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The Impact of Energy and Electricity Consumption on Quality of Life in Africa

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Abstract: **This paper sets out to investigate the impact of energy and electricity consumption on quality of life in Africa using fixed effects and random effects model for the period of 2008 - 2014. We consider twenty three countries from Africa on the basis of availability of data. The Hausman specification test of 1978 was applied to select the appropriate and better model for the estimation where fixed effects estimation was chosen over random effects estimation. The findings revealed that energy consumption had positive and statistically significant impact on quality of life while electricity consumption had negative and statistically significant impact on quality of life. Hence, the study recommended that African countries should devise means of achieving energy efficiency and ensuring sustainability of energy usage in the region through establishing energy research centers that will help in developing new sources of energy as well as retaining the existing energy with a view to improve quality of life.**

Keywords: **Quality of life, energy consumption, electricity consumption, Africa.**

1. INTRODUCTION

Energy is required to sustain and improve quality of life. The dramatic societal changes and high rate of population growth since the industrial revolution have required vast amounts of energy provided mainly by coal and petroleum. In the near future, further population growth and improvements in quality of life will increase the demand for non-renewable fossil fuels and intensify the associated environmental implications (Pasten and Santamarina, 2012).

Despite being endowed with natural energy resources and/or fossil fuel resources in African countries especially for those in the Sub-Saharan Africa, these countries experience the lowest per capita energy consumption levels in the world (United Nations Economic Commission of Africa, 2004; as cited in Bildirici, 2013). The rate of energy consumption increases with economic development and the consumption of energy sources improve quality of life, a higher level of socio-economic development is associated with a well developed energy sources (Bildirici, 2013). Energy consumption plays a very significant role in economic development of countries and has become a major concern of many researchers involved in the energy economics literature.

However, the striking feature that differentiates the developed from the developing countries (mostly Africa) is their level of quality of life achievable through improved access to energy resources. For instance, Nigeria the giant of Africa currently generates about 40 Kilowatts of electricity per one thousand inhabitants compared to 120 Kilowatts by Indonesia, 145 Kilowatts by India, 530 Kilowatts by Brazil, and 190 Kilowatts by Morocco. These figures illustrate the inadequacy of power available in the country that limit the earning capacity of individuals and declining welfare due to declining disposable income. The country seeks to reverse this situation through rapid investment in the power sector and by reforming the sector through deregulation and privatization. This resulted into energy sector reform and handing over of the successor companies of the defunct Power Holding Company of Nigeria (PHCN) to private investors (Olarinde and Sani, 2016).

Empirical studies investigating the relationship between energy consumption, electricity consumption and quality of life are abound (Pasten and Santamarina, 2012; Seng and Meisen, 2005; Qiaosheng, Maslyuk and Clulow, 2012; Pourali, A. (2014) Mart and Ebenhack, 2008; Bahadur, 2014). While some studies have found a positive relationship between energy consumption and quality of life (e,g. Pourali, 2014; Mart and Ebenhack, 2008; Seng and Meisen, 2005; Pasternak, 2000) others have established a negative relationships (e.g. Pasten and Santamarina, 2012). Yet some empirical results tend to lend support to the view neutrality of the relationships between the variables (e.g Qiaosheng, Maslyuk and Clulow, 2012; Mazur, 2011). This study therefore seeks to contribute to this growing literature and fill the aforesaid gap by examining the influence of energy and electricity consumption on quality of life in Africa over the period of 2008 to 2014. Therefore, the paper intends to answer questions such as: Do energy and electricity consumption influence quality of life in Africa. The paper is organized as follows: following this introduction is section 2 that contains literature reviews. Section 3 discusses the method of data collection and methodology. The results and discussion are presented in Section 4 and section 5 reports the conclusions and recommendations.

2. LITERATURE REVIEW

This section presents the extensive review of both conceptual and empirical literature on energy consumption and quality of life. Energy can be defined as ability to do work or the ability to move or elicit change in matter. It is power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines. In effect, the amount of energy something has refers to its capacity to cause things to happen and the available resources necessary for an improved life. Furthermore, energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy makes our bodies grow and allows our minds to think (Energy Efficiency and Renewable Energy, 2010). Scientists define energy as the ability to do work. Drawing from the above the amount of energy available to an individual determined its capacity to produce and maximize the available natural resources to its own advantage, hence the performance of an individual measured in term of its productivity and income relies on the amount of energy available.

