Assessing the Impact of Renewable Energy Consumption on Economic Growth - An Empirical Analysis in Nigeria

Prisca Ngozi Iwunze
Ph.D. Student in Environmental Technology and Management,
Azteca University, Mexico

Abstract:- The article examines the relationship between economic growth and the use of renewable energy through an empirical analysis conducted in Nigeria between 1990 and 2020. Further research was done to determine the direction of causation, which leans towards independence, between Nigeria's economic progress and its use of renewable energy. The paper offers a bivariate linear regression model as an empirical model to illustrate how using renewable energy affects economic growth. Descriptive analysis showed the data to be normally distributed and the econometric technique which includes unit root test, linear bivariate regression model, cusum test and pairwise Granger causality test was used to establish the efficacy of the study. Econometric evidence obtained from the survey showed that renewable energy consumption has a significant positive impact on economic growth. R square gives 0.99 variations in gross domestic product that is explained by renewable energy consumption and the probability value of 0.0001 indicates the overall significance of all independent variables in the model. Cusum test of stability evidenced the stability of the model and Durbin Watson statistic of 2.3 indicates the absence of autocorrelation in the model. The government must take a purposeful policy position to increase its investment in renewable energy to lower the economy's carbon footprint, as there is no statistically significant correlation between the use of renewable energy and economic growth.

Keywords:- *Causality Test, Cusum Test, Economic Growth, Ktoe, Renewable Energy, Unit Root Test.*

I. INTRODUCTION

Nigeria is the leading producer of oil on the continent. It was the largest natural gas holder on the continent and the fifth-largest LNG exporter in the world in 2018. Nigeria has failed to offer energy security to its citizens despite its high ranking, which has had a significant impact on its economy because of its huge reliance on crude oil, which is severely impacted by even a little fluctuation in price. Energy is a key component of every economy, and its inability to be supplied for daily operations would have a detrimental impact on the economy. With more than 200 million people living there, Nigeria, a developing nation in western Africa, has the continent's biggest population and economy. Nonetheless, around 60% of its population is impoverished. Since many Nigerians lack access to power and even those who do may find their electricity erratic, this is directly related to the population's energy access rate.

The largest source of greenhouse gas emissions into the environment is gas flaring by the nation's oil industry. Nigeria is responsible for around 19% of Africa's total greenhouse gas emissions. The country has some of the greatest CO2 emissions worldwide. Nigeria releases 45.8 billion kilowatts of heat into the sky per day while flaring 1.8 billion cubic feet of gas. The temperature has increased due to increased gas flaring, making certain regions dangerous. About 125.5 million cubic meters of natural gas were generated in Nigeria's Niger Delta between 1970 and 1986; however, 102.3 million of the natural gas generated were flared, while 2.6 million were used by oil-producing businesses. After that, another 14.6 million cubic meters were sold to other clients.

Nigeria has committed to reducing its national greenhouse gas (GHG) emissions in the Paris Agreement and is a party to the United Nations Framework Convention on Climate Change (UNFCCC). Natural gas dominates Nigeria's electrical supply system, which has resulted in negative pollution and greenhouse gas emissions. As the need for sustainable development becomes more prominent in the global energy discourse, world leaders seem to agree that focusing on renewable energy is the most effective way to promote economic growth. Therefore, it is essential to incorporate renewable energy into its energy mix, especially in emerging nations like Nigeria where the investment demand is greatest. Renewable energy is defined by the United Nations Environment Program (UNEP) [1] as any energy produced by natural means such as hydropower, geothermal, solar, wind, tides, biomass, and biofuels.

In 2015, the various mentioned energy sources accounted for 53.6% of the gigawatt capacity of all energy installations. Big hydropower projects are not included in this. As renewable energy sources became more affordable, dependable, and accessible, they were becoming more and more common in both developed and developing countries, according to the International Energy Agency (IEA) [2].

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14591298

People are being compelled to select renewable energy due to several external variables, including social instability in the Niger Delta, where most of Nigeria's crude oil is from, environmental degradation, global warming, and changing oil prices on the global market. Nigeria has a wealth of renewable energy sources, such as biomass, hydropower, wind, and solar. Hydropower has been Nigeria's main source of renewable energy since its independence in the 1960s, which accounts for 12.5% of the nation's on-grid electricity source. The current worldwide trend presents an opportunity to boost investment in the energy sector in line with the country's sustainability plan.

II. STATEMENT OF THE PROBLEM

It is impossible to overstate the contribution of the energy subsector to economic expansion. Nigeria's energy industry is one of its biggest obstacles. Given that Nigeria is an oil-rich nation, it should come as no surprise that non-renewable energy sources like coal, natural gas, and above all oil account for nearly all of Nigeria's energy consumption. According to Akuru and Okoro, the over-reliance on fossil fuels is one of the factors making the Nigerian energy industry very susceptible to shocks. They claim that further difficulties result from the present energy administration's poor policies and lack of professionalism: As the energy industry becomes more vulnerable due to climate change, poor governance, and pervasive poverty, Nigeria's energy system is not very resilient.

Inefficiency and inadequate environmental governance exacerbate the problems of energy security and access, while adverse impacts like gas flaring and oil pollution have continued to permanently harm marine ecosystems and agricultural land. Approximately 85% of budgetary income, 95% of export earnings, and 20% of GDP are derived from oil. Despite Nigeria's reliance on oil, the country nevertheless has a high rate of energy poverty. In Nigeria, almost 85 million people, or 60% of the population, lack access to power services. Less than 20% of the 40% of Nigerians with ready access to electricity live in rural regions. Overall, around 100 kWh of power is consumed each person, which is in poor comparison to 4,500 kWh, 1934 kWh, and 1379 kWh in South Africa, Brazil, and China, respectively. Programs to expand the energy supply industry's capacity have been initiated by the Nigerian government. The ability to generate energy from fossil fuels is anticipated to double as a result. Renewable energy is just a small percentage of public-sector energy spending, notwithstanding some initial initiatives in this area.

