy natural resources when indeed, mankind has been using energy in all activities that leads to economic growth [9]. To portray the importance of energy, human has used various sources of energy transiting from one source to another from human muscle power, energy from animals, solar, water and air used

in early history to biomass with the discovery of fire making process [10]. The discovery of coal leads to significant replacement of the use of biomass as source of energy especially in the industrialized nations and some developing countries. Likewise, the discovery of oil and gas resulted in significant shift to these sources of energy from coal most especially in developed economies [10]. Precisely, the incorporation of oil in to steam engines played significant role in the industrial revolution that started from Great Britain in the last part of the eighteenth century spreading to other parts of the world [11]. Since then, oil and gas sources of energy have been accounting for major share of global Total Primary Energy Supply (TPES) which was 61.30% in 1973, 60% in 1983, 58.82% in 1993, 52.10% in 2003, 68.70% in 2013 and most recently 54.20% in 2017 [12 13 14]. However, exploration, production and consumption of these energy sources are causing lots of environmental effects especially carbon emissions. Oil and gas sources of energy contributed 64.40% of total emitted CO_2 in 1973, about 72% in 1983, 59.10% in 1993, 57.70% in 2003, 53.40% in 2013 and 55.10% of the total emitted 34,840 Mt of CO_2 in 2017 [12] . To overcome the negative effects of exploration, production and consumption of oil and gas sources of energy, efforts are now focusing on renewable sources of energy [15 16]. For instance, global installed capacity of renewable energy sources in 2018 is 2,356GW up from 1,135 in 2009 (IRENA 2019 [15]. These global efforts of sourcing energy from renewable sources while it is aimed at overcoming the negative effects of fossil fuels as alternative energy supply sources on one hand, on the other hand it is depicting that energy is of significance to mankind hence, cannot be done away with [9]. Indeed, there are abundant literature evidencing relationship between energy consumption and economic growth [17 18 16 19 20 21 22 23].

However, despite evidences of strong linkages between energy consumption and economic growth, Nigeria has failed to optimally utilise its energy resources to achieve economic growth when it is aiming to be one of the twenty strongest economies in the world [6]. The country is blessed with oil and gas resources having proved oil reserves of 37.50 billion barrels as at end of December 2018 placing it as the eleventh in global ranking of reserves. Likewise, it has 180.80 trillion cubic feet of proved natural gas reserves making it in the tenth position of global ranking as at the end of December 2018 [24]. Similarly, the country is blessed with enormous renewable energy resources such as hydro, biomass, solar and winds [25 26 27 28 29 30 31]. However, electricity consumption per capita in the country in 2018 is only 796koe [32 33 34]. This low consumption of electricity tied to chronic supply shortage is responsible for poverty, unemployment, social inequality and stunted manufacturing sector. Indeed, Nigeria's energy crisis is responsible for undermining its industrialization process and undermining of its economic growth [35]. Thus, stable and sustained power supply could boost economic activities that will place back Nigeria on its industrialisation path and perhaps result in economic growth and development [36 20].

On the other hand, the United States of America (USA) is also a country blessed with oil and gas resources having 61.2 billion barrels of oil making the eighth in global ranking. It also has 419.80 trillion cubic feet of gas making it the fifth in global ranking [24]. Likewise, the country is blessed with renewable energy resources such as geothermal, biomass, hydro and wind [10]. However, energy consumption per capita in the country is 6,902koe in 2018 against Nigeria's 796koe [32 33 34].Thus, it is perhaps not surprising that the country has been maintaining its status of the strongest economy in the world for decades [37]. Consequently, it could be contended that consumption of enormous amount of energy is the driver to the sustained economic growth in the USA [38 39 9]. Situating this study within studies that found linkages between energy consumption and economic growth, the aim of this study is to descriptively present evidences that energy consumption levels in Nigeria and USA influences economic growth in these countries. While inefficient utilization of energy resources in Nigeria perhaps explain the slow or lack of economic growth in Nigeria, optimal utilisation of energy resources in USA perhaps explain its economic growth. Therefore, policy makers in Nigeria may draw lessons from the energy consumption intensity of the country with strongest economy in the world. This may possibly stimulate the provision of sufficient and sustained energy to help in achieving economic growth as envisaged.

The study employed descriptive statistics to show patterns of interactions of figures on per capita energy consumption and per capita GDP rather than the dominant regression analyses in previous studies. A comparison is drawn between a developed economy, the USA and an emerging and developing economy, Nigeria for policy makers in Nigeria to draw lessons from the interactions of per capita energy consumption and per capita GDP. This is section one of the paper, literature review is section two, the data utilized in the study is presented as section three. Section four is the methodology of the study, results of the study and discussions are presented as section five while conclusions and policy implications of the study are treated as section six.

II. LITERATURE REVIEW

This section presents prior literature related to the study from the perspectives of developed countries such as USA and emerging and developing countries like Nigeria. Reviewed literature helps in identifying gaps as well as aid in discussing the results obtained in this study. The study by [23] on the relationship between energy and Gross National Product (GNP) is contended as one of the pioneer works that tried to find out the

causal relationship between energy consumption and economic growth. That is, one; energy consumption results to economic growth, two; economic growth results in energy consumption and bidirectional of energy consumption to economic growth and economic growth to energy consumption [40 20]. This study is premised on the notion of energy consumption resulting to economic growth.