Using Pearson correlation analysis, Mazur (2011) examined the contribution of energy and electricity consumption on quality of life in twenty one industrialized countries with more than two million population spanning the period of 1980 to 2006. The study employed thirteen variables as measures of well-being that are related to energy and electricity consumption per capita e.g. GDP per capita. The study discovered that energy and electricity consumption had no significant impact on life expectancy. This is because all nations using five to fifteen *mw/h* electricity energy had longevity around eighty years. Similarly, all nations using forty to eighty mw/h energy consumption had the same longevity around eighty years.

Similarly, Qiaosheng, Maslyuk and Clulow (2012) examined the relationship between energy consumption inequality and human development of one hundred and twenty nine (129) countries spanning the period of 1998 – 2007 using Lorenz curve and Gini coefficient. The variables of choice were energy consumption and human development proxied by energy consumption per capita (in tones of oil equivalent) and human development index (HDI). The result revealed that the relationship between the HDI and energy consumption per capita was not linear. This means that at low human development levels, increase in energy consumption will lead to large increases in a country's HDI but countries with high or medium human development levels, increase in energy consumption is not enough to maintain its human development progress. Hence, it was recommended that countries ranked with high or medium human development index should combine more efficient energy use, development of energy-saving technologies, establishing appropriate social welfare systems, etc.

In addition, Pasten and Santamarina (2012) analyzed worldwide energy consumption situation in relation to quality of life. The variables of choice were energy consumption rate per capita, government's energy for life efficiency, and quality of life, etc. The results displayed the energy cost of increasing quality of life in the developing world, energy savings that can be realized by limiting overconsumption without impacting quality of life, and the role of governments on increasing energy for-life efficiency and reducing social inequality.

On the other hand, Pasternak (2000) investigated the relationship between human well-being and consumption of energy and electricity in sixty (60) populous countries encompassing 90% of the world's population over the period1997 – 2020 using correlation analysis. The finds showed that there was significant positive relationship between electricity consumption and Human Development Index. It also revealed that HDI attains a maximum value when electricity consumption annually was about 4,000 kWh per capita, which was lesser as well as greater than consumption levels of most developed and developing countries, respectively.

Also, Seng and Meisen, (2005) examined the effect of electricity consumption on social and economic development in comparison with low, medium and high human development countries based on UNDP classification covering forty (40) countries using regression analysis. Human development index and GDP per capita were proxies for social and economic development; while electricity consumption per capita was measured in Kilowatt-hours. The finds showed that electricity consumption per capita had significant positive effect on social development and economic performance with respect to medium and low human development countries. It was also found that the threshold for moving from a low to medium human development economy was when a country attained 500kwh per capita.

Lending support to the work of Bahadur (2014), who empirically studied the impacts of access to infrastructure on the human development (HDI) using dynamic panel estimation of General Methods of Moments over the period 1995 - 2010 covering 91 developing countries. The human development (dependent variable) was proxied by human development index of UNDP; the explanatory variables were access to electricity, access to clean drinking water sources, and access to road proxied by the percentage of the population with access to electricity, proportion of the population using improved drinking water sources, and road density in terms of kilometers of road network per 100 sq. km of land area, respectively. Also four variables were used as control variables: the consumer price index (CPI), population growth, Konjunkturforschungsstelle (KOF) index of globalization, and democracy index. More so, the paper went further to use each component of HDI as dependent variable. The results revealed that all three infrastructure variables had significant positive impact on HDI. The results with regard to component of HDI (as dependent variable) access to electricity and access to clean drinking water sources had significant positive impacts only on education and health indexes; while road density had significant positive impact on the income index.

In a similar study, Mart and Ebenhack (2008) studied the role of energy consumption on human development using correlation analysis for one hundred and twenty countries (120). The variables were human development index and energy consumption per capita as proxies for human development and energy consumption. The study revealed that there was strong correlation between human development and energy consumption per capita. Hence, it was suggested that tremendous gains in human development are possible for the developing countries with small incremental access to energy.

