DECARBONIZING NIGERIA'S ENERGY MIX: THE ROLE OF RENEWABLE ENERGY CONSUMPTION

Tochukwu G. Onyechi*,
Department of Economics, University of Nigeria, Nsukka.
Email: onyechitochukwu@gmail.com; +2347064562648

Chukwuemeka Chinedu Ejiofor
Department of Political Science, University of Nigeria, Nsukka.
Email: chukwuemeka.ejiofor@unn.edu.ng;+23438146266,

ABSTRACT
This study examines the effect of carbon emission from non- renewable energy sources on renewable energy consumption in Nigeria. The augmented Dickey–Fuller test was used to tests for unit root problem and possible cointegration of the variables. With evidence of cointegration, the Fully Modified Ordinary Least Squares approach which was designed by Philips and Hansen in 1990 was employed. This method adjusts the leasts squares to account for serial correlation and possible endogeneity problem, which arises, when using the standard Ordinary Least Squares approach with non-stationary series. Logarithmic transformations were made, with the model transformed into a double log model. The raw data for the analysis were all sourced from World Bank World Development Index 2019. The result shows a positive relationship between Trade openness, Co_2 emission from non-renewable sources and renewable energy consumption, with the variables being significant at 5% level. The coefficient value of (0.1949) for Co_2 shows that a percentage increase in Co_2 emission from non-renewable sources of energy, increases renewable energy consumption by just 19% of total energy use. The study found also, that a negative relationship exists between urban population, oil rent, GDP per capita and renewable energy consumption and are significant at 5% level except for oil rent which is not statistically significant. The study recommends, the need to intensify awareness and encourage government and private individuals to consider embracing alternative clean energy sources. That will be a right move in the drive to achieve the Sustainable Development Goals 7(affordable and clean energy) and 13(climate action).

Key words: Renewable, Carbon, emission, fossil-fuel, Energy, Degradation.

JEL: Q2:20, Q3:30, Q4:40, 42,

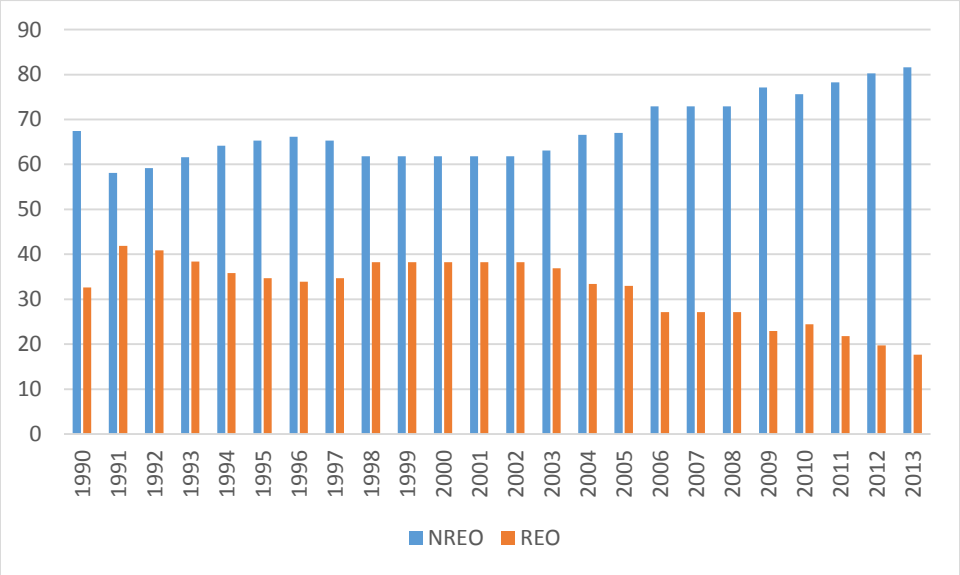
1. INTRODUCTION
Nigeria has abundant renewable and non-renewable sources of energy supply (Maina, Kyari & Tahir, 2020). Surprisingly, her energy needs have over the years, been highly dependent on high carbon emitting non- renewable energy sources. These carbon emitting sources of energy, comprising mainly of fossil fuels are not only unsustainable, but have been adjudged to be very harmful to both the environment and its inhabitants. The global community has renewed the war against environmental degradation, forcing many developed countries to set target on the year to minimize carbon emission through reduction in the use of automobiles powered by fossil fuel. As a result, there has been an aggressive advocacy for a move away, from those sources of energy supply which are not environmental friendly to the ones that are friendly to the environment.
It therefore call for concern that Nigeria is heavily reliant on carbon intensive sources of energy supply, despite, being blessed with a wide range of alternative natural sources that are non-polluting and inexhaustible. The development, exploitation and utilization of energy sources have been largely skewed in favour of hydro power and crude oil, leaving the other sources either

