International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(1), 433-439.

Energy Sustainability, Energy Financing and Economic Growth in Nigeria

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Received: 31 January 2020 **Accepted:** 15 September 2020 **DOI:** https://doi.org/10.32479/ijeep.9336

ABSTRACT

Increase in the global population growth has led to a simultaneous increased in demand for energy leading to increased fear of global warming. This situation has given the international community a cause for concern and as a result, countries are seeking alternative sources for cleaner and sustainable energy. The importance of utilising greener energy sources is evident in the United Nation's Sustainable Development Goals (SDGs), especially Goal 7, Target 2. This study examined the long-run relationship between economic growth, sustainable energy and the different financing options for sustainable energy in Nigeria. The Johansen Cointegration test was utilised in order to achieve this objective. The findings showed that different sources of sustainable energy and the different types of financing employed in Nigeria have different effects on the economic growth of Nigeria. A long-run relationship amongst all three variables was also established. These findings are an indication that with the right policies, SDG 7 could be achieved.

Keywords: Sustainable Energy, Energy Financing, Economic Growth, Sustainable development goals, Nigeria
JEL Classifications: Q20, Q28, Q43

1. INTRODUCTION

Energy is a highly demanded commodity in the world, and it is essential in achieving economic growth and development across the globe (Oyedepo, 2012; Onakoya et al., 2013). However, the phenomenon of global climate change and global warming, which are seen as threats to human existence, has led to a rise in the demand for sustainable energy (Simsek and Simsek, 2013; Alege et al., 2017). In addition, the global population increase has fuelled the demand for sustainable energy. Specifically, the continuous increase in the population of Nigeria, standing at about 200 million people (World Bank, 2019), has caused a rise in the country's demand for and usage of energy.

However, energy in Nigeria is mainly obtained from non-renewable sources which are not sustainable. The negative impacts of the excessive use of these fuels violate the concepts of sustainable energy as it causes environmental degradation through pollutants such as gas flaring/emissions from combustions, coal gases/particulates and oil spillage (Matthew et al., 2018). Therefore, there is a need for cleaner energy sources in order to ensure a sustainable energy provision in accordance with the sustainable development goal (SDG 7).

For this study and following the classical definition given by the World Commission on Environment and Development (WCED) in 1987, sustainable energy is defined as energy that "meets the need of the present generation without compromising the ability of the future generations to meet their own energy needs." This definition is as relevant today as it was three decades ago when it was initiated. Sustainable energy refers to the energy that is clean and renewable, thus making it inexhaustible. Although Nigeria is the largest oil producer in Africa and possesses both non-renewable and renewable (wind, solar, hydropower, and biomass) energy sources (Gershon et al., 2019). According to Iwayemi (2012), over 40% of the population of Nigeria live without electricity. This issue of the incessant power outage is one of the primary reasons why over 70% of the Nigerian population lives below the poverty line and negatively affect health outcomes (Iwayemi, 2012; Matthew et al., 2019). Similarly, Charles (2014) pointed out that only 10% of the people in the rural area and 30% of the total population have access to electricity. This has therefore made Nigeria seek other alternative means of power such as the use of diesel and petrol generating sets.

However, these sources of electricity are not sustainable and the continued usage may impact negatively on health outcomes and on the economy Matthew et al., 2019. The prospect of having a sufficient amount of sustainable energy in Nigeria is high since the country is endowed with numerous energy sources that can cater for the present and the future energy use. The energy source that is presently being invested in by the federal government of Nigeria is the hydropower, but it is still insufficient. As a result, other forms of sustainable energy (solar, biomass and wind) must be encouraged and developed.

Against these backdrops, this study aimed to empirically examine the relationship amongst economic growth, sustainable energy and the different financing options for sustainable energy in Nigeria. This study is structured into five sections; following this introductory section is section two which presents some insights from the empirical literature. The methodology adopted is discussed in section three. Section four discusses the estimations and results of the study, while section five concludes the study and policy recommendations are provided.