Nigeria is the sixth-largest crude oil producer in the world, with an estimated 36.2 billion barrels of crude oil. In addition, Nigeria has a gas province with around 5,000 billion m3 of reserves, which is growing to become increasingly significant. An estimated 2.7 billion tonnes of lignite and coal are in its reserves. 31 billion barrels of oil equivalent are included in its tar sand deposits. It could be challenging to transition to renewable energy in Nigeria because of the country's abundant fossil fuel reserves. Furthermore, Nigeria's oil consumption has only gone up since the Central Bank of Nigeria estimated in 1985 that the country used around 180,000 barrels of oil per day. However, Nigeria's energy demands cannot be met by depending just on fossil fuels, as only 60% of the country's population is now connected to the power grid.

Nigeria may have more energy available and capable thanks to renewable energy options. Given the wealth and potential of energy resources, there is no need for Nigeria to import energy to attain a sustainable generating capacity for the best possible economic growth, according to the subsector's poor performance. Furthermore, Nigeria was able to link the insufficient and unstable nature of the nation's energy market to the demise of her industrial sector, small and medium-sized enterprises, and economic depression [3]. Nigeria must turn its attention from fossil fuels to renewable energy sources to fulfil its rising energy demands. This is because fossil fuels have negative effects on the environment, are more costly, and are not renewable. Nonetheless, renewable energy sources like sun, wind, biomass, geothermal, and tidal may be continuously regenerated. Around 100 gigawatts (GW) of wind and solar power capacity were constructed worldwide in 2014, up from 74GW in 2013 [4]. The research is therefore aimed at assessing the impact of renewable energy consumption on economic growth in Nigeria, adopting the following objectives:

- To determine to what extent has the renewable energy sector contributed to the Nigerian economy
- To examine the legal, policies and regulatory framework of renewable energy sub-sector in Nigeria.
- To examine or discover the various challenges in the sector.
- To curb some external factors such as environmental degradation, global warming, unstable oil prices in the international market and social crisis in the Niger Delta.

III. LITERATURE REVIEW

Regarding the connection between GDP and the use of renewable energy, the following hypotheses have been developed based on four different causation scenarios. The growth hypothesis may be demonstrated, first, if rising GDP is a result of rising renewable energy use. In the production process, energy serves as a complement to labour and capital, and the growth hypothesis implies a unidirectional causal relationship between energy consumption and GDP [5].

According to the growth hypothesis, energy is a factor in economic expansion, hence energy-saving measures like lowering emissions may cause GDP to decline. The growth hypothesis is the opposite of the second scenario. Accordingly, the conservation hypothesis asserts that the relationship between GDP and energy consumption is unidirectional. According to the conservation hypothesis, energy-saving measures like lowering emissions or increasing energy efficiency won't hurt economic expansion [5]. According to the third scenario, there is an interdependent link between GDP and energy consumption

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14591298

that has an impact on both at the same time [5]. Evidence of bidirectional causation between GDP and energy use supports this scenario, which is known as the feedback hypothesis. Lastly, according to the neutrality hypothesis, energy use should not significantly affect economic growth since it represents a very tiny portion of GDP [5]. Therefore, the lack of a causal link between GDP and energy use supports the neutrality theory.

Renewable energy, which is defined as any energy generated by natural processes such as hydropower, geothermal, solar, wind, tides, biomass, and biofuels, accounted for 53.6% of the gigawatt capacity of all installed energy systems in 2015. Large hydropower projects are not included in this. As renewable energy sources became more affordable, dependable, and accessible, they were becoming considerably more common in both developed and emerging nations, according to [2]. The advantages of renewable energy technology for developing nations go beyond their environmental friendliness. By diversifying the energy portfolio, they might also help balance the budget and trade deficits, hedge against future rises in the price of conventional fuels, and provide new local economic possibilities that would help reduce poverty and spur economic growth [6; 7].

The body of research on the connection between renewable energy and economic development has grown significantly during the last 10 years. For instance, [8] investigates the relationship between the utilisation of renewable energy and South Africa's economic progress. Trade openness, capital formation, and carbon dioxide emissions are included as additional variables to produce a multivariate framework. To determine the direction of causality between the variables, he employed the Vector Error Correction Model (VECM). While the short-term data demonstrated a unidirectional causal relationship between economic growth and renewable energy consumption, the long-term results showed a unidirectional causal relationship between renewable energy consumption and economic growth. It established fresh local business prospects that aided in the fight against poverty and encouraged economic expansion [6; 7].

[9] used dynamic simultaneous-equation panel data models for 17 rich and emerging countries to examine the connection between nuclear usage, consumption of renewable energy, and economic growth. While the data from the individual nations were inconsistent, it was resolved that there was a unidirectional causal relationship between economic development and the use of renewable energy. [10] investigated the impact of combustible renewables, waste consumption, CO_2 emissions, and economic development in North Africa. The study adopted panel cointegration methods and Granger causality tests to examine the dynamic causal link between CO_2 emissions, consumption of combustible renewables and waste (CRW), and per capita real gross domestic product (GDP) for a panel of five North African countries between 1971 and 2008. Their Granger causality test results indicate a short-term unidirectional link between CRW and CO_2 emissions, as well as short- and long-term unidirectional causal correlations between CO_2 emissions and CRW consumption and real GDP.

[11] Examined the connection between economic growth and renewable energy use: using various information from some selected 15 West African countries using panel dynamic ordinary least squares (DOLS) on a sample of these countries from 1995 to 2014. Their findings showed that these nations' economic progress is slowed by their use of renewable energy. They ascribed this to the characteristics and origin of the renewable energy source primarily wood biomass used in West Africa. In West Africa, wood biomass is very polluting because of the residue it leaves behind when burned. West Africa, on the other hand, employs less renewable energy sources that don't harm the environment or people's health, such as solar, wind, and hydropower. Therefore, employing unclean and ineffective renewable energy sources can hinder economic growth and lower productivity.

[12] used yearly time series data from 1965 to 2015 to examine the connection between Pakistan's energy use, economic development, and carbon dioxide emissions. According to their anticipated ARDL estimates, Pakistan's CO_2 emissions rise over the long and short terms as a result of economic expansion and energy consumption. In light of the anticipated outcomes, the researchers recommended that Pakistani politicians adopt and encourage renewable energy sources, which will help meet the nation's expanding energy demand by replacing antiquated, traditional energy sources like coal, gas, and oil. Reusable renewable energy sources can help Pakistan achieve sustainable economic growth while reducing CO_2 emissions.