untouched or poorly harnessed (Nwofe, 2013 & Kalu 2020). This is supported by Asogwa, Ugwuanyi & Anumudu (2018) who asserts that renewable energy represents only a little portion of its expected electricity output all over the world. With Nigeria's fast growing population, it has become so glaring that the current energy need of the populace cannot be met by this over dependence on these non-renewable energy. According to Olowo (2015) only about 40% of households in Nigeria are connected to the national electricity grid. Hence, most energy supply comes from the use of generating sets which are high carbon emitters.

There is a growing trend across the globe, to promote the use of renewable energy such as solar, wind, biomass, hydropower, geothermal energy et cetera; as we are at a point in history when the issue of climate change and global warming is receiving global concern. Even, renewable energy encourages unrestricted access to energy supply (Ikhide, 2021). Amuka, Asogwa, Ugwuanyi, Omeje, & Onyechi (2018) assert that fossil fuels used to power machines have contributed greatly to the build-up of greenhouse gases. Renewable energy sources have proven to have zero carbon effect on the environment, as, studies have shown that the level of emission from renewable energy sources is equal to that absorbed by plant growth (United Nations Educational Scientific and Cultural Organization [UNESCO], 2017). Despite being climate friendly, renewable energy sources are yet to be properly harnessed, as an alternative energy supply to the carbon intensive conventional energy sources available.

Available statistics show that carbon emission from electricity and heat production in Nigeria have been increasing overtime and remained all-time high. As at 2006, the carbon dioxide (co_2) emission from non-renewable energy source averaged 33% rising to 35% by 2009. Within the period 2013 to 2016 the carbon emission from this source was over 37% of total combustion (World Bank World Development Index, 2016). These outcomes are of course not good for Nigeria's ecosystem and may have grave environmental consequences. This is further expressed in Figure 1.

Fig 1: Non- renewable electricity output versus renewable electricity output in Nigeria.



Source: World Bank World Development Index (WDI) 2016.

It is not quite surprising, that despite the massive investment by government and awareness being created about renewable energy in Nigeria, its production and hence, consumption have still not shown any significant improvement. This is attributable to the loads of challenges such as finance and technical expertise needed by these renewable energy investors. More so, it is also very important for Nigeria to look beyond the financing aspect of this renewable energy consumption challenges, to consider what really drives people's demand for renewable energy in Nigeria; which is basically the differences in price of the two energy sources. In more advanced economies, people are more likely to consider environmental quality while demanding for energy, which is a different case in Nigeria where individuals are more likely to consider cost before the environment.

The global community is now concerned about environmental degradation and its threat to human existence. Consumption of non-renewable energy is considered to be contributing greatly to this degradation, which is part of the reason why many developed countries have set the year 2030 as the target year for the phase out of automobiles powered by fossil fuel. Nigeria is blessed with solar and wind energy. These can be tapped in substantial quantity to reduce the combustion of hydrocarbons and reduce environmental degradation and pollution. The relevance of this study is evident in two dimensions i) Most country specific studies on renewable energy consumption in Nigeria like the works of Akpan & Akpan (2012), Chindo, Abdulrahim, Waziri, Huong, & Ahmad (2014), (Alege, Adediran & Ogundipe (2016), Abdulrashid(2016) and Gambo,Ishak,ismail,&Idris(2018) have always focused on its effect on Economic growth while studies which attempted to study the relationship between the variables and the effect of one on the other employed descriptive statistics like the works of Yahaya & Nwabuogo (2016) and Akuru, Okoro & Chikunu (2016). ii) Extant studies and literatures in Nigeria like Olowo(2015), Asogwa, Ugwuanyi & Anumudu (2018) and Yahaya & Nwabuogo (2016) have tried to explain the relative importance of these renewable energy sources as complement for the energy produced from fossil fuels; which are unreliable and insufficient to meet the country's energy demand.