In another study, Pourali (2014) examined the relationship between environmental life quality indices and energy consumption in high energy- consuming countries including America, China, Japan, India, Iran, Russia, etc. using fixed effects model estimation over the period 2007 - 2011. The energy consumption was proxied by energy consumption based on oil consumption; the environmental life quality indices were under-5 children mortality, agricultural subsidies, access to drinking water, access to sanitation and CO2 per capita. The results indicated that there is a significant positive relationship between environmental life quality indices and energy consumption.

Also, Scheidel (2010) examined long run relationship between human development and quality of life in Greece. The study established that there were continuities and discontinuities between ancient, medieval and modern periods of Greek history which have repercussion on human development, quality of life and gross national happiness. The study further discovered that problems encountered in determining quality of life are inherent irrespective of time domain. The study, hence, suggested that institutional arrangement in political and military mobilization, and slavery, have repercussion that can be simultaneously beneficial and detrimental to the quality of life.

In summary, there are numbers of empirical studies focusing on the relationship between energy consumption, electricity consumption and quality of life albeit with mixed results. Therefore, the major gap here to be addressed is lack of consistency in the earlier studies whether energy consumption influences quality of life or not.

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3. METHODOLOGY

This section contains type and sources of data, variables measurement and method of data analysis.

3.1 Sources of Data and Description of the Variables:

In **es**timating the relationship between energy consumption, electricity consumption and quality of life in Africa, the secondary data was used spanning the period of 2008 to 2014. The data was obtained from World Bank's World Development Indicators and United Nations Development Programme (UNDP). However, the study used purposive sampling technique to select the countries from the region based on availability of data in the region. This study employed human development index as proxy for quality of life which is consistent with the work of Morote (2010). Thus, electricity consumption is measured as the average annual electric energy usage per person in kilowatt/hours and energy consumption is measured by the fossil fuel energy consumption, following the works of Pasten and Santamarina (2012) and Mazur (2011).

3.2 Model Specification:

The relationship between energy consumption, electricity consumption and quality of life for this research work are expressed in a linear econometric model as follows:

$HDIX_{it} = \beta_0 + \beta_1 ENCO_{it} + \beta_2 ELCO_{it} + U_{it}$ (3.1)

Where:

HDIX = Quality of Life

ENCO = Energy Consumption Per Capita

ELCO = Electricity Consumption Per Capita

$\beta_0 - \beta_2$ = Coefficients of the independent variables

i = The Cross Section Unit

u_t = Stochastic Disturbance Term

t = Time of Observation

3.3 Technique of Data Analysis:

This study employs panel data approach to analyze the determinants of quality of life in Africa. There are basically three types of panel data models, namely, the pooled ordinary least squares (OLS) model, the fixed effects model and the random effects model. The choice of either to use, the fixed effects model or the random effects model, is determined by the outcomes of F-test and Hausman (1978) test.

4. RESULTS AND DISCUSSIONS

This section presents the results of panel data regression analysis of fixed effects model and random effects model employed in estimating the influence of energy consumption and electricity consumption on quality of life. It also presents the diagnostic test of Hausman specification test of 1978 for appropriate and best model selection.

Table 4.1 Regression Results of Fixed Effects and Random Effects Estimations				
Dependent Variable: Quality of Life				
Independent Variables	Coefficient Estimates and t-statistic			
	Fixed Effects Regression		Random Effects Regression	
Energy Consumption	0.005286	(5.12)***	-0.002291	(-3.38)***
Electricity Consumption	-0.002161	(-1.70)*	5.50E-05	(0.10)
Constant	0.305564	(6.91)***	-0.054785	(-2.44)**
R – Square	0.99		0.99	
F – Statistics	74811.00***		9925.47***	
Hausman Specification Test				
Test Summary	Chi-Sq. Statistic		Chi-Sq. d.f.	
Cross section random	111.152629***		7	
Significant at 1% (***), 5% (**) & 10% (*)				

Source: author's computation using Eviews version 7.0.

