Effect of Energy Utilization on Economic Growth in Nigeria

G.O. Idowu, O.O. Ajide, O.O. Oluwole, J.E. Elusakin and A. Alabi
Department of Mechanical Engineering, University of Ibadan, Nigeria

ABSTRACT

Energy plays an important role in economic development, and being the mainstay of any economy, it plays a vital role in shaping and/or transforming the economic destiny of such a country. Different studies have attempted to test, for many countries, the causal relationship between energy and economic growth using both theoretical and empirical methods. This paper therefore analyses the relationship between energy consumption and economic growth in Nigeria, based on the review of existing literature of other countries, and the few existing ones on Nigeria. It is evident from the review that there is a causality running from energy consumption to economic growth. It also reveals that the positive relationship between electricity and economic growth has been justified by many authors and economists as being consistent. Based on this review, it could be concluded that the demand for energy leads to economic growth. Therefore, the energy policy regarding electricity consumption in Nigeria should be meticulously implemented in such a way that it will further boost its impact on economic growth in no small measures.

GLOSSARY

Causality: (also referred to as **causation**) is the relationship between an event (the *cause*) and a second event (the effect), where the second event is understood as a consequence of the first. In common usage, **causality** is also the relationship between a set of factors (causes) and a phenomenon (the effect). Anything that affects an effect is a factor of that effect. A direct factor is a factor that affects an effect directly, that is, without any intervening factors. The connection between a cause(s) and an effect in this way can also be referred to as a *causal nexus*.

IEA: International Energy Agency

GDP: Gross Domestic Product

PPP: Purchasing Power Parity

GDP per unit of energy use is the PPP GDP per kilogram of oil equivalent of energy use.

PPP GDP (or GDP, PPP): is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.

GDP growth (annual %): at market prices based on constant local currency. Aggregates are based on constant 2000 U.S. dollars.

GDP per capita is gross domestic product divided by midyear population.

ECM: Error Correction Model

LDCs: Less Developed Countries

EPC: Electric power consumption. It measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants.

Diminishing Returns: In economics, is the decrease in the marginal (per-unit) output of a production process as the amount of a single factor of production is increased, while the amounts of all other factors of production stay constant.

1. INTRODUCTION

According to a release by the International Energy Agency in 2009, global energy demand has tended to rise broadly in line with GDP growth over the past decades and will continue to accelerate. The causal relationship between economic growth and energy in a country represents a commonly studied topic in energy economics literature, yet the direction of this relationship still remains controversial. That is, whether economic growth leads to energy consumption or that energy consumption is the engine of economic growth is still a question for debate. But either way, the direction of the causal relationship has significant policy implications, and this paper aimed at examining this relationship. A relationship that has received significant attention in recent times because of the persistent increase in the awareness of global warming and climate change. Empirically it has been tried to find the direction of causality between energy consumption and economic activities for the developing as well as for the developed countries; however, results are mixed. In the recent papers, studies have dealt with different aspects of energy and growth issues using both theoretical and empirical evidence; for example: Toman and Jemelkova (2003) claimed that economic development has an impact on energy use. In contrast to the above view, Stern and Cleveland (2004) view energy as an essential factor of production and thus suggested that energy is necessary for growth. Ghosh (2002) found no co-integration and argued that there is unidirectional Granger causality from economic growth to electricity consumption using annual data covering the time span 1950–1997 in India. Oh and Lee (2004) found causal relationship between energy consumption and economic growth respectively in Korea from 1970 to 1999 using year data by co-integration & ECM. Lee (2005) investigated the causality between energy consumption and economic growth for 18 developing countries by using Panel Co-integration and ECM, and found that energy-GDP causality exist from 1975 to 2001. In light of all this reports, a similar study would be beneficial in the case of Nigeria to design an economic policy framework for the energy and other sectors. Like other developing countries, Nigeria is

also an energy intensive growing economy, but on the downside, she still faces energy constraints from both the supply side and demand management policies. However, from a policy point of view, it is essential to determine the causal relationship between energy consumption and general economic activities. In doing so, the purpose of this paper is to add to the debate by examining the direction of causality between energy and economic growth in Nigeria by assessing how they respond to variable changes. The direction of causality between energy consumption and economic growth has significant implications. Ozturk and Acaravci (2010) classified this direction based on four important hypotheses. The first is called 'conservation hypotheses'. This hypothesis argues that economic growth causes energy consumption. A finding in favour of this causality direction may imply that a country is not dependent on energy for its economic growth. Thus, energy conservation policies may be implemented with no adverse effect on growth. The second hypothesis is known as 'growth hypothesis' and it argues that energy consumption causes economic growth. This implies that economic growth is dependent on energy consumption and hence energy is a stimulus to growth. This means that a shortage of energy may negatively affect economic growth or may cause poor economic performance, leading to a fall in income. The third hypothesis is referred to as 'feedback hypotheses', which implies that both energy consumption and economic growth cause each other. Finally, the 'neutrality hypothesis' implies that there is no causality between energy consumption and economic growth.