This study, however, focuses not on these, but on the threats the use of this method of energy supply poses to the environment. Thus, it views renewable energy from supplementary point of view. The target of this study is, therefore, to examine the possibility of emissions from non-renewable sources of energy supply causing Nigerians to utilize more renewable energy sources; which are regarded as clean energies- in other to protect the environment. Following also from the work of Yazdi,Khanalizadeh & Mastorakis (2019) which found a bidirectional causality between renewable energy and carbon emissions in Iran, the work of Zafar, Mirza, Sah & Hou(2019) which found a uni directional causality running from carbon emissions to renewable energy consumption for some selected emerging economies, and the work of Gershon & Emekalam (2021) which found a unidirectional causality running from Co_2 to renewable energy consumption this study seeks to : Assess the effects of carbon emissions from non-renewable energy sources on renewable energy consumption in Nigeria.

2. LITERATURE REVIEW

Theoretical literature

With the global warming and climate change effects on the earth, coupled with the discovery of alternate sources of energy supply which are free, clean and inexhaustible; it is expected, that renewable energy must at this point of mankind's existence, be at the forefront of global world energy supply and use. Possibly, replacing the harmful non-renewable energy sources; but the reverse appears to be the case. Attempts at demystifying this lax in the use of renewable energy

sources, points to this energy conspiracy theory, which is the leading theory of alternative energy use. **The Free Energy Suppression Conspiracy Theory** developed in 18th century and popularised by David Childress, Eugene Mallove, Gary McKinnon and some other natural scientists holds that, government agencies, corporate bodies and special interest groups who are involved in fossil fuel and nuclear industries allegedly suppresses the research and development of alternative sources of energy supply, that are technologically viable, and pollution free in order to protect their interests and businesses. This theory explains why renewable energy production and consumption has remained all the time low. Even though various governments and institutions claim to be developing and implementing environmental protection policies. According to Ballonoff (1997) the reason for special regulation of energy is based on myths that it is done to protect special-interest groups at the expense of energy consumers. He further explained that since government regulates the energy industry more intensely than it does to other sectors of the economy, getting renewable sources of energy supply to replace the non-renewable sources may be practically difficult.

Empirical literature review

Several studies on renewable energy and carbon emissions have been done for countries outside Nigeria. For instance, the effect of renewable energy consumption on carbon emission in Indonesia was examined by Sasana & Putri (2018).The study covered the period 1990-2014 and ordinary least squares method was used for analysis. The result show that renewable energy has a negative effect on carbon emission in Indonesia and also that population growth and fossil energy use has a positive effect on carbon emissions. Nguyen & Kakinaka (2019) examined the relationship between renewable energy, carbon emissions, and development stages using a panel cointegration of 107 countries for the period 1990-2013. The countries were grouped into developing and developed countries and diverse effects observed from the two groups. The result show that the relation between renewable energy consumption and carbon emissions depends to a large extent on the development stage of the economy under review. The study also investigated the Environmental Kuznets Curve hypothesis whose findings revealed the existence of the hypothesis across the selected countries. The study suggests that renewable energy consumption should be promoted to reduce emissions which usually results in climatic problems.

In the same light, Yazdi, Khanalizadeh & Mastorakis (2019) also assessed the relation between renewable energy, non- renewable energy consumption, economic growth and carbon emissions for Iran for the period 1975-2011. The Autoregressive Distributed Lag model as well as the Granger causality was used and the result show a bi directional causality between the variables, and also a long term relationship was confirmed for the variables. In Nigeria, the relationship between energy consumption, environmental emission and economic growth was also examined by Gambo, Ishak, Ismail, & Idris (2018). Result from the Auto Regressive Distributed Lag model (ARDL) supports earlier studies that energy use has both short run and long run relationship with economic growth.

Kwakwa & Adu (2016) studied the effect of income, energy consumption and trade openness on carbon emissions in Sub Saharan Africa. The study is very relevant and adds to existing literature as few works have tried to discuss these issues in Sub Saharan Africa. Based on the research findings, it is necessary to encourage economic development in Sub Saharan Africa as it lowers carbon emissions in the region. This is evident in the inverted U relationship that exists between income and carbon emission within the period of study. The study also shows that trade openness, industrialization, energy consumption and urbanisation affects carbon emission in Sub Saharan

Africa. Adams & Nsaih (2019) also in their study of sub-Saharan Africa looked at how carbon emissions can be reduced through renewable energy use. A panel of 28 countries were modelled using the fully modified OLS and Generalized method of moments. The result show that renewable and non- renewable energy contributes to carbon emission in these countries but only non-renewable energy sources have a significant positive effect on emissions and this is consistent with earlier studies that have shown that emission from renewable energy sources have no effect on the environment as it equals that required for plant growth.