In a multivariate framework, [13] re-examined the connection between energy consumption and economic development by including labour and capital among the variables. Applying the Granger causality test, impulse response, and variance decomposition analysis, the research established the absence of a causal relationship among the sampled variables, and the variance decomposition showed that labour and capital had a greater impact on production growth than energy consumption. [14] computed the effect of renewable and non-renewable energy usage on the growth and expansion of manufacturing and services, it established renewable energy stimulates growth in high-growth industries, such as manufacturing in middle-income countries and services in high-income ones.

[15] examined, during 57 years (1960–2017), the causal relationship between economic development, CO_2 emissions, and renewable energy among sampled 45 sub-Saharan African countries. Using the GMM-PVAR technique, the researchers established a reciprocal causal relationship between renewable energy and economic growth [15]. In 2003, Ugur and Sari did another study (comparatively) that examined the causal relationship between the two series in the top 10 developing economies and G7 countries. Energy and consumption to GDP for Turkey, France, Germany, and Japan, as well as GDP to

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14591298

energy consumption for Korea and Italy, are all proven to be bidirectionally causal for Argentina. Additionally, it reveals countries such as Uruguay, Venezuela, Paraguay, Argentina, and Brazil had low percentages of renewable energy in their energy mix. The usage of fossil fuels and renewable energy was shown to be correlated for these countries, which might be a response to reservoir shortages [16].

However, in the case of the remaining four countries, energy conservation may cause economic development to slow down [17]. In many countries in the Organisation for Economic Co-operation and Development (OECD), the use of non-renewable energy has been estimated to have a favourable and substantial effect on economic development and activity [18]. There has been an evaluation of hybrid renewable energy systems (HRES) in developing nations [19]. According to them, Asian emerging nations outperform African ones in terms of production and maintenance of both renewable and non-renewable mini-grids. Additionally, they anticipate that mini-grid prices will generally continue to drop, increasing the utility-scale competitiveness of renewable energy sources. Additionally, other scholars looked for the reverse link between the development of renewable energy and economic growth (barriers). [20] think that while social, technological, and legal hurdles impede the growth of renewable energy, economic limitations have little direct effect on the results of renewable energy.

A. Renewable Energy Projects in Nigeria

The Renewable Energy Master Plan (REMP) of 2005 stipulates that by 2030, 36% of power should come from renewable sources, up from 13% in 2015. Renewable energy sources are projected to account for 10% of Nigeria's total energy consumption by 2025. In addition, the REMP has installed capacity targets for a variety of suitable renewable energy sources, such as small hydro (600 MW in 2015 and 2,000 MW by 2025), biomass-based power plants (50 MW in 2015 and 400 MW by 2025), solar photovoltaics (500 MW by 2025), wind energy (40 MW by 2025), and small hydro.

In 2017, the German Federal Ministry for Economic Cooperation and Development (BMZ) was involved in the Nigeria Energy Support Programme II, which was co-funded by the EU. The whole-time frame was between 2017 and 2018. Thanks to this project, about 16,000 people in rural areas now have access to solar power. Six off-grid village energy plants, commonly referred to as mini-grids, that provided clean electricity to 3,147 homes in five states were funded by public-private partnerships. A mini-grid regulation, a building energy efficiency code, an item energy efficiency label, and a national drive for energy efficiency and renewable energy are among the eleven new laws and regulations that have gone into force. More than 600 people also participated in training seminars on solar and mini-grid architecture.

The Renewable Energy and Energy Efficiency Project (REEEP), a four-year project in Nigeria, was started in 2018 by USAID and Power Africa. It is estimated that 26,938 Nigerians now have access to renewable energy, lowering their carbon emissions, thanks to the connection of 16,600 solar arrays. To support the economic recovery after the COVID-19 pandemic, the Federal Government of Nigeria launched an initiative as part of the Economic Sustainability Plan (ESP). To help private developers provide energy to five million homes, the Rural Electrification Agency (REA) launched the Solar Power Naija project to establish five million connections through an N140 billion financial plan.

B. Sources of Renewable Energy in Nigeria

- *Hydro Energy*

The nation has a fair number of natural waterfalls and major rivers. Within the current division of the nation into eleven River Basin Authorities, there are additional small rivers and streams, some of which maintain minimal discharges throughout the year. Currently, over 29% of the electrical power source comes from hydropower. More than 278 untapped small hydropower (SHP) sources with a combined capacity of 734.3 MW were found in research conducted throughout twelve states and four river basins [21]. Nonetheless, there are SHP prospective locations with an estimated 3,500 MW of total capacity in almost every region of Nigeria. According to them, Nigeria has a large number of river systems with potential renewable energy sources. A total of 70 micro dams, 126 mini dams, and 86 tiny sites have been discovered.

In Nigeria, eight SHP stations totalling 37.0 MW in capacity have been erected by the government and a commercial firm, the Nigerian Electricity Supply Firm (NESCO). Kwall and Kurra Falls are home to the majority of these stations in the Jos area. According to conservative estimates, the nation's river system has a total theoretically usable hydropower potential of 11,000 MW, of which only 19% is being developed or utilised at the moment [22]. If correctly utilised, these rivers, waterfalls, and streams with hydropower potential would result in decentralised use and offer the most accessible and reasonably priced alternative to off-grid electricity services, particularly for rural populations.

- *Solar Energy*

Nigeria is situated in an area with a lot of sunshine, which means the country is endowed with a potential amount of solar energy. Solar radiation is spread quite evenly, with an average of 19.8 MJm–2 day-1 and an average of 6 hours of sunlight each day. If solar collectors or modules were placed on 1% of Nigeria's geographical area, the country could generate 1850 x103 GWh of solar power annually, which is more than 100 times its present grid energy consumption level [23].

Numerous studies have been conducted by the National Centre for Energy Research and Development (NCERD) and the Sokoto Energy Research Centre (SERC) under the supervision of the ECN. Numerous solar-thermal, PV-water pumping and electrical installations have been put in place. These solar thermal applications include solar incubators, solar crop drying, solar cooking, and solar chick

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14591298

brooding. Water pumping, village electrification, powering rural clinics and schools, vaccine refrigeration, traffic lights, and road sign illumination, for low- and medium-power uses for solar electricity.