1.1 Presentation of Theories

Given the global environmental implications of energy use and the need for energy conservation policies, a number of studies have investigated causality between energy consumption and economic growth during the past few decades. The majority of these empirical studies examine energy-GDP causality based on time series approach (survey of Chontanawat et al., 2006 and 2008).

Part of this paper deals with a review of such existing literatures on the causal relationship between energy consumption and economic growth. It also covers the review of existing theories and empirical findings.

1.2 Empirical Literature

Traditionally, to test for the causal relationship between the two variables; namely energy consumption and economic growth, several test methods have been employed in literatures. Studies on the relationships between energy consumption and economic growth can be traced back to Kraft and Kraft (1978) with the application of a standard Granger causality test. Since then, there has been a vast body of literature testing for the existence and direction of causality between the two variables in either a bivariate or a multivariate context. However, the empirical evidence is ambiguous and the direction of causation of this relationship

remains controversial, that is whether energy consumption causes economic growth or whether energy use is determined by the level of output is yet to be fully determined. This is because previous empirical studies found different results for different countries as well as for different time periods within the same country, thereby leading to no definite conclusion. Several studies have since been conducted on the subject, with some studies confirming or contradicting Kraft-Kraft's conclusion. Some of the other test methods used in literatures include Hsiao's granger causality test, Co-integration method, Vector error-correction modeling technique, Akaike's final prediction error (FPE), Augmented Dickey-Fuller (ADF) test.

2. THEORETICAL FRAMEWORK

Empirical analyses of the relationship issue are few in number and varied in their results. On the whole it seems that capital and energy act more as substitutes in the long-run and more as complements in the short run, and that they may be gross substitutes but net complements (Apostolakis, 1990). It has been tried to find the direction of causality between energy consumption and economic activities for the developing countries, but the investigation about African countries is almost wholly based on the bivariate causality model with energy consumption used as the only factor input. With the omission of the clear differences among countries in terms of structural and economic policy characters, the diversity of findings obtained depend upon the adopted variables and, above all, from the methodological approach used to test causality. Initially the causal relationship was checked by using the standard Granger (1969) test and the Sims' (1972) approach. These two methodologies suppose that data series are stationary. As pointed out by Granger (1986), (1988), these tests do not permit to find any long-run information between the variables; it is only able to capture the short-run relationships. For this reason, the empirical findings of causal linkages based on these tests are often inconsistent.

3. DISCUSSION OF REVIEW FACTS/FIGURES

3.1 Nigerian Economy

Economic growth is the increase in the amount of the goods and services produced by an economy over time. It is conventionally measured as the percent rate of increase in real GDP, or as a measure of the qualitative and quantitative changes in an economy. The economy of Nigeria is a middle income, mixed economy emerging market with well-developed financial, legal, communications, and entertainment sectors. It was ranked 31st in the world in terms of GDP (PPP) as of 2009, and its emergent manufacturing sector is the third-largest on the continent. Though previously hindered by years of mismanagement, economic reforms of the past decade have put Nigeria back on track towards achieving its full economic

potential. Nigerian GDP at purchasing power parity more than doubled from $170.7 billion in 2005 to $374.3 billion in 2010. Correspondingly, the GDP per capita doubled from $1200 per person in 2005 to an estimated $2,500 per person in 2009. It is the largest economy in the West Africa Region, 3rd largest economy in Africa (behind South Africa and Egypt), and on track to becoming one of the top 30 economies in the world. Table 1 gives a statistical data of Nigeria's GDP growth.