In china, the impact of energy and Co_2 emission on renewable energy development was assessed by Zhang, Qi & Karplus (2013). Simulation method for forecast was entirely adopted for this study to show how renewable energy use has improved over the years and what targets are achievable in the future. The study observed that huge reliance on renewable energy has a way of promoting fossil fuel use in non- regulated sectors as the price of fossil fuels will reduce due to shortfall in demand. Hence, emission reduction from renewable energy use is off- set by increased emission from non- regulated sectors up to 2050. Use of simulation is a very good idea as it enables for predictions which is of good relevance for drafting emission policies.

The role of renewable and non- renewable energy consumption in abating carbon dio oxide emission in Africa was assessed by Nathaniel & Iheonu (2019). This study was done for 19 African countries using the panel Augmented Mean Group method. The study reveals that renewable energy consumption does not significantly affect CO_2 emissions in Africa whereas non- renewable energy consumption contributes greatly to emissions within the region. These results conform to earlier studies despite the diversity in the methodology adopted. This methodology used is quite unique in that it gives the average value of emissions from each energy use for the selected countries of study. Hasnisah, Azlina & Che Mohd Imran Che Taib (2019) assessed the impact of renewable energy consumption on carbon emissions in Asian countries. Panel cointegration and fully modified OLS methods was used to test for long run cointegration, and the result shows that renewable energy consumption has no significant impact in the reduction of pollution from Co_2 emissions. This finding conforms to the result showed by Nathaniel &Iheonu (2019) for 19 African countries but the methodologies employed for both studies are different.

Within Nigeria, a handful of research have been done on renewable energy and carbon emission nexus. The relationship between electricity consumption, carbon emission and economic growth in Nigeria was examined by Akpan & Akpan (2012). Multivariate vector Error Correction Model was adopted for the study using data for the period 1980-2008. The findings violated the environmental Kuznets Curve and shows a unidirectional causality running from economic growth to carbon emissions. This shows that economic growth increases the level of emission in the environment. Yahaya & Nwabuogo (2016) examined how the use of renewable energy could act as mitigant for climate change in Nigeria. The study used descriptive method of analysis to discuss efforts made by Nigeria so far in addressing the challenges of climate change. Their analysis shows that not much have been done in Nigeria to reduce the emission of Green House Gases.
Works by Alege, Adediran & ogundipe (2016) and Chindo et al (2014) examines the relationship between energy consumption, emissions and Economic growth in Nigeria. While Alege et al (2016) employed causality analysis, Chindo et al (2014) used the autoregressive distributed lag model for analysis. The result of the studies confirm that there exists both long run and short run relationship between the variables of the study and there exists a uni-directional relationship between Co_2 emission and Economic growth.

Abdulrashid (2016) examined the relationship between economic growth, energy demands and Co_2 emissions in Nigeria using ARDL bounds test to test for Co integration. The author's inclusion of trade openness and financial development as explanatory variables made it different from existing studies. The study show that financial development increases energy demand but reduces Co_2 emission. A similar study to this was done by Zafar, Mirza, Sah, & Hou (2019) it also looked at the effect of renewable and non- renewable energy consumption on carbon emission by employing trade openness into the model of Environmental Kuznets curve. The findings differed from the previous studies in that it revealed a negative effect of renewable energy consumption on carbon emission and revealed a causal relationship running from renewable energy consumption to carbon emission. This may have been so, due to discrepancy in the use of methodologies.

Cosmas, Chitedz & Mourad (2019) studied the macroeconomic determinants of carbon dio oxide emissions in Nigeria. Linear and Non-linear Autoregressive Distributed Lag model was employed to cover the period 1981-2015. The EKC hypothesis was also investigated but unlike other studies that supported the EKC existence in Nigeria. This study shows a violation for the period under study, evident in the N-shaped rather than the U-shaped curve of the EKC hypothesis. Population density, financial development and Economic growth were observed to affect carbon emissions in Nigeria for the period under study. Similarly, de Souza, Freire, & Pires (2018) also investigated the determinants of carbon emission in Argentina, Brazil, Paraguay, Uruguay, and Venezuela classified as the Southern Common Market (MERCOSUR). A panel analysis covering the period 1990-2014 was done for these countries. The result of the study supports the EKC hypothesis and also shows that renewable energy consumption lowers carbon emission whereas non- renewable sources increases it. This is in line with results from earlier studies. Akuru, Okoro & Chikunu (2016) assessed the effect of renewable energy use on climate change effects in Nigeria. A different methodology which was not econometrically based was adopted for the analysis. This involved the use of descriptive tools such as tables and charts to profile the levels of energy use and corresponding Green House Gas emission from each energy use. The profile suggests that energy from fossil fuels were the most commonly used means of energy supply in Nigeria and posed serious threats to existing climatic conditions.