- *Wind Energy*

The average annual wind speed near the coast is about 2.0 m/s, whereas in the extreme north of the nation it is 4.0 m/s. In the extreme north, where the air density is 1.1 kg/m3, the wind energy intensity perpendicular to the wind direction ranges from 35.2 W/m2 to 4.4 W/m2 along the shore [23]. In Sokoto State, Sayyan Gidan Gada erected a 5-kW wind electricity conversion system for village electrification. In five northern states, only a few stand-alone wind power plants were set up in the early 1960s, mostly to supply electricity for water pumps. Without any commercial wind power facilities linked to the national grid, the nation's wind energy contribution has stayed low as of this writing [24].

- *Biomass*

Nigeria's biomass resources include crops, forage grasses and shrubs, animal waste, forestry waste, agricultural, forestry, municipal, and industrial operations, as well as aquatic biomass. Sugarcane, maize, and sweet sorghum were among the most promising crops to be used as feedstock for the production of biofuels [25]. Plant biomass may be used as fuel by small businesses. It may be fermented by anaerobic bacteria to produce bio gases, which are cheap fuel gases. The creation of biogas from agricultural residues, industrial waste, and municipal trash would reduce the risks caused by these wastes, in contrast to the production of bioethanol and biodiesel, which compete with food crops for land, water, and fertilisers.

In Nigeria, water lettuce, water hyacinth, manure, cassava leaves and processing waste, urban garbage, solid (including industrial) waste, agricultural leftovers, and sewage have been found as feedstock substrates for an economically viable biogas production [26]. Nigeria is thought to generate over 227,500 tonnes of fresh animal faeces per day. Nigeria can generate over 6.8 million m3 of biogas per day from animal waste alone since 1 kilogram of fresh animal waste generates roughly 0.03 m3 of biogas. Even though biogas technology is not widely used in Nigeria, several experts there have conducted studies on the technological and policy aspects of biogas generation. To optimise the process of developing anaerobic digesters, a considerable amount of research has been conducted on reactor design [26].

Wood waste and sawdust are two more significant biomass resources related to the timber sector. Sawdust and wood shaving may already be burned in small particle biomass burners. The use of biomass as an energy resource is now restricted to thermal applications such as crop drying and cooking fuel.

IV. RESEARCH METHODOLOGY

The study adopts both descriptive, charts and econometric analysis. The chart which depicts the data pictorially is drawn. This shows the extent of disparity between the Gross Domestic Product (GDP) and Renewable Energy Consumption (REC). The econometric method centres on regression analysis. The researcher conducted the stationarity test using the augmented Dickey Fuller test (ADF) to ensure the regression analysis did not yield spurious results. The study relies on secondary data such as compilation from the Central Bank of Nigeria Statistical Bulletin 2020, Nigeria Energy Market (enerdata.net), National Bureau Statistics and other government institutions. The data includes GDP and REC. This data covers (1990-2020). Econometric analysis was undertaken using Econometric View (E-view 7) software to test the efficacy of the study. The test of the hypothesis was conducted using a simple bivariate regression model in the study. The research model is specified as follows:

A. Model Specification

- *Stationarity Test:*
-

$\Delta Yt = \beta1 + \beta2 + Y\ \partial t\text{-}1 + \alpha1 \sum \Delta Y\ t\text{-}1 + \sum t$ …………………………………………….. (1)

Yt is the value of the variable Y in the period t
β1 is the intercept
β2 is the coefficient of the time period
∂ is the coefficient of the lagged variable and it is the main item use in testing for stationarity
∑t is the error term

- *Regression Analysis:*

This study will adopt bivariate regression analysis. The dependent variable will be gross domestic product (GDP) which proxies' economic growth while the regressor is renewable energy consumption (REC).

$Y = \beta0 + \beta1 + REC + \mu$ ………………………………………………………… (linear form)

The initial model in functional form is hereby stated below:

GDP = f(REC) ……………………………………………………… (2)

The model in explicit form is stated below:

$Y = \beta0 + \beta1REC + \mu$ ………………………………………………………… (3)

where GDP is gross domestic product
REC is for Renewable energy consumption
β0 stands for intercept
β1 stands for coefficient

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14591298

➢ *Apriori Expectations:*

$\beta 0$ ----- $\beta 1 \quad > 0$

The model has GDP as its dependent variable and renewable energy consumption as its explanatory variable. It is expected that renewable energy consumption (REC) will have positive direct relationship with gross domestic product (GDP). The magnitude effect of REC on GDP depends on deliberate policy of government on clean energy. Good government policy on clean energy coupled with proper implementation may bring about significant effect of REC on GDP.

➢ *Causality Model Specification:*

The bivariate pairwise causality model is as present below:

$GDP = \sum \alpha 1GDPt\text{-}1 + \sum \beta 1RECt\text{-}1 + \varepsilon t$ …………………………………………. (4)

$REC = \sum \alpha 1RECt\text{-}1 + \sum \beta 1GDPt\text{-}1 + \varepsilon t$ ………………………………………….. (5)

In the equation 4, GDP was related to its past values as well as past values of REC. On the other hand, equation 5 postulated that REC was related to its past values as well as past values of GDP. If $\beta 1$, $\beta 2$ ……. β t = 0 in equation 4, implies REC does not granger cause GDP. Similarly, if

$\beta 1$, $\beta 2$ ……. $\beta t = 0$ in equation 5 implied GDP does not granger cause REC.

In equation 4 above, current gross domestic product (GDP) was related to its past values as well as past values of renewable energy consumption (REC). On the other hand, equation 5 postulated that renewable energy consumption (REC) was related to its past values as well as past values of gross domestic product (GDP).

V. DATA PRESENTATION AND EMPIRICAL ANALYSIS

Descriptive Statistics was used to test for normality, which is otherwise known as the summary statistics. It is an essential statistic to be computed before running any regression because of the need to have a feel of your data set which your sample survey reveals. In computing this, raw data must be used and not a logged transformation data of first difference of a series. The usefulness of the statistics shows whether there is outlier in the data and also to reveal if the sample is normally distributed. The average GDP from 1990 to 2020 is N42390.06 billion and the average REC for the period is 29837.97 Ktoe. The skewness measures the degree of asymmetry of the series from the mean and kurtosis measures the peakness or flatness of the distribution of the series. The normal skewness has 0 skew that is distribution is symmetric around its mean. Positive skewness is a long right tail, much higher value than the sample mean while negative skewness is a long-left tail much lower value than the sample mean.