2.1 Studies on Energy Consumption and Economic Growth in Developed Countries

The International Monetary Fund (IMF) 2019 World Economic Outlook classified countries into two broad categories of advanced economies and emerging and developing economies. The advanced economies are composed of thirty nine countries characterised by high GDP of 40.80% of global total, 63% of global export of goods and services while accounting for only 14% of global population. There are one hundred and fifty five countries under the Emerging and developing economies category sharing 59.20% of global GDP, 37% of global export of goods and services while having 85.70% of global total population [41]. The dominance of the advanced economies on GDP and export of goods and services could be linked to consumption of 343,793KWh almost 51% of electricity from global total consumption of 676,362KWh in 2017 [32]; therefore, review of literature findings in these economies is of significance.

Using an asymmetric threshold cointegration approach and monthly energy consumption data in the United States of America January 1991 to May 2016; Granger causality tests support the hypothesis that energy consumption has strong causal effect on economic growth [42]. Another study examines the linkages between energy consumption and economic growth in top ten energy-consuming countries of China, the USA, Russia, India, Japan, Canada, Germany, Brazil, France and South Korea using the quantile-on-quantile (QQ) approach. Results from the study found strong relationship between energy consumption and economic growth in USA, Japan, Germany and France [43]. A new Granger non-causality testing procedure was applied to re-investigate the relationship between energy consumption and income in 11 major industrialized countries of United Kingdom, Germany, Sweden, United States, Canada, Belgium, the Netherlands, Switzerland, France, Italy and Japan. Results revealed that energy consumption causes growth of GDP in Canada, Belgium, the Netherlands and Switzerland [44].

Employing electricity energy consumption data of the USA 1949-2014, it is found that energy consumption do not cause economic growth. The finding is attributed to significant shift in the economy from manufacturing to services which reduces energy intensity [45]. Similarly, the existence of causal relationship between Energy consumption and Economic growth was investigated in the United Kingdom 1987 to 2007 applying the Johansen Cointegration and standard Granger causality tests. Results from the study indicated no cointegration relationship between the variables of Energy consumption and economic growth [46]. Integrating neoclassical growth, endogenous growth, and ecological-economics viewpoints of how energy consumption affects economic growth in Australia using data 1970 to 2011 and employing bound testing cointegration approach along with multivariate Granger causality test, it is found that although energy consumption and Australian economic growth are positively related, they are statistically insignificant either in the short run or the long run [47]. There are also empirical findings on the causal relationship between energy consumption and economic growth in emerging and developing economies to which Nigeria belong.

2.1 Energy consumption and Economic Growth in Emerging and Developing Countries

In an effort to establish the causal relationship amongst energy consumption, net fixed capital stocks and economic growth in India, Engle-Granger co-integration and Johanson Juselius multivariate methods were employed to analyse time series data of energy consumption, net fixed capital stocks and GDP 1970-2002. Empirical results found causality between energy consumption and economic growth [48]. Similarly, data on China's real GDP 1978-2016 was subjected to Granger causality test to determine the causal relationship between energy consumption and economic growth. Results from the study indicated strong positive relationship between China's energy consumption and economic growth [49]. Likewise, a study that evaluated the causal relationship between electricity consumption and economic growth in Nigeria for the period of 1980 to 2014 was undertaken. The Johansen co-integration and VAR-based techniques of analyses were employed in the study; obtained result reveals causal relationship between energy consumption and economic growth [50].
Utilising annual data on energy consumption and GDP per capita in Ghana 1980-2013 and subjecting the data to co-integrated VAR framework of analysis in order to examine the nexus between energy consumption and Economic Growth, it is found that there is no long run relationship between electricity consumption and economic growth [51]. Similarly, annual time series data on Nigerian economy from 1980 to 2011 were subjected to Johansen and Juselius cointegration Vector Error Correction (VEC) and generalized impulse response approaches of analyses to find out the causal relationship between energy consumption and economic growth in Nigeria. Results indicate that there is no causal relationship between energy consumption and economic growth [20]. Similarly, an investigation was carried out to determine causality between energy consumption and economic growth in Turkey employing Hsiao's version of Granger causality method

1950-2000. The main conclusion of the study is that there is no evidence of causality between energy consumption and economic growth in Turkey [52].Thus far; results from literature have found evidences that energy consumption causes economic growth whereas others have found that energy consumption do not causes economic growth.

The essence of the literature review section is to identify types of data, time period of data, methods of data analyses in previous studies for the purpose of identifying gaps which this study will attempt to fill. However, the approach of this study is on the strong support of findings that indicated causal relationships between energy consumption and economic growth. This study rather than focusing on conducting regression analyses, it utilises data on per capita energy consumption and per capita GDP at constant prices to descriptively show the relationships between energy consumption and economic growth. In this way, the study show the patterns of the relationships, perhaps policy makers in Nigeria could learn lessons from the patterns of the relationships in the USA as the strongest economy in the world. This may perhaps motivate policy makers in Nigeria to provide sufficient and stable energy in the country to achieve Nigeria's quest of becoming one of the twenty strongest economies in the world. Subsequent section discusses the data utilised in conducting the study.