3. METHODOLOGY

In Time series analysis, the very first step to choosing an appropriate methodology lies in conducting a unit root test, to check for stationarity of the variables. This is because, in standard time series procedures, methods used to analyse stationary series cannot be used to analyse non stationary series. According to Shrestha & Bhatta (2018) once all the variables are not stationary at level forms, the simple Ordinary Least Squares becomes less favourable. Along this line, this study conducted a unit root test using the Augmented Dickey Fully test for Unit root, with evidence of I(1) series. The ADF model for cointegration was employed to test for cointegration among the variable with result showing evidence of cointegration. Following Hasnisah et al (2019), Olofin, Aiyegbusi & Adebayo (2019), Bashier & Siam (2014), The Fully Modified Ordinary Least Squares method for Error Correction designed by Philips and Hansen (1990) was employed to empirically test the objectives of the study for the periods 1990-2015. These estimators have been adjudged to be superior in small samples and accounts for possible simultaneity within regressors (Masih & Masih, 1996). According to Philips (1993) the method modifies least squares to account for serial correlation effects and for the endogeneity in the regressors that results from the existence of a cointegrating relationship. The raw data for the analysis was sourced from World Bank WDI, 2019.

The variable selection was based on the empirical model of Yazdi, Khanalizedeh &Mastorakis (2019) and akintade, Olubusoye, Adenikinju & Olanrewaju (2020), as shown in table 3.1.

Table 3.1: Variable description and data source

Variable	Data source	Choice of variable source	Variable measurement
Renewable energy consumption	World Bank World Development indicators	Yazdi, Khanalizedeh & Mastorakis (2019)	Renewable energy consumption (% of total final energy consumption)
Trade Openness	WDI	Yazdi, Khanalizedeh &Mastorakis (2019)	$\frac{imports + exports}{RGdp}$
Co_2	WDI	akintade,Olubusoye,Adenikinju & Olanrewaju (2020),	Co_2 emissions from electricity and heat production, total (% of total fuel combustion), Co_2 emissions (metric tons per capita)
population growth	WDI	akintade,Olubusoye, Adenikinju & Olanrewaju (2020),	Population growth (annual %)
Per capita Gross Domestic Product	WDI	Yazdi, Khanalizedeh & Mastorakis (2019)	GDP per capita (constant 2010 US$)
Urban population	WDI	akintade, Olubusoye,Adenikinju & Olanrewaju (2020	Urban population (% of total population)
Oil rent	WDI	Yazdi,Khanalizedeh & Mastorakis (2019)	Oil rents (% of GDP)

Source: Authors' computation

A double log model specification was adopted to rescale the data and minimise outliers.
The econometric form of the model in logarithmic form is shown thus:

$$lnREC_t = \alpha + \beta lnCO_{2\ t-i} + \delta lnGDPPC_{t-i} + \theta lnURBPOP_{t-i} + \lambda lnTOP_{t-i} + \varphi lnOR_{t-i} + \mu_{1t} \quad (1)$$

Where: lnREC=log of renewable Energy Consumption, $lnCO_2$=log of carbon emission from electricity and heat production, lnGDPPC=log of per capita GDP, lnURBPOP=log of urban population, lnOR= log of oil rent, lnTOP= log of trade openness, μ = error term.Equation 1 was transferred to Vector Error Correction because of evidence of co integrated series. Hence,

$$lnREC_t = \alpha + \beta d\sum lnCO_{2\ t-i} + \delta d\sum lnGDPPC_{t-i} + \theta d\sum lnURBPOP_{t-i} + \varphi d\sum lnOR_{t-i} + \lambda d\sum lnTOP_{t-i} + ECM + \mu_{it} \quad (2)$$

Where: ∑ = difference Operator, ECM=speed of adjustment.