Mesokurtic is a normal distribution with a kurtosis of 3. Since normal skewness is 0 and the normal distribution with a kurtosis of 3 is mesokurtic, the GDP mirrors normal skewness of 0.3052 and playtikurtic (flatness of curve) because $1.47<3$. Similarly, REC demonstrates normal skewness of 0.0026 and playtikurtic (flattened curve) because $2.24<3$. This shows the lack of outlier in the residual. Jarque-Bera test is a goodness of fit test that determines whether or not sample data have skewness or kurtosiss that matches a normal distribution.

According to the data, the Jarque-Bera under the GDP is 3,4990 and its probability is 0,173. Since the probability is more than the significance level threshold of 0.05, the distribution is normal. Hence, the null hypothesis cannot be rejected. Similarly, Jarque-Bera under REC is 0.7343 and its probability is 0.692. Since the probability is more than the threshold of 0.05 level of significance, the distribution is normal. Hence, the null hypothesis cannot be rejected. Therefore, the probability distribution for both GDP and REC are normal.

Table 1: Result of Skewness of Residual (Jarque- Bera Test) Descriptive Statistics

	GDP	**REC**
Mean	42390.06	29837.97
Median	38378.80	29771.00
Maximum	71387.83	36441.00
Minimum	21462.73	21651.00
Std. Dev.	19161.30	3816.640
Skewness	0.305256	0.002625
Kurtosis	1.471543	2.246031
Jarque-Bera	3.499003	0.734308
Probability	0.173861	0.692703
Sum	1314092.	924977.0
Sum Sq. Dev.	1.10E+10	4.37E+08
Observations	31	31

Source: Computed by the author with E-view 7

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14591298

A. Correlation Analysis Result:

In this section, the relationship that exist among the variables, such as the independent variable and a dependent variable is measured using correlation analysis. The degree of linear relationship between range 1 to -1, which establish the level of correlation.

The Pearson correlation coefficient result shown in the table below indicates a somewhat positive relationship between GDP and REC across the research period. The low Pearson correlation value of 0.071961 indicates that there is limited chance of economic activity and, hence, a slight GDP growth when REC consumption increases.

Table 2: Correlation Analysis

	GDP	**REC**
GDP	1.000000	0.071961
REC	0.071961	1.000000

Source: Computed by the Author with E-view 7

B. Unit Root or Stationarity Test

In running a regression of any type, it is assumed that the variables are stationary at level I(0), That is the order of integration of each of the variable must be at I(0). However, if the assumption is relaxed, it becomes necessary to stabilize the data by performing the unit root test using Augmented Dickey fuller. Running a regression with a time series data will result to spurious regression hence the need for unit root test. The raw data of GDP and REC will either be trending upward, downward, or stochastic until the unit root test eventually stabilizes it thereby making them ready for regression. Below are trending examples of the series before the unit root test and after the unit root has been carried out. After the unit root test had been carried out, the two variables (GDP and REC) will now have constant mean and constant variance which means the two are now stabilized ready to be regressed.

C. Unit Root Test Result using ADF Method

VARIABLE	**ADF@LEVEL**	**ADF@FIRST**	**DIFFERENCE**
Order of Integration I(0)			
Intercept	GDP	-3.039553**	-I(0)
Intercept	REC	-3.459157**	-I(0)

Note: ***, **, and *. This implies the significance at 1%, 5% and 10% level respectively

CRITICAL VALUES

LEVEL

FIRST DIFFERENCE

-2981038

-

-2.963972

-

Source: Computed by the Author with E-view 7

The decision rule for using Augmented Dickey Fuller method is when:

Null hypothesis: p = 0. There is unit root i.e. (Not stationary)

Alternative hypothesis: p # 0. There is no unit root (stationary)

If t* > ADF critical value, Do not reject the null hypothesis i.e. unit root exist

If t* < ADF critical, Reject the null hypothesis i.e. unit root does not exist

Since our Augmented Dickey Fuller unit root test is based on intercept regression forms:

$\Delta GDPt = \alpha + \zeta GDPt\text{-}1 + \mu$

$\Delta RECt = \alpha + \zeta RECt\text{-}1 + \mu$

Where REC stands for renewable energy consumption and GDP stands for gross domestic product

In the course of unit root test for GDP, the variable was stabilized at level I(0) with ADF critical value of -2.981038 at 0.05 level of significance and the ADF statistic (t*) is -3.039553. This is shown with the graph DGDP. Similarly, REC was stabilized at level I(0) with ADF critical value of -2.963972 at 0.05 level of significance and the ADF statistic(t*) is -3.459157.

With the above result, t* < ADF critical value at level for the two variables i.e. GDP and REC. This means there is no unit root in the two variables after performing the unit root test on them.

D. Regression Analysis

This equation demonstrates the magnitude of response of regress and as a result of change in regressor. Regression analysis can be bivariate, that is two variable model or multivariate, that is contains one dependent variable and two or more independent variables. The coefficient in the model connotes the magnitude of change in dependent variable as a result of change in independent variables.

Table 3: Regression Result after the Unit Root Test

Dependent Variable: GDP				
Method: Least Squares				
Date: 02/13/22 Time: 22:54				
Sample (adjusted): 1995 2020				
Included observations: 26 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	85.67532	1787.849	0.047921	0.9623
GDP(-1)	0.958301	0.014157	67.69240	0.0000
D(GDP(-1))	0.638253	0.194090	3.288433	0.0039
D(GDP(-2))	-0.020274	0.228753	-0.088627	0.9303
D(GDP(-3))	-0.182743	0.222963	-0.819609	0.4226
D(GDP(-4))	0.698114	0.199552	3.498409	0.0024
REC(-1)	0.050844	0.054744	0.928758	0.3647
R-squared	0.997633	Mean dependent var		46338.36
Adjusted R-squared	0.996885	S.D. dependent var		18440.06
S.E. of regression	1029.129	Akaike info criterion		16.93562
Sum squared resid	20123010	Schwarz criterion		17.27433
Log likelihood	-213.1630	Hannan-Quinn criter.		17.03316
F-statistic	1334.581	Durbin-Watson stat		2.321019
Prob(F-statistic)	0.000000			

Source: Computed by the Author with E-view 7

From the regression analysis above, the past lagged GDP has a statistically significant effect on the current GDP. However, the model as a whole is stable going by the result of cusum test of significance at 0.05 levels. REC has no statistically significant effect on GDP. This may be a result of insufficient data at this stage on renewable energy consumption and effort in that area is still evolving. There is a need for a deliberate action plan by the government to invest more in that sector and introduce more incentives to enhance participation by potential investors.