III. DATA AND METHODS

Data

Research data is obtained from two broad sources of primary and secondary data which could be obtained through conducting interviews, making observations, questionnaire surveys, and content analysis of documents among others [53 54]. Thus, this section specifies and justifies the type of data collected in the study which depends on the method considered most appropriate and suitable in achieving the aim of the study [55]. This study aims to analyse the patterns of energy consumption and economic growth in the USA as compared with Nigeria which is aiming to be among the twenty strongest economies in the world. Therefore, the study collected data on per capita energy consumption and per capita GDP in USA and Nigeria from World Bank data base 1999-2014 for Nigeria and 1999-2015 for USA respectively. For the years 2015, 2016, 2017 and 2018 data is obtained from Enerdata which was given in Million tons of oil equivalent (Mtoe). Therefore, the data was converted to per capita bases using population data on Nigeria and USA from World Bank data base [34 56]. Thus, data for this study is mainly sourced from secondary source. This study descriptively analyse Nigerian government policy 20:2020 looking at lack of adequate energy supply as major hindrance to achieving the policy. In this context previous literature that evaluated policies normally look at equal number of years before and after implementation of policies [57]. Nigeria implemented the policy objective of 20:2020 in 2009; therefore, the study is covering twenty years 1999-2018, ten years each before (1999-2008) and after the policy (2009-2018).

Methods

It is of significance when conducting research that the methodology and methods utilised in the study are clearly stated. While methodology is seen as the approach utilized in the process of conducting research which involves body of methods; the techniques used in collecting and/or analysing data for the research constitute methods [58]. However, identifying and choosing philosophical assumptions that will guide any study is of significance as the assumptions have impact on how the social world is investigated [58 59]. Positivism and intrepretivism research paradigms have been identified as the two ends of the continuums of research paradigms along which others exist. While positivism has its roots in an objective philosophy known as realism; interpretivism paradigm has its roots in idealism which is subjective [58]. Therefore, the perspectives of chosen philosophical assumptions vary with chosen research paradigm.

Three philosophical assumptions of ontology, epistemology and methodology are identified [59] although axiological and rhetorical assumptions are added [58]. Ontology is about the nature of reality [60]; hence, if reality is seen as objective, then the research is ontologically objective following positivism research paradigm. However, it is considered subjective; if the research is ontologically subjective following interpretivism paradigm [58]. Epistemology is dealing with what constitute valid knowledge; in positivism, only observable and measurable phenomena constitute valid knowledge; but, interpretivistism is encouraging participation of the researcher in the inquiry [58 61]. Methodological assumption is simply concerned with actual processes involved in conducting research [62]. This study is ontologically subjective; data on energy consumption and economic growth are subjected to descriptive analyses; thus, the epistemology of the study is participatory while its strategy is that of drawing reasoning from particular to general [63]. However, studies of this nature require a blueprint, guide or map to guide the conduct of the study referred to as theoretical framework [64 65].

Theoretical Framework of the Study

Theoretical framework is the blueprint or guide for a research [64]; while [66] sees it as the specific theory or theories about aspects of human endeavour that can be useful to the study of events. Theoretical framework assists in situating and contextualizing formal theories into studies as guides [67]; thereby making research findings more meaningful and generalizable [68]; hence, identifying and linking this study with a chosen theoretical framework is of significance. Activities in an economic system are viewed by the production and consumption of certain units which are normally constrained by possibilities of the production and availability of physical resources. An optimal utilization of resources is said to occur if satisfaction is attained with small amount of physical resources [69]. The Cambridge English Dictionary defined optimal as the best or most effective possible in a particular situation [1].

Drawing from above and in consideration of empirical evidences that found strong linkage between energy consumption and economic growth [42 43 44 48 49 50], Nigeria should have optimally utilize its abundant energy resources to derive economic growth and satisfy its quest of becoming one of the strongest economies in the world. Similarly, in consistence with the Cambridge definition of optimal, the best or most effective way for Nigeria to achieve economic growth and become one of the strongest economies in the world is to provide sufficient energy from its abundant energy resources. Thus, it could be contended that while USA succeeded in optimally utilizing energy resources internally and externally to derive the growth of its economy as the strongest economy in the world, Nigeria has failed to utilise its energy resources optimally to derive economic growth. Consequently, the lens of optimal resource utilisation theory is employed to underpin this study [70 71 72]; next section is results and discussions of the results.

IV. RESULTS

This section is devoted to organising, summarizing and presenting descriptive and analytical results of collected data on per capita energy consumption and per capita GDP in Nigeria and USA 1999-2018. However, the period is divided into two ten years pre-formulation of policy objective by Nigerian of becoming one of the twenty strongest economies in the world 1999-2008 and ten years post the policy 2009-2018. Findings from the study are interpreted and discussed by linking the aim of the study with literature, theory and practice [73 74]. Descriptive statistics aid in presenting large volume of research data numerically or graphically; while numeric descriptive statistics enables presentation of data by measures of central tendencies and measures of dispersion, graphical data presentations enable identification of patterns in the data [75]. This study employed the graphical descriptive statistics in order to show patterns of per capita energy consumption and per capita GDP of Nigeria and USA 1999-2018. Figures 5.1 indicate energy consumption per capita and GDP per capita in Nigeria 1999–2008.