4. RESULTS AND DISCUSSION OF RESEARCH FINDINGS

This section shows the results of the various tests conducted and analysis of the research findings.

Stationarity test.

The unit root test on all variables was done with the Augmented Dickey Fuller test method and the results are presented in table 4.1.

Table 4.1: Augmented Dickey-Fuller unit root tests.

Variable	level			First difference			status
	intercept	Inter. & trend	No inter. &trend	intercept	Inter. & trend	No inter.&trent	
lnREC	-2.632	-2.572	-0.172	-5.124**	-4.996**	-5.240**	I(1)
lnGDPPC	-0.096	-2.377	1.539	-2.691***	-2.726	-2.145**	I(1)
lnURBPOP	-0.051	-2.728	1.495	-2.548***	-1.305***	-0.047	I(1)
lnCO2	-1.548	-2.141	0.6031	-5.759**	-5.657**	-5.760**	I(1)
ln TOP	0.093	-2.062	3.208	-4.201**	-4.177**	-3.289**	I(1)
lnOR	-1.959	-2.460	-1.132	-5.213**	-5.256**	-5.102**	I(1)

Source: Authors' computation. Note: * = 1% sig.level;** =5% sig. level; ***=10% sig. level

The stationarity result as shown, has all the variables integrated of order 1 and thus considered non stationary variables at level form. This further confirms our Justification for the choice of the Fully Modified OLS. As the series were established to be cointegrated, following an ADF Test for cointegration performed on the series residuals with critical value of (-3.732) and probability (0.019).Having established cointegration of the series of the regression, we estimate an Error Correction Model to reconcile the long-run and short run discrepancies in the behaviours of the dependent and explanatory variables. The ECM result is presented in Table 4.2.

Table 4.2: Result of the Fully Modified Ordinary Least Squares for ECM

variables	coefficients	Std.errors	t-values	probability
lnREC	3.1399	0.3548	8.849**	0.000
lnCO2	0.1949	0.0186	10.467**	0.000
lnURBPOP	-0.185	0.0550	-3.361**	0.003
lnGDPPC	-0.0760	0.0282	-2.686**	0.014
lnOR	-0.0082	0.0038	-2.157**	0.044
lnTOP	0.0735	0.0243	3.361**	0.007
ECM(-1)	-0.006	0.0043	-1.310**	0.211
Adj.R^2 0.76				
Std. error of regression: 0.008				

Source: Authors' computation. ** = 5% level of significance.

The main objective of the study is, to examine the effects of carbon emission from non-renewable energy sources on renewable energy consumption in Nigeria. With emphasis on whether increased carbon emission will increase the level of renewable energy consumption in Nigeria from 1990-2015. The result as presented in Table 4.2 show that there is a positive relationship between Trade openness, Co_2 emission from non-renewable sources and renewable energy consumption, with the variables being significant at 5% level. The coefficient value of (0.1949) for co2 shows that a percentage increase in co_2 emission from non-renewable sources of energy, increases renewable energy consumption by 19% of total energy use. This shows that energy consumers in Nigeria are

likely to increase their demand for renewable energy for some units of carbon emitted. This is consistent with a priori postulations, as empirical evidence show that there is one way relationship between the two variables moving from co_2 to renewable energy consumption Zafar, Mirza, Sah & Hou (2019), Gershon & Emekalam (2021). A percentage increase in the level of trade openness increases renewable consumption by 7% of total energy use. Practically, the more the economy is open to trade, the more likely are energy consumers going to demand for renewable energy.

Negative relationship exists between urban population, oil rent, GDP per capita and renewable energy consumption and are significant at 5% level except for oil rent which is not statistically significant. A percentage increase in urban population reduces renewable energy consumption by 18% of total energy use. This is surprising because, increased urban population is expected to increase total energy need and thus demand. Individual's share of energy supply is expected to fall, causing people to rely on alternative energy supply which may likely be renewable energy sources. A percentage increase in GDP per capita reduces renewable energy consumption by 7% of total energy use. Table 4.2 also shows the result of ECM which reconciles the long run and short run discrepancy in the behaviours of the variables of the model. The negative value of the ECM shows that in the long-run, the dependent and independent variables will adjust to equilibrium. The ECM value -0.00512946 shows that practically, it takes about 5 weeks for disequilibrium in short run behaviour of the variables to adjust in the long run.The adjusted R^2 of 0.76 shows that 76% of the variations in the model is explained by the independent variable.