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From the fixed effects regression result in Table 4.1, it is evidently presented that energy consumption has positive impact on quality of life at 1 percent level of significance. On the other hand electricity consumption has negative impact on quality of life at 10 percent level of significance. Furthermore, the magnitude of the impact differs by all the coefficients. That is, a 1 percent increase in energy consumption will lead to 0.5286 percent increase in quality of life, respectively. However, a 1 percent increase in electricity consumption will decrease quality of life by 0.2161 percentage. However, the F – statistic shows that the model is adequate even at 1 percent level of significance. More so, the analysis of Table 4.2 revealed that the overall model is well fitted as the independent variables explain about 99.9 percent influence on the dependent variable. Moreover, the result of diagnostic test was depicted in Table 4.1. In order to perform robustness check of the estimated results. The study applied Hausman specification test of 1978 to compare fixed effects model and random effects model. The value of Hausman test is 111.152629 which is significant at 1 percent level; implying that fixed effects model is consistent and more appropriate than random effects model. This is because the P – value is significant leading to rejection of the null hypothesis and the acceptance of alternative hypothesis that fixed effects model is more appropriate and better choice for the analysis than random effects model.

Moreover, the result revealed that the coefficient of energy consumption (0.0053) is positively related with quality of life at one percent level of significance. This also implies that energy consumption is an important factor that affects quality of life in Africa. This concurs with the findings of Mart and Ebenhack (2008) for one hundred and twenty countries (120); Qiaosheng, Maslyuk and Clulow (2012) for one hundred and twenty nine (129) countries; and Pourali (2014) for high energy consuming countries, China, America, Japan, India, Iran and Russia; but Mazur (2011) for twenty one (21) industrialized countries found no significant relationship between energy consumption and quality of life.

Surprisingly, the coefficient of electricity consumption (-0.0022) disclosed a negative relationship between electricity consumption and quality of life at 10 percent level of significance; this implies that an increase in electricity consumption deteriorate quality of life in Africa. This finding is contrary to the findings of Seng and Meisen (2005) for forty (40) countries and Bahadur (2014) for ninety one (91) developing countries who found that electricity consumption has positive significant relationship with quality of life but Mazur (2011) for twenty one (21) industrialized countries found no significant relationship between electricity consumption and quality of life.

Although electricity consumption has negative impact on quality of life which is contrary to a priori expectation of this study that electricity consumption improves quality of life. This is not surprising because there are two possible explanations for the cause. Firstly, it may reflect the fact that African countries were vulnerable to poor infrastructure and lack of facilities that improve quality of life. For instance in hospitals electricity is required to operate some facilities that are indispensable to reduce mortality rate and improve healthy condition of people but as a result of on-and-off of electricity, poor infrastructure and inadequacy of required machineries; quality of life may deteriorate. Secondly, electricity is needed to access safe drinking water but since there is poor source of energy in Africa, over the period of the study, which may compel people to be using contaminated water from streams or lakes that deteriorate healthy condition of people which dramatically affect their quality of life.

5. CONCLUSION AND RECOMMENDATIONS

On the basis of the findings of this study, the following conclusion is drawn: It was revealed that energy consumption plays a very important role in improving quality of life of people in Africa. On the other hand, electricity consumption dampens quality of life in the region over the period of the study but this is due to lack on-and-off of electric power supply and inadequate infrastructural facilities. The following recommendations are drawn:

Energy consumption was established to positively affect quality of life; as such policies that would promote the development of energy infrastructure as well as energy efficiency shall be pursuit in order to get high quality of life in the region. This can be attained through diligent efforts of the government to make the existing energy research centers often doing and to open new centers in order to develop new sources of energy and ensure sustainability of energy usage in the region. In addition, the low rate of human development index is as a result of high mortality rate in the region which might be attributed to several factors including erratic power supply that is needed to operate health care facilities in the hospitals. Hence, it is recommended that government should widen the electrification coverage in the region. Without constant supply of electricity health care facilities cannot be fully utilized towards improving quality of life.

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APPENDIX - I

List of Selected African Countries:

1	Algeria	9	Egypt	17	Senegal
2	Angola	10	Ghana	18	South Africa
3	Benin	11	Kenya	19	Sudan
4	Botswana	12	Mauritius	20	Tanzania
5	Cote d'Ivoire	13	Morocco	21	Togo
6	Cameroun	14	Mozambique	22	Tunisia
7	Congo (Democratic Republic of Congo)	15	Namibia	23	Zambia
8	Congo	16	Nigeria		