Table 1: Economic data on Nigeria

STATISTICS	
GDP	$415 billion (2011 est.) (PPP: 30th)
GDP growth	7.8% (2011 est.) (driven by non-oil production activities)
GDP per capita	$2,500 (2010 est.)
GDP by sector	Agriculture: 40%; services: 30%; manufacturing: 15%; oil: 14% (2012 est.)
Inflation (CPI)	11.9% (2011 est.)
Gini coefficient	43.7 (2003)
Labor force	48.53 million (2011est.)
Labor force by occupation	Services: 32%; agriculture: 30%; manufacturing: 11%
Main industries	Crude oil, coal, tin, textiles, cement and other construction materials, uranium, food products, ceramics, steel, cotton, rubber
Ease of Doing Business Rank	133rd

Main Data Source: CIA World Fact Book. (Data extraction point: Wikipedia)

3.2 Industrial Development in Nigeria

Looking at the work of Elijah Udoh et al. (2011), and the Communiqué of the 45th Annual Conference of the Nigeria Economic Society, Industrialization can be defined as the mechanism that brings about rapid growth and development to any economy, be it developed, developing or under-developed, and is seen as a process of complete social and economic change whereby a particular society is transformed from pre-industrial and traditional state to an industrial one with all its features. It is usually argued that industrialization is capable of increasing the pace of economic growth and ensuring swift structural transformation of the economy. Paradoxically, most developing countries have failed to achieve industrial development despite several industrial policies and reforms. In Nigeria, the drive to transform her economy from non-industrialized state to an industrialized one has been the pre-occupation of successive administrations that has piloted the affairs of the nation since independence till date. The industrial sector

in Nigeria like most other developing countries is dominated by industries producing construction materials, clothing, textiles, footwear and processed foods using simple assembly processes, but in recent times have began making moves towards developing an industrial sector that is internationally competitive. The path towards industrialization in Nigeria has not been easy because of the disparity in resources endowment of the economic units and the low level of investment in the economy. While some units have resources beyond their immediate needs, others may have need for resources beyond what they can presently generate. Pass and Pike (1983) opined that the level of investment in an economy is one of the major elements in determining its future productive capacity and ultimately the growth in the real living standards of its people. Industrialization is a deliberate and sustained application, and combination of appropriate technology, infrastructure, managerial expertise and other important resources to attract considerable development. And for a country to industrialize, electricity supply and demand are important elements of the process. Iwayemi (1988) argued for the importance of energy sector in the socio-economic development of Nigeria. He submitted that strong demand and increased supply would stimulate increased income and higher living standards. Okafor (2008) used descriptive analysis to corroborate the views of these authors by arguing that poor and inefficient electricity supply has adverse implication for industrial development in Nigeria. Table 2 gives the economic data for Nigeria from 1980 to 2011.

Table 2: Economic Data Indicator for Nigeria

YEAR	GDP per Capita (US $)	GDP, PPP ($)	YEAR	GDP per Capita (US $)	GDP, PPP ($)
1980	849.866412	59346941321	1996	313.440605	1.34958E+11
1981	772.104632	56387952410	1997	314.303573	1.41274E+11
1982	624.982801	59683143845	1998	272.44364	1.45951E+11
1983	428.127926	58759021925	1999	287.91829	1.4972E+11
1984	336.742886	58028291849	2000	371.76808	1.6122E+11
1985	330.984025	65603937582	2001	378.830928	1.69986E+11
1986	229.518117	68756700234	2002	455.332004	1.75422E+11
1987	259.410332	70275573364	2003	508.434028	1.97566E+11
1988	246.386343	79922010629	2004	644.030542	2.24651E+11
1989	250.632109	88901866113	2005	802.788785	2.44642E+11
1990	291.86951	99836294288	2006	1024.61575	2.68191E+11
1991	273.171394	1.08138E+11	2007	1129.08607	2.93766E+11
1992	319.297589	1.13638E+11	2008	1374.68495	3.18278E+11

1993	203.492253	1.18684E+11	2009	1091.13627	3.44179E+11
1994	220.2216	1.21221E+11	2010	1242.4798	3.75384E+11
1995	255.500666	1.27143E+11	2011	1452.09482	4.11372E+11

(Extraction Source: World Bank International Comparison Program Database and OECD National Accounts data files)

3.3 Role of Energy in Economic Activities

Energy is an essential ingredient for socio-economic development and economic growth. The objective of the energy system is to provide energy services. Energy services are the desired and useful products, processes or indeed services that result from the use of energy, such as for lighting, provision of air-conditioned indoor climate, refrigerated storage, transportation, appropriate temperatures for cooking etc. It is an essential input to all aspects of modern life, and indeed the life-wire of industrial production (A.S Sambo, 2005). The role of energy in the economy is described across a range of concepts and theories encompassing ideologies in both traditional economics and other interdisciplinary relations. The importance of energy as an input to the economy is paramount, and time series and cross-sectional correlations seem to validate claims that there is a strong relationship between energy use and economic activity. However, more empirical analysis of this relationship has shown that it is flexible. This flexibility is associated with details like the types of fuels consumed, types of goods and services produced and consumed, energy prices, technical issues, social and political factors, etc. This relation then begs the question, how does energy use affects economic activity? Table 3 shows a typical relationship between energy consumption and its economic impacts.