5. CONCLUSION AND RECOMMENDATION

The conclusion based on the research findings is, that Nigerians are not yet totally receptive to the adoption of renewable energy, as much as they are towards non-renewable energy use. This is seen, in the percentage increase per total energy use of renewable energy consumption, estimated at just about 19% of total energy use. This reveals that, about 81% increase of total energy use comes from non-renewable energy sources, despite rises in carbon emission from these sources, which are not only unreliable, but adjudged to be very harmful to humans and their environment. This result points to the fact, that more carbon emissions will continue to be expelled into the atmosphere, thereby, causing serious environmental damages to the atmosphere. A confirmation of this fear, is the observed acid rain and rain of black soot which are already being experienced in some parts of Nigeria. Nigerians are increasingly facing various health challenges which may not totally be alienated from environmental happenings. There is, therefore, need to intensify awareness and encourage government and private individuals to consider embracing alternative clean energy sources. That will surely be a right move, in the drive to achieve the Sustainable Development Goals 7(affordable and clean energy) and 13(climate action).

REFERENCES

Abdulrashid,R.(2016). Does the need for economic growth influence energy consumption and Co_2 emissions in Nigeria?. *Renewable and sustainable Energy Reviews 62*(C): 1209- 1225.

Adams, S., & Nsiah, C.(2019) Reducing carbon dioxide emissions; Does renewable energy matter?.*Sci total environ 693*(133288): DOI: 10.1016/j.scitotenv.2019.07.09.

Olofin,O., Aiyegbusi,O & Adebayo, A(2019). Analysis of Foreign Direct Investment and Economic Growth in Nigeria: Application of Spatial Econometrics and Fully Modified Ordinary Least Square (FMOLS). *Foreign Trade Review. 18*(3); 159-176.

Akpan, G., & Akpan, U. (2012). Electricity Consumption, Carbon Emissions and Economic Growth in Nigeria .*International Journal of Energy Economics and Policy*.*2* (4); 292-306**.**

Akuru, U., Okoro,O., & Chikuni,E.(2015)Impact of renewable energy deployment on climate change in Nigeria. *Journal of Energy in Southern Africa*. *26*(3); 125-134.

Alege, P., Adediran, O., & Ogundipe,A.(2016) Pollutant Emissions, Energy Consumption and Economic Growth in Nigeria. *International Journal of Energy Economics and Policy6*(2): 202-207.

Amuka, J., Asogwa, F., Ugwuanyi, R., Omeje,A., & Onyechi,T, (2018). Climate change and life Expectancy in a developing country: Evidence from greenhouse gas (CO_2) emission in Nigeria. *International Journal of Economicsand Financial Issues, 8* (4) ; 113-119.

Asogwa, I.,Ugwuanyi, C &Anumudu.C(2018)Determinants of renewable energy use and carbon emission intensity in Sub Saharan. *Journal of Economics and Allied Research, 2*(2); 66-77.

Ballonoff, P. (1997). Energy: ending the never ending crisis. Cato Institute: amazon.com.

Bashier, A& Siam, A(2014) Immigration and Economic Growth in Jordan: FMOLS Approach *International Journal of Humanities Social Sciences and Education (IJHSSE)* Volume *1*(9); 85-92

Central Bank of Nigeria (2015). Statistical Bulletin. Abuja: Nigeria.

Chindo,S ., Abdulrahim, A., Waziri,S., Huong,W., &Ahmad.A(2014) Energy consumption, CO2 emissions and GDP in Nigeria. *Geo Journal79* (3):xxx, DOI 10.1007/s10708-014-9558-6.

Cosmas, N., Chitedze, I., & Mourad, K. (2019). An econometric analysis of the macroeconomic determinants of carbon dioxide emissions in Nigeria. *Sci Total Environ. 20*(675):313-324. doi: 10.1016/j.scitotenv.2019.04.188.

De Souza, E., Freire, F., & Pires, J. (2018) Determinants of CO_2 emissions in the MERCOSUR: the role of economic growth, and renewable and non-renewable energy. *Environ Sci Pollut Res Int. 25*(21):20769-20781. doi: 10.1007/s11356-018-2231-8.

Emere, E., Okoro,U., Etete, E.,& Okunbor,O.(2016). Free energy option and its relevance to improve domestic energy demands in southern Nigeria. *Energy reports2*(1) 229-236.