The significance level of 0.01 is equivalent to the probability (F-statistic) of 0.0000. This displays each independence variable's total importance. All of the variables in the model together have a significant impact on the dependent variable at the 1% significant level if the prob (F-statistic) is equal to or less than 0.01. In this case, the model specification's renewable energy consumption has a large overall impact on GDP at the 1% level, as indicated by the pro (F-statistic) of 0.0000. The model suggests that if the industry is sufficiently incentivised, the use of renewable energy might have a major effect on GDP.

The adjusted R square of 99% shows the overall variation in GDP caused by changes in renewable energy consumption. This further indicates the importance of renewable energy consumption by the model used in the study provided the sector is properly harnessed. Durbin Watson's statistic of 2.3 is an indication of a lack of serial correlation in the data involved.

E. Granger Causality Test:

This is the capacity of one variable to predict the result of another. It is possible for causation to be unidirectional, meaning that REC to GDP causality does not imply GDP to REC causality. On the other hand, unidirectional causation between GDP and REC does not imply that REC and GDP are causally related. When both regressions' sets of GDP and REC coefficients are statistically substantially different from zero, feedback or bilateral causation is implied. Lastly, when the GDP and REC coefficient sets in both regressions are not statistically significant, independence is recommended.

Table 4: Granger Causality test

Pairwise Granger Causality Tests			
Date: 03/09/22 Time: 12:06			
Sample: 1990 2020			
Lags: 2			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
REC does not Granger Cause GDP	29	1.27511	0.2977
GDP does not Granger Cause REC		0.06813	0.9343

Source: Computed by the Author with E-view 7

From the table above, independence is applicable because the sets of REC and GDP coefficient are not statistically significant in the regression. The level of significance is set at the threshold of 0.05 level. Analysis from the data shows that it is independence causality which means REC does not granger cause GDP. Similarly, GDP does not granger cause REC because both variables are not statistically significant to each other. They do not fall within the threshold of 0.05 level of significance. The probability level of both variables are 0.2977 and 0.9343 respectively which are above the decision rule of 0.05 level of significance.

F. Cusum Test

This is a test of stability of the model. The decision rule is that the line within graph should not go outside the 5% within the graph. If the line goes outside the graph, it means the model is not stable and cannot be used for forecasting. From the graph below, the line stays within the 5% band which is an indication that the model used in the study is stable and can be used for forecasting.

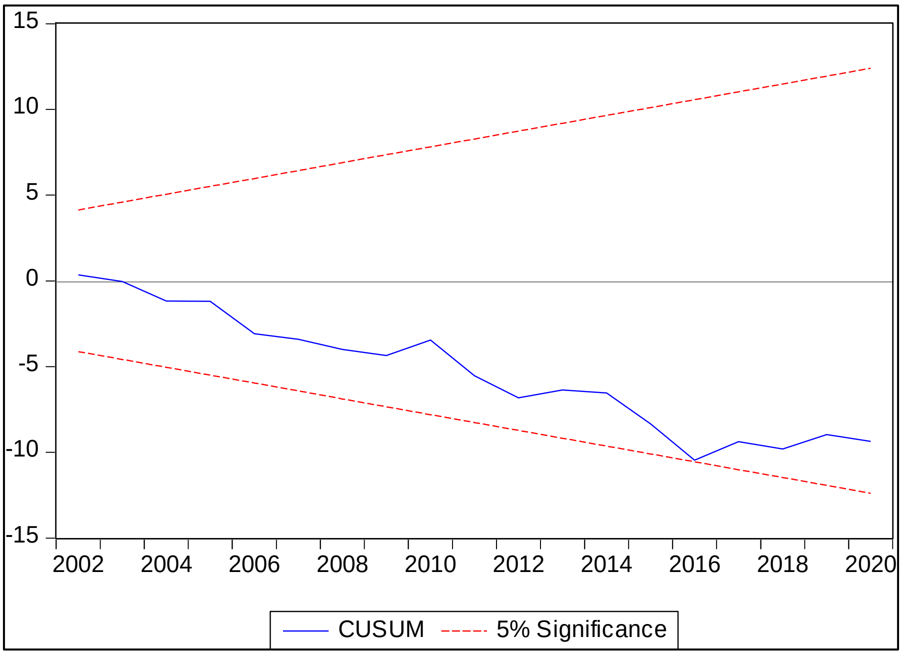

Fig 1: Cusum Test of Stability
Source: Computed by the Author with E-view 7

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

A. Summary

Nigeria as a big brother in the continent of Africa and the largest economy, the country has failed to provide its teeming population with energy security. There is no gainsaying that increased energy demand will enhance socio-economic and development. The provision of unclean energy has caused adverse effects on the population and retarded the economic growth process. Between 1970 and 1986, the Niger Delta region flared 102.3 million cubic meters out of the total production of 125.5 million cubic meters. Sustainable development is necessary, which has elevated it to a major position in the global energy discourse. Since renewable energy is more affordable, dependable, and widely accessible in both developed and developing nations, international leaders seem to agree that it is the greatest approach to promoting economic growth [2].

Incorporating renewable energy into our energy mix would surely reduce the nation's vulnerability to environmental degradation, fluctuating global oil prices, global warming, and social upheavals in the Niger Delta, where most of Nigeria's crude oil is derived. Increasing the quantity of power produced from renewable sources is the aim of the Renewable Energy Master Plan (REMP) for 2005. Additionally, the Nigerian government has been collaborating with several local and international groups to make solar energy available to the people, especially in rural regions.

The Federal Government of Nigeria and the Central Bank of Nigeria created a solar intervention fund to provide affordable power to rural populations. The fund will allow obligors to receive loan facilities up to N500 million. Renewable energy is without a doubt a viable solution to Nigeria's energy issues. It can be put up in small units and is sustainable and inexhaustible, which makes it suitable for ownership and management in rural areas and may be essential for economic development. To meet its growing energy needs, Nigeria must shift its focus from fossil fuels to renewable energy sources. This is because fossil fuels are not renewable, are more expensive, and hurt the environment. According to [5], the neutrality hypothesis concludes that there is no appreciable impact of renewable energy consumption on economic growth because it accounts for a negligible percentage of GDP.