2. EMPIRICAL LITERATURE

It is clear from the literature that the inability to secure the required investment in Sub-Saharan African is a hindrance to accessing clean energy (Chirambo, 2016). Chirambo (2018) using an exploratory research method, investigated numerous innovations aimed at increasing the access of sub-Sahara African to Sustainable and clean energy. Findings from the study indicate the need for a regional institutional regulator to monitor the progress of both climate change and clean energy, thereby taking an important step towards realising the SGD 7. The relationship between energy consumption and economic growth has been examined in literature; for example, Shiu and Lam (2004) in a study examined the relationship between economic growth and electricity consumption in China using the error correction model (ECM), the study affirms the presence of co-integration between the energy consumption and economic growth.

Literature covering Sub-Saharan African such as Akinlo (2008) examined the link between economic growth and energy consumption for selected countries in Sub-Saharan Africa. The autoregressive distributed lag (ARDL) bounds test and the vector error correction model (VECM) were used in order to achieve the set objectives. The results from the study showed that for Ghana, Cameroon, Zimbabwe, Gambia, Sudan, Cote d'Ivoire and Senegal, economic growth and energy consumption were co-integrated. In Senegal, Ghana, Sudan and Kenya, it was observed that energy consumption was growth-enhancing. The study confirmed a two-way causal relationship between economic growth and energy consumption for Senegal, Ghana and Gambia. While a unidirectional relationship was confirmed for Zimbabwe and Sudan, the neutrality hypothesis was established in Nigeria, Cameroon, Togo, Kenya and Cote d'Ivoire.

A similar study on the relationship between economic growth and energy consumption was conducted by Onakoya et al. (2013). The study was limited to the Nigeria economy with a scope covering 35 years (1975-2010). The Ordinary Least Square method and co-integration technique were adopted. The result from the analysis indicated that the variables are co-integrated. Further analysis reveals a significant and positive relationship amongst petroleum, electricity and energy consumption. In a more recent study, Mitic et al. (2017) analysed the link between economic growth and carbon emissions for 17 transitional economies. The authors utilised annual data from 1997 to 2014 and made use of both the fully modified OLS (FMOLS) and dynamic ordinary least squares (DOLS) approaches in order to achieve their objectives. Economic growth and carbon emissions were confirmed to have a long-run relationship.

With the use of a structural vector autoregressive (SVAR) approach, Silva et al. (2012) analysed the effect of renewable energy sources (RES) on the growth of the economy and Carbon dioxide emission, employing a sample of four countries from the period of 1960 to 2004. The findings of the study show that there was an economic cost in terms of economic growth and there is also a significant decrease in the CO_2 emissions per capita as a result of using RES. Jebli and Youssef (2014) examined whether there was a causal relationship amongst combustible renewables and waste consumption, carbon dioxide (CO_2) emission and economic growth and using data from five countries in North Africa during the period of 1971-2008. The major variable in determining economic growth was found to be CO_2 emission. The study, therefore, recommended that the North Africa region can use renewable energy sources in place of fossil fuel in order to avoid the depletion of the atmosphere as well as stimulate the growth of the economy.

By using a group of eighteen Latin American countries, Al-Mulali et al. (2014) investigated the effect of renewable electricity consumption and non-renewable electricity consumption on the growth of the economy. To this end, the authors made use of the vector error correction model (VECM) and Granger causality tests. Results of the study confirmed the existence of a bidirectional relationship amongst all the variables used in the study. The authors found that out of the two energy sources, renewable energy was more significant in stimulating economic growth. Pao et al. (2014) opined that a sustainable energy economy could be enhanced through the creation of clean and fossil fuel energy partnerships. They investigated the relationship amongst clean energy consumption, unclean energy consumption and economic growth of four nations (South Korea, Mexico, Turkey and Indonesia). The authors recommended that in order to address the issues surrounding climate change and energy security, it was necessary to develop renewable and nuclear energy sources.

Troster et al. (2018) carried out a study to determine whether there is a causal relationship amongst renewable energy consumption, the prices of oil and growth of the economy in the United States of America. The study made use of the Granger Causality method. The results obtained confirmed the presence of a two-way relationship amongst the study variables. Despite the extensive research conducted on sustainable energy, there are only a few that consider the various financing options available in the same model. This is the gap in the literature that this study intends to fill as considering both sustainable energy and different financing options available, important policy-inferences could be made from the results obtained.