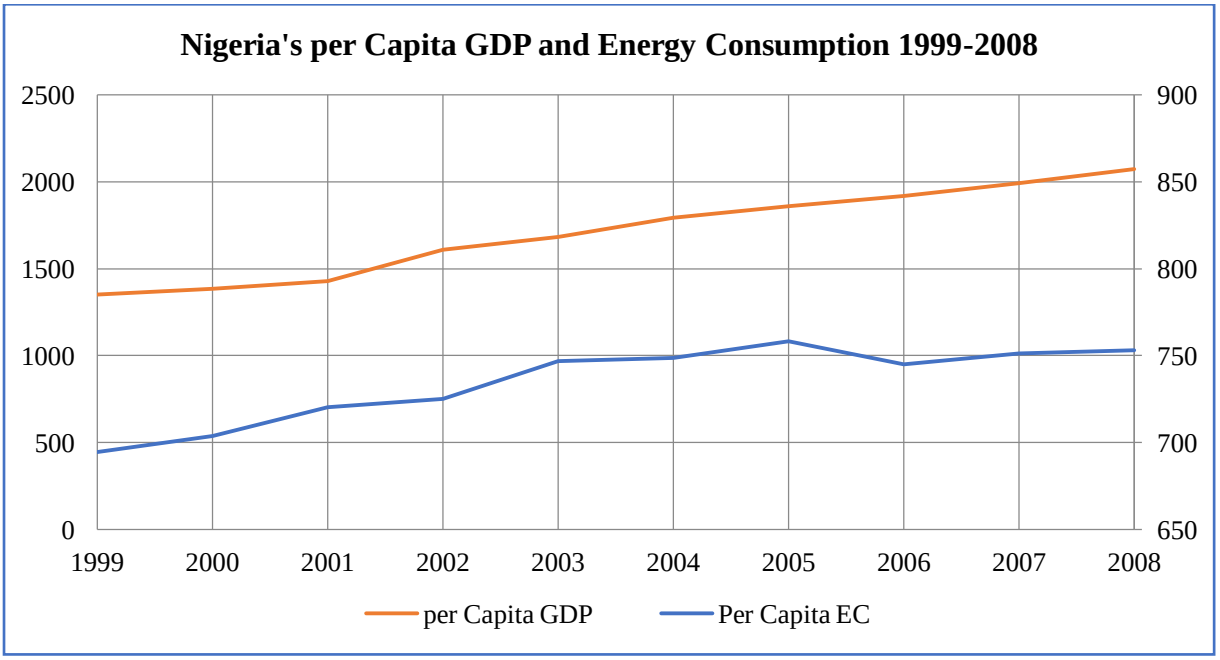

FIGURE 5.1: Nigeria's per Capita GDP (US dollars) and per Capita Energy Consumption (koe) 1999-2008

Descriptive analyses of per capita energy consumption in Figure 5.1 for Nigeria before the policy objective of vision 20:2020 are set forth. The values on the right hand side of the Figure represent per capita energy consumption expressed in kilograms of oil equivalent (koe) while values on the left are per capita GDP in US dollars. In 1999 per capita energy consumption was 695koe and the per capita GDP for the year was $1,351. Energy consumption per capita in 2000 increased to 704koe and per capita GDP also increased to $1,384. Similarly, per capita energy consumption increased to 720koe in 2001 which is accompanied by corresponding increase in per capita GDP from $1,384 to $1,429. In 2002, per capita energy consumption increased to 725koe from 720koe in 2001 with corresponding increase in per capita GDP to $1,607 from $1,429 in 2001. Likewise per capita energy consumption saw an increase in 2003 from 725koe in 2001 to 747koe and this perhaps derives per capita GDP to $1,682 from $1,607. Increasing per capita energy consumption also occurred in 2004 to 749koe from 747koe in 2003 and the GDP also increased to $1,791 from $1,682 in 2003. Energy consumption per capita in 2005 increase to 758koe from 749koe in 2004 and GDP per capita also increased to $1,858 from $1,791 in 2004. However, per capita energy consumption decreased to 745koe in 2006 from 758koe in 2005; conversely, GDP per capita increased to $1,920 from $1,858 in 2005. The decrease in per capita energy consumption witnessed in 2006 was reversed to an increase in 2007 to 751koe from 745koe. This went along with increase in per capita GDP from $1,920 in 2006 to $1,993. The increase in per capita energy consumption is sustained in 2008 increasing to 753koe from 751koe in 2007 accompanied with increase in per capita GDP to $2,072 from $1,993 in 2007. Figure 5.2 is Nigeria's per capita energy consumption and per capita GDP 2009-2018.