The neutrality argument is supported by the absence of a causal relationship between GDP and the usage of renewable energy. This might be due to a lack of data at this stage of the country's renewable energy development, as well as a lack of incentives and government support for the sector. All of the independent variables combined are significant, according to the study's model's probability (F-statistic), which is 0.01 at the significance level. According to the study's findings, using renewable energy as a gauge of economic development is crucial. When the probability is 0.01 or below, the combined effect of all the factors in the model on the dependent variable is significant at the 1% significance level. The corrected R square, which shows the total GDP variance brought on by the usage of renewable energy, is 99%. This is a good indication that the future is bright and that economic advancement is imminent if the government can support the growth of the renewable energy sector.

Renewable energy at lag1 (REC-1) shows that it has no significant effect on GDP. Efforts in this area are still evolving and there is still a paucity of data on this variable. A deliberate policy stance is expected from the government to invest more in renewable energy development. However, past lagged GDP has a statistically significant effect on the current GDP which means there is potential for economic growth, if necessary, policies and actions can be put in place and properly implemented especially the renewable energy revolution which in turn accelerates the rate of economic growth and development. To further support the finding, the cusum test of stability shows that the model is stable because the curve within the cusum test lies within the 5% band. Any curve outside this band shows instability in the model. It is an indication that the variables involved in the study can interact. Correlation analysis shows that there is a positive weak relationship between renewable energy consumption and gross domestic product which is 0.07. The data used in the study is found to be normally distributed with the use of descriptive statistics. The same data also shows the absence of serial correlation after Durbin Watson statistic was carried out. These results indicate that the regression equation in the study is not spurious and can be used for prediction and forecasting.

B. Conclusion

The research study shows that the bane of our economic development is the failure of the government to provide its teeming population with energy security. The conventional electricity being provided by the government has been epileptic and could not even serve up to 60% of the country's population. This situation necessitated the shift of focus away from conventional electricity to a more sustainable one which is renewable energy. Renewable energy is expected to be a better option because of some advantages such as cheaper, more reliable and readily available. Its inclusion in the energy mix will lessen the nation's susceptibility to both internal and foreign threats, including social unrest in the Niger Delta, environmental degradation, fluctuating oil prices, and global warming.

Adequate energy security is undoubtedly the driver of economic growth; hence government must put in place effective regulations and incentives that will encourage more private participation to complement government efforts in that sector. The empirical evidence shows some positive effects, though slightly of renewable energy consumption on economic growth. This is an indication that the future of renewable energy in Nigeria is very bright if efficiently harnessed. However, the model on the two variables showed that renewable energy consumption has a massive significant impact on gross domestic product.

C. Policy Recommendations

Some of these policies are hereby recommended to boost renewable energy in Nigeria.

- The Renewable Energy Master Plan (REMP) must be strictly followed. The plans seek to increase the supply of renewable electricity from 13% of total electricity generation in 2015 to 23% in 2025 and 36% by 2030. Renewable electricity would account for 10% of Nigeria total energy consumption by 2025.
- Nigeria government should endeavor to invite competent bidders to tender for construction of various off grid solar system and other energy infrastructure projects across the nation.
- Energy laws relating to renewable energy must be constantly reviewed to foster collaboration between government and stakeholders to provide Nigerian citizens with renewable energy in aid to reduce carbon emissions.
- Regular solar intervention fund that offers soft loans to developers who engage in renewable energy projects.
- Government should come up with policy on massive rural electrification scheme in partnership with some

competent agencies to ensure that the average household in the rural communities have access to clean energy.

- Sanitization and strict monitoring of regulatory agencies of government in order to get rid of corruption that may hinder the government goal of delivering the desired renewable energy connection to the people especially those in remote communities.
- Policies put in place by government to promote the use of renewable energy must be constantly reviewed and efficiently managed.
- Authority should partner with international agencies for the purpose of securing huge loans at favorable interest and repayment term.
- General Business- friendly measure: Their exist several general (that is, not necessarily specific to energy) policies that can facilitate renewable energy investment. These include tax policy (such as not withholding taxes on profits, and no VAT on clean power sales), allowing foreign direct investment (FDI), improved permitting processes, and foreign currency/ ability to repatriate profits. All these enhance renewable energy generation.
- Regulated, transparent power arrangement: Policies must establish transparency and predictability, which provides confidence for investors in the ability to recover investments in power generation.
- Specific clean energy/climate incentives: Having an integrated, multi-year energy strategy with short term targets for retiring fossil fuel plants, if applicable, and building renewable energy helps lay the foundation for conducive policies. Establishing a carbon market or other carbon-pricing mechanism, as well as governance/legislation around carbon removal, is also of value.
- Chile offers an example: license passed a binding decommissioning schedule for coal-fired power plants; engaged with private power plant owners to develop coal phase out schedule; and implemented a tax on carbon for larger coal-fired power plants.
- Easy risk assumption: several successful projects have included an early sponsor that was willing to assume various risks. Once certain risks in the project had been ameliorated, the sponsor was able to attract additional or less expensive, capital.
- Financial incentives: such as grants, loans, rebates and tax credits should be provided in some states to encourage renewable energy development.
- Interconnections standards: These are processes and technical requirements that delineate how electric utilities in a state will treat renewable energy sources that need to connect to the electric grid. The establishment of standard procedures can reduce uncertainty and delay that renewable energy system can encounter when obtaining electric grid connection in states that have not established interconnection standards.
- Output-based environmental regulations establish emission limit per unit of productive energy output of a process with the goal of encouraging fuel conversion efficiency and renewable energy as air pollution control measures.
- Making easy the environmental permit: Larger scale renewable energy technologies are subject to all the necessary environmental permits of major industrial facilities. Renewable energy generation using new technologies can face permitting hurdles until permitting officials are familiar with the environmental effects of the generation process. Granting of environmental permit must be less cumbersome.
- Making available cost-effective and cost recovery transmission: many renewable resources are located in remote areas that lack ready or cost-effective access to transmission. States that have not established clear utility regulations that enable investments in transmission to be reimbursable (i.e. cost recovery) nor coordinated planning and permitting processes slow the development of utility- scale renewable projects in their territory.
- Establishment of favorable utility rate structure will increase the deployment of renewable energy technologies. Unless carefully monitored, development of distributed generation will be a mirage.
- Boosting the hydro power stations in Nigeria. Concession must be given to building of dams and maintenance in the country

REFERENCES

[1]. WORLD ENERGY ASSESSMENT (2000). http://www.undp.org/seed/eap.activities/wea/ at 299-302.