Table 3: Electric Power Consumption (EPC) Indicator

Year	EPC (kWh per Capita)	GDP per unit of Energy Used	Year	EPC (kWh per Capita)	GDP per unit of Energy Used
1980	66.1474172	1.13128236	1996	84.4178921	1.63005054
1981	49.4818796	1.02781565	1997	80.7157432	1.67578969
1982	79.637146	1.03735096	1998	75.8835771	1.77413156
1983	79.5119283	0.99236898	1999	74.8109806	1.71168569
1984	60.4003435	0.97559646	2000	73.6446585	1.79500933
1985	78.3304355	1.06798084	2001	74.7880572	1.82813662
1986	88.5217186	1.10638359	2002	103.664379	1.81405352
1987	87.0148165	1.08692358	2003	101.031737	2.00512643
1988	84.9443463	1.19647477	2004	122.654464	2.22390336

1989	94.6774835	1.28596742	2005	128.440645	2.34783219
1990	84.9905195	1.41446676	2006	111.128212	2.55085998
1991	87.5221341	1.46450103	2007	138.331376	2.77393277
1992	88.04744	1.47004013	2008	126.910081	2.87066787
1993	98.7405514	1.50879113	2009	120.507686	3.17943656
1994	93.6412657	1.58244614	2010		
1995	89.7698315	1.58923302	2011		

(Extraction Source: IEA, Energy Statistics and World Bank PPP Data).

3.4 Energy in Production

Gaining an understanding of the role of energy in economic growth cannot be achieved without first understanding the role of energy in production. However, institutional phenomena also affect how this role plays out and therefore the economic view of growth and production and of the potential role of energy is necessarily more complex than just this scientific understanding. Energy is an essential factor of production (Stern, 1997). Every production process involves the transformation or movement of matter in some way and all such transformations require energy. The first law of thermodynamics (the conservation law) implies the mass-balance principle. In order to obtain a given material output, greater or equal quantities of matter must enter the production process as inputs with the residual as a pollutant or waste product. The second law of thermodynamics (the efficiency law) implies that a minimum quantity of energy is required to carry out the transformation of matter. Thermodynamics limits are easily identified for individual processes by an energy-materials analysis that defines the fundamental limitations of transforming materials into different thermodynamic states and on the use of energy to achieve that transformation (Ruth 1993). These types of analyses have shown where technological improvements exist, and where substantial room for improvements in the efficiency of energy and material use is needed. Production is a work process that uses energy to transform materials into goods and services (Cleveland et al., 1984). According to Georgescu-Roegen's (1976), it is a transformation process in which a flow of materials, energy, and information is transformed by two agents of transformation; human labour and manufactured capital. The flow of energy, materials and services from natural capital is what is being transformed, while manufactured capital effects the transformation.

3.5 Energy and Economic Growth

Energy economics is a field that studies human utilization of energy resources and energy commodities, and the consequences of that utilization (Sweeney, 2000). Over the precedent few years the relationship

between economic growth and energy has been widely researched. Since the pioneering study of Kraft and Kraft (1978), the great amount of researches in this matter find evidence of unidirectional, bidirectional, or no causality according to the country studied. Furthermore, in some countries, different results occur for different time periods, leading to no definite conclusion. Most studies that examined the relationship between energy use and economic growth for the various countries using time series data show two different findings: either unidirectional or bidirectional. Lord et al. (2010), revealed a bidirectional causal relationship between electrical energy consumption and real GDP in the long run, but only a unidirectional causal relationship from energy to output in the short run. 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 (2007) argues that demand for energy has surged and in that respect, the unrelenting increase has helped fuelled global economic growth. 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 (2001) have discovered, using Pearson correlation coefficient that economic growth and energy consumption in Sri Lanka are highly correlated. 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).