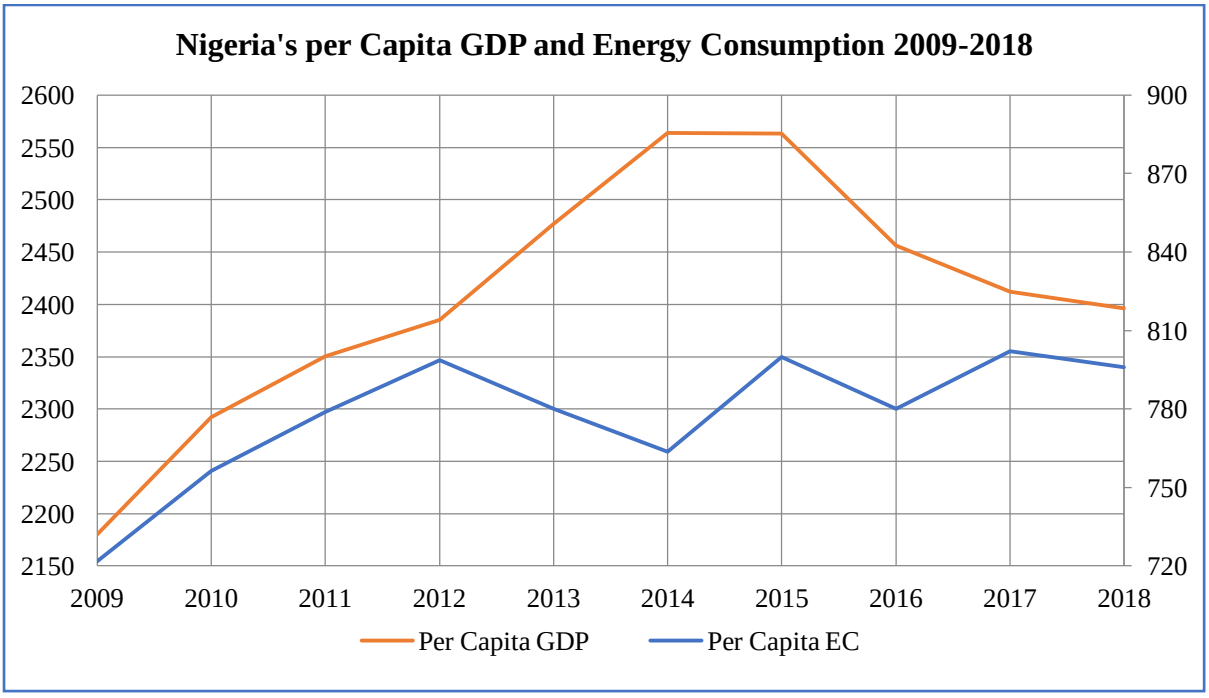

FIGURE 5.2: Nigeria's per Capita GDP (US dollars) and per Capita Energy Consumption (koe) 2009-2018

From Figure 5.2, per capita energy consumption in 2009 is 722koe indicating a decrease of 31koe from 2008; however, per capita GDP in 2009 increased to $2,180 which is higher than that of 2008 by $108. Energy consumption per capita in 2010 increased to 756koe higher than 2009 by 34koe and the corresponding per capita GDP also increased to $2,292 higher by $112 against 2009. In 2011, the per capita energy consumed in Nigeria is 779koe indicating an increase of 23koe over 2010 consumption and this perhaps derives per capita GDP to $2,350, an increase of $58 over 2010. Per Capita energy consumption is 799koe in 2012 depicting an increase of 20koe over 2011 consumption and this is accompanied by an increase in per capita GDP by $35 to $2,385. In 2013, per capita energy consumption is 780koe showing a decrease in consumption by 19koe compared to 2012; conversely corresponding per capita GDP for the year increased to $2,477 showing an increase of $92 against 2012. Energy consumption per capita showed further decrease in 2014 to 764koe against 780koe in 2013 while per capita GDP corresponding to this period rises to $2,564 from $2,477 in 2013. The per capita energy consumed in 2015 is 800koe showing an increase of 36koe compared to 2014 while the corresponding per capita GDP for the year slightly decreased to $2,563 against $2,564 in 2014.

In 2016, per capita energy consumption is 780koe showing a decrease of 20koe compared to the previous year and the per capita GDP for the year also decreased to $2,456 against previous year per capita GDP of $2,563. Per Capita energy consumption in 2017 is 802koe indicating an increase of 22koe over consumption in 2017; however, corresponding per capita GDP is indicating a decrease to $2,412 from $2,456 in 2016. In 2018, the per capita energy consumption is 796koe indicating decrease of 6koe against 2017 and this is accompanied by decreasing per capita GDP to $2,396 from $2,412 in 2017.Table 5.1 is depicting the net effects of fluctuating interactions in per capita energy consumption and per capita GDP in Nigeria 1999-2018 which took four dimensions.

TABLE 5.1: INTERACTIONS OF PER CAPITA ENERGY CONSUMPTION AND PER CAPITA GDP IN NIGERIA 1999-2018

Results showing increase in per Capita Energy Consumption and increase in per Capita GDP in Nigeria 1999-2018			
S/N	**Years**	**Increase in per capita energy consumption (koe)**	**Increase in per capita GDP ($US)**
1	1999	Initial per capita energy consumption 695koe	Initial per capita GDP 1,351
2	2000	9	33
3	2001	16	45
4	2002	5	178
5	2003	22	75
6	2004	2	109
7	2005	9	67
8	2007	6	73
9	2008	2	79
10	2010	34	112
11	2011	23	58
12	2012	20	35
Total		**148**	**864**
Results showing increase in per Capita Energy Consumption and decrease in per Capita GDP in Nigeria 1999-2018			
		Increase in per capita energy consumption (koe)	Decrease in per capita GDP ($US)
1	2015	36	(1)
Total		**36**	**(1)**
Results showing decrease in per Capita Energy Consumption and increase in per Capita GDP in Nigeria 1999-2018			
S/N	Years	Decrease in per Capita Energy Consumption	Increase in per Capita GDP (US dollars
1	2006	(13)	62
2	2009	(31)	108
3	2013	(19)	92
4	2014	(16)	87
5	2016	(20)	3
Total		**(99)**	**352**
Results showing decrease in per Capita Energy Consumption and decrease in per Capita GDP in Nigeria 1999-2018			
S/N	Years	Decrease in per Capita Energy Consumption	Decrease in per Capita GDP (US dollars
1	2017	(22)	(44)
2	2018	(6)	(16)
Total		**(28)**	**(60)**