Gambo,S., Ishak,S., Ismail,N., & Idris,M.(2018). Energy Consumption, Environmental Emissions and Economic Growth: An Empirical Analysis in Nigeria.*IOSR Journal Of Humanities And Social Science (IOSR-JHSS).23:2(2); 11-22.*

Gershon, O., & Emekalam,P(2021). Determinants of Renewable Energy Consumption in Nigeria: A Toda Yamamoto Approach. IOP Conf. Ser.: *Earth Environ. Sci. 665*(2021) 012005; 1-10. Doi:10.1088/1755-1315/665/1/012005.

Hasnisah, A., Azlina, A., Che Mohd Imran Che Taib (2019).The Impact of Renewable Energy Consumption on Carbon Dioxide Emissions: Empirical Evidence from Developing Countries in Asia .*International Journal of Energy Economics and Policy*. *9* (3), 135- 143.

Ikhide, E(2021). Alternative energy consumption and economic growth in Nigeria. *Journal of Economics and Allied Research.6*(1); 1-20.

Kalu, U(2020). Energy storage and market implication for powering African Countries, *Journal of Economics and Allied Research.4*(2);27-45.

Kwakwa, P., & Adu,G(2016). The effects of income, energy consumption, and trade openness on carbon emissions in Sub Saharan Africa. *The Journal of Energy and Development .41*(1/2 Autumn 2015 and Spring 2016): 86-117.

Maina,Y.,Kyari, B.,& Tahir,A.(2020) Patterns and Determinants of demand for alternative electricity in Nigeria. *Journal of Economics and Allied Research. 4* (1);54-66.

Masih,R & Masih,M (1996). Stock-Watson dynamic OLS and error correction modelling approaches to estimating long and short run elasticities in a demand function: new evidence and methodological implications from an application to the demand for coal in main land China. *Energy Economics; 18*(4); 315-334.

Nathaniel, S., & Iheonu, C (2019). Carbon dioxide abatement in Africa: The role of renewable and non-renewable energy consumption. *Sci Total Environ. 20*(679):337-345. doi: 10.1016/j.scitotenv.2019.05.011.

Nguyen.K & kakinaka (2019). Renewable energy consumption, carbon emissions,and development stages: some evidence from panel cointgration analysis. *Renewable Energy.* 132(xxx); 1049-1057.

Nwofe, P. (2013). Comparative analysis of domestic energy use in Nigeria - a review.

Continental Journal of Renewable energy 4 (1): 7-17.

Olowo, S.(2015). Renewable energy financing- challenges, opportunities and prospects: The Eco bank experience. Eco bank report, Lagos: Nigeria.

Philips.P (1993). Fully Modified Least Squares and Vector Autoregression. *Cowles Foundation Yale University ; discussion paper; 1047.*

Sasana, H., &Putri ,A.(2018).The Increase of Energy Consumption and Carbon Dioxide (CO2) Emission in Indonesia.*E3S Web of Conference* 31, https://doi.org/10.1051/e3sconf/20183101008.

Shrestha, M.,& Bhatta,G.(2018) Selecting appropriate methodological framework for time series data analysis. .*Journal of Finance and Data Science.4* (2);1-19.

UNESCO (2017). Underutilization of renewable energy impacts on sustainable development in the Southern African region. Harare.

World Bank (2016). World Development Indicators. Geneva: Switzerland.

Yahaya, O., & Nwabuogo,O (2016). Renewable Energy Deployment as Climate Change Mitigation in Nigeria. *Global Journal of human-social science.* 16 (4);19-28

Yazdi,S.,Khanalizadeh ,B.,& Mastorakis,N(2019). Renewable, Non-Renewable EnergymConsumption, Economic Growth and CO2 emission: Evidence for Iran. *Advances in Environmental Sciences, Development and Chemistry* xxx (xxx); 399-404.

Zafar, M., Mirza, F., SAH, Z., & Hou, F(2019). The nexus of renewable and non-renewable Energy consumption, trade openness, and CO_2emissions in the framework of EKC: evidence from emerging economies. *Environ Sci Pollut Res Int*. *26*(15):15162-15173. doi: 10.1007/s11356-019-04912-w.

Zhang, X., T. Qi and V.J. Karplus (2013): The Energy and CO2 emissions impact of renewable Energy Development in China. *Joint Program Report Series Report 242*; 20-34.