3. METHODOLOGY

3.1. Data Source

This study examined the relationship amongst economic growth, sustainable energy and the different financing options for sustainable energy in Nigeria. In order to achieve this, annual data was obtained from the world development indicators (WDI), ranging from 1981 to 2014, thus spanning a period of 34 years. The selection of the period is exclusively based on the availability of data for Nigeria. The variables of interest are shown in Table 1 with their respective symbols, descriptions, sources and measurements. Gross domestic product per capita (GDPPC) is used to proxy economic growth; combustible renewables and wastes (COREW), alternative and nuclear energy (ALNUE), and electricity production from hydroelectric sources (HYDRO) are used as proxies for sustainable energy; net official development assistance received (NETOD), net taxes on products (TAXES) and external debt (EXTDT) are used as proxies for sustainable energy financing options.

3.2. Model Specification

This study adopted the method proposed by Maji (2015) and modifies in order to suit this study. Our modification draws from the introduction of the different financing options available for sustainable energy in Nigeria, the baseline model is specified in equation (1).

$$GDPPC_t = f(COREW_t, ALNUE_t, HYDRO_t, NETOD_t, TAXES_t, EXTDT_t) \quad (1)$$

The above expression in equation (1) can be expressed in the classic Cobb-Douglas production function form, which is shown below:

$$GDPPC_t = ACOREW_t^{\omega_1} ALNUE_t^{\omega_2} HYDRO_t^{\omega_3} NETOD_t^{\omega_4} TAXES_t^{\omega_5} EXTDT_t^{\omega_6} \mu_t \quad (2)$$

In order to satisfy the linearity condition of the OLS assumption, we obtain the natural logarithm transformation of equation (2) which yields the following:

$$LNGDPPC_t = a + \omega_1 \; LNCOREW_t + \omega_2 \; LNALNUE_t + \omega_3 \; LNHYDRO_t + \omega_4 \; LNNETOD_t + \omega_5 \; LNTAXES_t + \omega_6 \; LNEXTDT_t + \mu_t \quad (3)$$

where a represents the intercept. *LN* represents the natural logarithm. a represent the intercept while μ_t represent the error term. ω_1, ω_2, ω_3, ω_4, ω_5 and ω_6 represent the elasticities of COREW, ALNUE, HYDRO, NETOD, TAXES and EXTDT, respectively.

4. ESTIMATIONS AND RESULTS

4.1. Unit Root Tests

A fundamental requirement when dealing with times series data is to test for the existence of unit root in order to determine the stationarity of the series. This is due to the non-stationary property of time series. The consequences of using non-stationary data for econometric analysis is that it usually leads to a spurious result. The Philip Phillips-Peron (PP) unit root test and the Augmented Dickey-Fuller (ADF) unit root test was conducted in order to show whether the following log-linearised time series are stationary or not: COREW,ALNUE,HYDRO,NETOD,TAXES and EXTDT. Table 2 show's us the result of the unit root test. All the variables of importance in this paper are stationary after first differencing. Thus, using these series eliminates the possibility of obtaining spurious empirical results. With stationarity established, the Cointegration test is carried out so as to achieve the objective of this study.

4.2. Johansen Cointegration Test

This paper employs the widely-used Johansen Cointegration test (Johansen, 1991). It is used to show whether the explanatory and explained variables possess a long-run relationship. The result of the Cointegration test is shown in Tables 3 and 4, respectively. Both the Trace statistic and the maximum Eigen statistic reveal 4 co-integrating equations amongst the selected variables of interest. This thus supports that a long-run relationship exists amongst economic growth, sustainable energy and the different financing options for sustainable energy.