From Table 5.1, increases in per capita energy consumption are accompanied by increases in per capita GDP in 11 years out of the 20 years covered by the study which is 57.89% of the total number of studied years after

removing 1999 as the initial year. Per capita energy consumption increases in one year representing 5.30%% of studied period which is however accompanied by decreased per capita GDP. In five years of the studied period which is 26.31% of the period, per capita energy consumption decreases which are conversely accompanied with increase in per capita GDP. In two years which means 10.50% of the studied years, there are decreases in both per capita energy consumption and per capita GDP and these are the four dimensions of the results on Nigeria. Figure 5.3 is per capita energy consumption and GDP for USA 1999-2018.

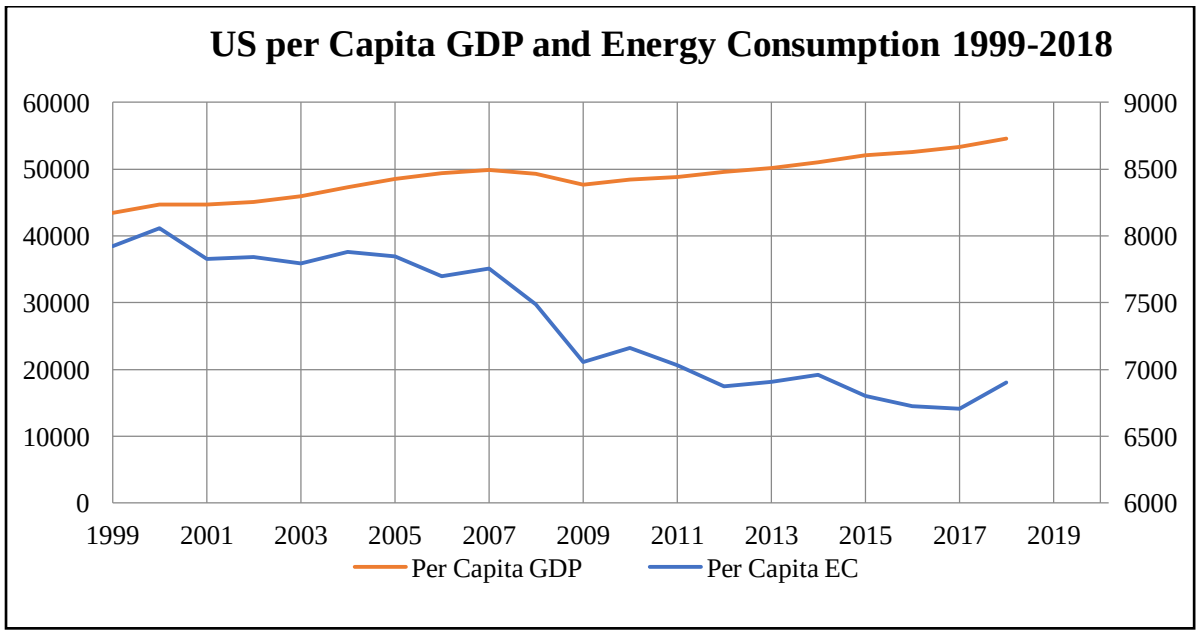

FIGURE 5.3: US per Capita GDP (US dollars) and per Capita Energy Consumption (koe) 1999-2018

Per capita energy consumption in the USA in 1999 is 7,923koe while the corresponding per capita GDP is $43,435. However, per capita energy consumption increased to 8,057koe in the year 2000 and this is accompanied by increase in per capita GDP to $44,727. In 2001, per capita energy consumption reduced to 7,828koe which however is accompanied by a slight increase in per capita GDP to $44,729. Per capita energy consumption slightly increased to 7,843koe in 2002 with a corresponding increase in per capita GDP to $45,087 in the year. Energy consumption per capita slide down to 7,794koe in 2003 but per capita GDP for the year increased to $45,981. In 2004, per capita energy consumption increased to 7,882koe which is accompanied by increase in per capita GDP to $47,288. Per capita energy consumption in 2005 further decreased to 7,846koe with an accompanying increase in per capita GDP of $48,500. Energy consumption per capita in 2006 decreased to 7,698koe; however, per capita GDP increased to $49,406. In 2007, per capita energy consumption increased to 7,758koe while per capita GDP for the year increased to $49,856. The per capita energy consumption in 2008 decreased to 7,488koe and corresponding per GDP also decreased to $49,319.