Table 4: EPC and GDP Growth. *(Extract Source: IEA Energy Statistics, and World Bank national accounts data)*

Year	EPC (kWh per Capita)	GDP Growth (Annual %)	Year	EPC (kWh per Capita)	GDP Growth (Annual %)
1980	66.1474172	4.204831047	1996	84.4178921	4.3
1981	49.4818796	-13.1278805	1997	80.7157432	2.7
1982	79.637146	-0.23469532	1998	75.8835771	1.879438638
1983	79.5119283	-5.29448444	1999	74.8109806	1.100377306
1984	60.4003435	-4.81833962	2000	73.6446585	5.4
1985	78.3304355	9.704754119	2001	74.7880572	3.1
1986	88.5217186	2.513578195	2002	103.664379	1.548922781
1987	87.0148165	-0.70035647	2003	101.031737	10.3
1988	84.9443463	9.899484754	2004	122.654464	10.6
1989	94.6774835	7.20031768	2005	128.440645	5.4
1990	84.9905195	8.196016108	2006	111.128212	6.2

1991	87.5221341	4.755593842	2007	138.331376	6.449828107
1992	88.04744	2.918230506	2008	126.910081	6
1993	98.7405514	2.199483274	2009	120.507686	7
1994	93.6412657	0.1	2010		
1995	89.7698315	2.5	2011		

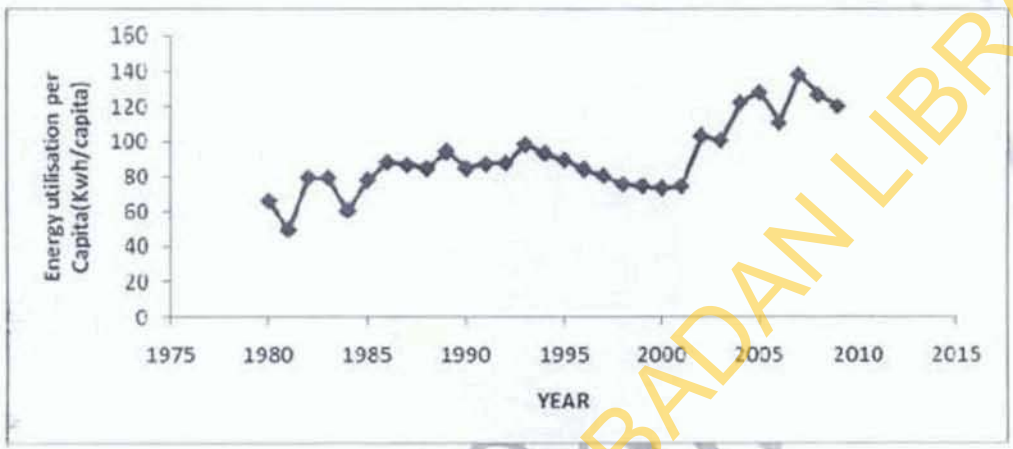

Fig 1: Energy utilisation per capital

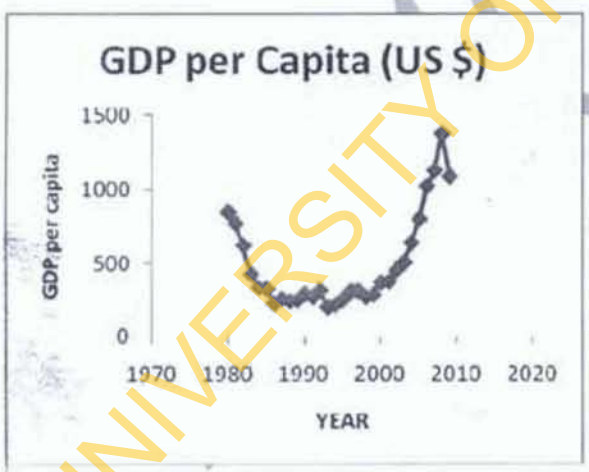

Fig 2: GDP per capital

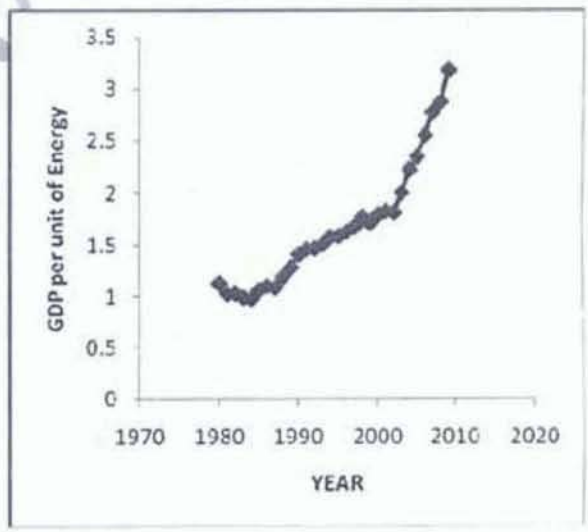

Fig 3: GDP per unit of energy