[2]. International Energy Agency (IEA) (2018). *World Energy Outlook*, (OECD: Paris) International Energy Agency (IEA), (2017). World Energy Outlook 2017. *OECD: Paris*.

[3]. Olugbenga, E. O. (2013). The politics of pharmaceutical regulation in Nigeria: Policy options for third world countries. *Politics*, *3*(8), 89-100.

[4]. Kenneth, H. (2014). Making the commitment to renewable energy. Global wind reports annual market update

[5]. Payne, Phillip. (2010). The globally great moral challenge: Ecocentric democracy, values, morals and meaning. Environmental Education Research - ENVIRON EDUC RES. 16. 153-171. 10.1080/13504620903504115.

[6]. Asian Development Outlook (2021). Financing a Green and Inclusive Recovery. (2021). https://doi.org/10.22617/fls210163-3

[7]. Yépez-García, R. A., & Dana, J. (2012). Mitigating Vulnerability to High and Volatile Oil Prices. In The World Bank eBooks. https://doi.org/10.1596/978-0-8213-9577-6

[8]. Okoye, L.U., Modebe, N.J., Erin, O.A., Evbuomwan, G.O. (2017). Effect of External Debt on Economic Growth: Evidence from Nigeria. Austria, Vienna: Proceedings of the 29th International Business

[9]. Omri, A., Daly, S. & Nguyen, D., (2015). A robust analysis of the relationship between renewable energy consumption and its main drivers, *Applied Economics*, 47(28): 2913-2923, DOI: 10.1080/00036846.2015.1011312 NNPC, (2010). Nigerian National Petroleum Corporation: Available at: www.nnpcgroup.com .

[10]. Ben Jebli, Mehdi & Ben Youssef, Slim. (2017). Renewable energy, arable land, agriculture, CO2 emissions, and economic growth in Morocco. MPRA Paper.

[11]. Maji, I., Sulaiman, C., & Rahim, A. (2019). Renewable energy consumption and economic growth nexus: Fresh evidence from West Africa. *Energy Reports*, Volume 5, March. DOI: 10.1016/j.egyr.2019.03.005

[12]. Khan, M. K., Khan, M. I., & Rehan, M. (2020). The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. Financial Innovation, 6(1), 1. doi:https://doi.org/10.1186/s40854-019-0162-0

[13]. Ibrahim Aminu, Mohammed. (2015). Mediating Role of Dynamic Capabilities on the Relationship between Intellectual Capital and Performance: A Hierarchical Component Model Perspective in PLS-SEM Path Modeling. Research Journal of Business Management. 9. 443-456. 10.3923/rjbm.2015.443.456.

[14]. Doytch, Nadia & Narayan, Seema. (2021). Does Transitioning towards Renewable Energy Accelerate Economic Growth? An Analysis of Sectoral Growth for a Dynamic Panel of Countries. Energy. 235. 121290. 10.1016/j.energy.2021.121290.

[15]. Acheampong EO, Sayer J, Macgregor CJ, Sloan S. (2021). Factors Influencing the Adoption of Agricultural Practices in Ghana's Forest-Fringe Communities. *Land*; 10(3):266. https://doi.org/10.3390/land10030266

[16]. Koengkan, M., Fuinhas, J. A., & Santiago, R. (2020). The relationship between CO2 emissions, renewable and non-renewable energy consumption, economic growth, and urbanisation in the Southern Common Market. *Journal of Environmental Economics and Policy*, *9*(4), 383-401.

[17]. Soytas, Ugur & Sari, Ramazan. (2003). Energy Consumption and GDP: Causality Relationship in G-7 Countries and Emerging Markets. Energy Economics. 25. 33-37. 10.1016/S0140-9883(02)00009-9.

[18]. Ivanovski, Kris & Hailemariam, Abebe & Smyth, Russell. (2021). The effect of renewable and non-renewable energy consumption on economic growth: Non-parametric evidence. Journal of Cleaner Production. 286. Article 124956. 10.1016/j.jclepro.2020.124956.

[19]. Zebra, E. I. C., van der Windt, H. J., Nhumaio, G. & Faaij, A. P.C. (2021). A Review of Hybrid Renewable Energy Systems in Mini-grids for off-grid Electrification in Developing Countries. *Renewable and Sustainable Energy Reviews*, 144 (1), 1 – 23. 111036,https://doi.org/10.1016/j.rser.2021.111036.

[20]. Seetharaman, Krishna Moorthy, Nitin Patwa, Saravanan, and Yash Gupta. (2019). "Breaking Barriers in Deployment of Renewable Energy." Heliyon 5 (1). https://doi.org/10.1016/j.heliyon.2019.e01166.

[21]. Aliyu, U.O. and Elegba, S. B. (1990). Prospects for Small Hydropower Development for Rural Applications in Nigeria. Nigerian Journal of Renewable Energy, 1, 74-86.

[22]. Okafor E.N.C. and Joe-Uzuegbu (2010). Challenges to development of renewable energy for electricity power sector in Nigeria. International journal of academic research, 2:2 211- 216

[23]. Sambo, A. S. (2009). Strategic Developments in Renewable Energy in Nigeria. International Association for Energy Economics. Third Quarter: 15 – 19.

[24]. Uzoma, C. C.; Nnaji, C. E; Ibeto, C.N.; Okpara, C.G.; Nwoke, O.O.; Obi, I.O.; Unachukwu, G. O and Oparaku, O. U. (2011). Renewable Energy Penetration in Nigeria: A Study of The South East Zone. Continental J. Environmental Sciences 5 (1): 1 - 5, ISSN: 2141 - 4084 http://www.wiloludiournal.com

[25]. Nnaji, Chibueze & Uzoma, Chigasa & Chukwu, Jude. (2010). The Role of Renewable Energy Resources in Poverty Alleviation and Sustainable Development in Nigeria. Continental J. of Social Sciences. 3. 31-37.

[26]. Akinbami, J.F.K. (2001). Renewable Energy Resources and Technologies in Nigeria: Present Situation, Future Prospects and Policy Framework. Mitigation and Adaptation Strategies for Global Change 6: 155-188. Kluwer Academic Publishers. Netherlands.