Per capita energy consumption continued decreasing in 2009 to 7,057koe and the corresponding per capita GDP also decreased to $47,649. However, in 2010 per capita energy consumption increased to 7,161koe and per capita GDP also increased to $48,467. In 2011, the per capita energy consumption slide down to 7,030koe but per capita GDP increased to $48,862. The per capita energy consumption in 2012 is 6,872 indicating further decrease compared to 2011; however, per capita GDP further increased to $49,596. In 2013, the per capita energy consumption increased slightly to 6,906koe which is accompanied with a corresponding increase in per capita GDP to $50,161. Per capita energy consumption further increased to 6,961koe in 2014 and the corresponding per capita GDP for the year increased to $51,015. Thereafter, per capita energy consumption decreased to 6,804koe in 2015 which is however having an increased per capita GDP of $52,099 in the year. The decreasing pattern of per capita energy consumption is sustained in 2016 to 6,726koe but with increased per capita GDP to $52,534. The per capita energy consumption further decreased to 6,705 in 2017 while the per capita GDP increased to $53,356 in the year. Finally, in 2018 the per capita energy consumption slightly increased to 6,902koe and the corresponding per capita GDP also increased to $54,579. Table 5.2 summarises the above interactions between per capita energy consumption and per capita GDP in the USA 1999-2018.

TABLE 5.2: INTERACTIONS BETWEEN PER CAPITA ENERGY CONSUMPTION AND PER CAPITA GDP IN USA 1999-2018.

Results showing increase in per Capita Energy Consumption and increase in per Capita GDP in USA 1999-2018			
S/N	**Years**	**Increase in per capita energy consumption (koe)**	**Increase in per capita GDP ($US)**
1	1999	Initial per capita energy consumption 7,923koe	Initial per capita GDP 43,435
2	2000	134	1,292
3	2002	15	359
4	2004	87	1,307
5	2007	61	451
6	2010	105	818
7	2013	34	565
8	2014	55	854
9	2018	197	1,223
Total		**688**	**6,869**
Results showing decrease in per Capita Energy Consumption and increase in per Capita GDP in USA 1999-2018			
S/N	Years	Decrease in per Capita Energy Consumption	Increase in per Capita GDP (US dollars
1	2001	(229)	2
2	2003	(49)	893
3	2005	(35)	1,212
4	2006	(149)	906
5	2011	(131)	396
6	2012	(158)	734
7	2015	(157)	1,084
8	2016	(78)	435
9	2017	(21)	822
Total		**(1,007)**	**6,484**
Results showing decrease in per Capita Energy Consumption and decrease in per Capita GDP in Nigeria 1999-2018			
1	2008	(270)	(537)
2	2009	(431)	(1,671)
Total		**(701)**	**(2,208)**

From Table 5.2, increases in per capita energy consumption accompanied by increases in per capita GDP is in 8 years out of the 20 years covered by the study which is 42.11% of the total number of studied years on removing 1999. Per capita energy consumption decreases in 9 years out of the studied years translating to 47.37% of the total period; however, per capita GDP in these 9 years in contrast, is on the increasing side. Per capita energy consumption decreases in two years which is 10.52% and these decreases are accompanied by decreases in per capita GDP.

V. DISCUSSION AND CONCLUSIONS

Results in Figure 5.1 and 5.2 and Table 5.1 on Nigeria indicates that 11 years which is 57.89% of the 20 years studied, revealed increasing per capita energy consumption and increasing per capita GDP. Therefore, it could be contended that the results is consistent with previous studies that found causal relationship between energy consumption and economic growth [42 47 49 69 70 71]. However, it is inconsistent with previous studies that found no causal relationships between energy consumption and economic growth [20 45 46 47 51 52]. Conversely, there was significant increase in per capita energy consumption of 800koe in 2015 an increment of 36koe over 2014, while per capita GDP decreased by $1 against 2014. This decrease is attributed to shrinking activities in the service sector, persistent fuel scarcity and withdrawal of capital by foreign investors in apprehension of the 2015 general elections [75].

In the years 2006, 2009, 2013, 2014 and 2016 there were decreases in per capita energy consumption of 99koe which are however accompanied with increases in per capita GDP amounting to $352. This translates to an increase of $3.55 per capita GDP for every decrease in the consumption of 1koe of per capita energy consumption. Increase in per capita GDP in 2006 is attributed to increased economic activities in the communications and services sub-sectors [76]. Growth in per capita GDP recorded in 2009 is attributed to significant growth in wholesale and retail activities despite the global financial crisis in the preceding year [77 78]. In 2013, economic growth in Nigeria measured by GDP was mainly accounted by growth in the services sub-sector which accounted for 58.10% of the total GDP growth in the year [79]. Similarly, increase in per capita GDP recorded in 2014 despite decrease in per capita energy consumption is attributed to increased activities in the services sub-sector followed by agriculture. Improved per capita GDP recorded in 2016 with decreased per capita energy consumption is again attributed to information and communications, real estate, professional, finance and insurance, public administration, and education components of the service sub-sector. Therefore, increased in per capita GDP recorded in the years that per capita energy consumption decreased were accounted by increased activities in the services sub-sector of the Nigeria economy and agriculture in 2014. The service sub-sector is acknowledged not an energy intensive sector [80 81] while the Nigerian agricultural sector is heavily dependent on human labour rather than mechanised methods of farming; hence, it is not energy intensive [82]. These perhaps explain results of decreasing per capita energy consumption with corresponding increases in per capita GDP in these years. In 2017 and 2018, results indicated decreasing per capita energy consumption which is accompanied by decreasing per capita GDP. Consequently, results in these two years could be argued as consistent with previous results that found causal relationship between energy consumption and economic growth [43 49 71] as it is apparent that it was decrease in energy consumption that invariably resulted in decrease in per capita GDP.

Perhaps other interesting explanations of obtained results are that total increment in per capita energy consumption in the years that increase in per capita energy consumption and accompanied with increase in per capita GDP is 148koe while increase in per capita GDP is $864. Dividing the increase in per capita GDP with increase in per capita energy consumption, it translates to an increase of $5.83 for every increase in consuming 1koe of energy. In 2015 which showed increased per capita energy consumption of 36koe and a corresponding decrease in per capita income by $1, it means that for every 1koe of energy consumed, per capita GDP decreases by$0.03 cents. For the five years that per capita energy consumption decreases while per capita GDP increases, the total decrease in energy consumption is 99koe while total decrease in GDP is $352. Therefore, dividing total increase in per capita GDP with total decrease in per capita energy consumption, it translates to increase of $3.56 per capita GDP for every decrease in consuming 1koe of energy. For the two years that decrease in energy consumption is accompanied with decrease in GDP, total decrease in energy consumed is 28koe while total decrease in GDP is $60. This means that for every 1koe decrease in energy consumption there is a corresponding decrease in per capita GDP of $2.14.

From above, incremental volume of per capita energy consumption and per capita GDP are 1koe to $5.83; then increase and decrease of 1koe to $0.03cents; followed by decrease of 1koe to increase of $3.56 and finally decrease of 1koe to decrease of $2.14. It is perhaps certain that the most favourable scenario for economic growth in Nigeria is to increase energy consumption as every 1koe will translate to increase in per capita GDP by $5.83. If this is sustained the economy will have more potentials of growing than in all the other scenarios. Employing the lens of optimal resource utilization theory; perhaps, Nigeria has failed to optimally utilize energy resource as a significant component of economic growth to ensure the growth of its economy. Throughout studied years the highest per capita energy consumption was 802koe when the least for USA is 6,705koe while the highest per capita GDP is $2,564 when the least for USA is $43,435. From the perspectives of USA, total increase in per capita energy consumption in the 8 years that also showed increase in per capita GDP are 688koe and $6,869 respectively. This means that for every increase in per capita energy consumption of 1koe, the corresponding increase in per capita GDP is $9.98. Total decrease in per capita energy consumption in nine years out of the studied period is 1,007koe while the total increases in the per capita GDP are $6,484. This is implying that for every decrease in per capita energy consumption by 1koe, per capita GDP increases by $6.43. Per capita energy consumption decreases in 2008 and 2009 which is accompanied by decrease in per capita GDP. Total decreases in per capita energy consumption in these two years are 701koe while the corresponding decreases in per capita GDP are $2,208. This means that decrease in 1koe results in decrease in per capita GDP of $3.14.

Thus, the US economy has shown significant increase in per capita GDP of $6.43 when per capita energy consumption decreases by 1koe; perhaps consistent with structural changes in the US economy and energy efficiency [83 84 85]. However, results that reveals increase in energy consumption by 1koe translating to increase in per capita GDP by $9.98 is more significant on economic growth. Consequently, it could be contended that energy consumption is causing economic growth in USA consistent with [42 44 43 49 50 69 70 71]. Utilising the lens of optimal resource utilization theory, it could be argued that USA has optimally utilize

energy resources to drive economic growth with per capita energy consumption of not less than 6,705koe and per capita GDP of not less $43,435 in all studied years. The result is however inconsistent with previous studies that found no causal relationships between energy consumption and economic growth [20 45 46 47 51 52]. The influence of per capita energy consumption on per capita GDP is further confirmed by results obtained in 2008 and 2009 as decreases in per capita energy consumption resulted in decreases in per capita GDP. The results obtained from USA on the overall could be contended as indicating that USA has either through improved technology became fuel efficient or production of goods has been shifted to less energy-intensive sectors which has decreased energy demand with accompanying increase in economic growth. The result is perhaps consistent with the view that structural economic shifts, saturation effects and efficiency gains have resulted in peak of energy consumption in OECD countries [84].

From results showing increasing per capita energy consumption and per capita GDP in the ratio of 1koe to $5.83 in Nigeria and 1koe to $9.98 in USA respectively; it could be concluded that the figures have confirmed energy consumption drives per capita economic growth in Nigeria and USA. Similarly, decrease in per capita energy consumption and per capita GDP in the ratio of 1koe and $2.14 and $3.14 in Nigeria and USA respectively further confirms that per capita energy consumption influences per capita GDP. The policy implications of obtained results are that; one, policy makers in Nigeria must provide sufficient and sustained energy to drive economic growth. This is confirmed by obtained results evidencing the influence of energy consumption on economic growth in USA, the leading economy of the world. Two, Nigerian policy makers should also strive to after achieving energy supply sufficiency ensures energy efficiency which will still sustain economic growth as revealed by results from USA. Three, for the US policy makers, results have confirmed attainment of energy supply sufficiency and efficiency in driving economic growth. However, policy makers should carefully study the sustainability of decreasing energy consumption and economic growth to ascertain implications arising from this scenario.

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