4.3. Granger Causality Test

After establishing that the variables are co-integrated, this study goes ahead to determine the causal relationship that

Table 1: Data description and measurement

Symbol	Description	Source	Measurement
GDPPC	Gross domestic product per capita	World Development Indicators (2017)	Constant Naira (₦)
COREW	Combustible renewables and wastes	World Development Indicators (2017)	Percentage of total energy
ALNUE	Alternative and nuclear energy	World Development Indicators (2017)	Percentage of total energy
HYDRO	Electricity production from hydroelectric sources	World Development Indicators (2017)	Percentage of total energy
NETOD	Net official development assistance received	World Development Indicators (2017)	Percentage of GNI
TAXES	Net taxes on products	World Development Indicators (2017)	Constant Naira (₦)
EXTDT	External debt	World Development Indicators (2017)	Percentage of Gross National Income

Source: Authors

Table 2: PP and ADF unit root tests

Variables	PP test		ADF test		
	Level	First difference	Level	First difference	Decision
LNGDPPC	0.261009	−4.242329*	0.542457	−4.257043*	I(1)
LNCOREW	−2.594056	−6.408230*	−2.518695	−5.695536*	I(1)
LNALNUE	−1.344122	−6.867076*	−1.402457	−6.844402*	I(1)
LNHYDRO	0.048891	−6.829895*	−1.103063	−0.554822*	I(1)
LNNETOD	−2.536004	−5.021321*	−2.959760	−5.199612*	I(1)
LNTAXES	−1.918897	−4.846880*	−1.922424	−3.754164*	I(1)
LNEXTDT	−0.252437	−4.839246*	−0.145566	−4.841518*	I(1)

Source: Authors' Computation Using EViews 10 Software. *indicate the 1% level of significance for the test critical values

Table 3: Johansen cointegration test (trace statistic)

Hypothesised number of CEs	Eigen value	Trace statistic	0.05 Critical value	Prob.**
None*	0.937457	214.1193	125.6154	0.0000
At most 1*	0.898236	144.8218	95.75366	0.0000
At most 2*	0.793800	87.69443	69.81889	0.0010
At most 3*	0.725451	48.22174	47.85613	0.0462
At most 4	0.353448	15.90610	29.79707	0.7189
At most 5	0.178246	5.003541	15.49471	0.8084
At most 6	0.003820	0.095695	3.841466	0.7570

Table 4: Johansen Cointegration test (maximum Eigen statistic)

Hypothesised number of CEs	Eigen value	Max-Eigen statistic	0.05 critical value	Prob.**
None*	0.937457	69.29751	46.23142	0.0000
At most 1*	0.898236	57.12738	40.07757	0.0003
At most 2*	0.793800	39.47269	33.87687	0.0097
At most 3*	0.725451	32.31564	27.58434	0.0114
At most 4	0.353448	10.90255	21.13162	0.6570
At most 5	0.178246	4.907847	14.26460	0.7534
At most 6	0.003820	0.095695	3.841466	0.7570

Source: Authors' computation using EViews 10 Software. *denotes rejection of the null hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) P-values

exists, if any, amongst the variables. Table 5 presents the result from the granger causality test. From the results, it is seen that a unidirectional causal relationship exists for all the pairs considered except for combustible renewables and wastes and gross domestic product per capita. Specifically, there is a unidirectional causal relationship flowing from gross domestic product per capita to alternative and nuclear energy, electricity production from hydroelectric sources, net official development assistance received and external debt. Also, a unidirectional causal relationship flowing from net taxes on products to gross domestic product per capita was discovered.

4.4. Impulse Response Functions

The granger causality test, despite being useful in pointing out the direction of causality that exists between any two variables, is not able to provide inferences concerning the variables of interest beyond the time period utilised. As a result, forecasts cannot be made from it. In addition, the granger causality test is silent as to the sign of the relationship existing between the variables. Due to these reasons, this study goes ahead to determine the impulse responses over a 10-year period when there is a one standard deviation positive innovation to another variable. The results from the impulse response functions (IRFs) are shown in Figure 1.

From Figure 1, it is seen that gross domestic product per capita rises for two periods following a positive shock to itself. In the third period, it declines before increasing again in the subsequent period. The gross domestic product per capita witnesses an initial decline in after a shock to combustible renewables and wastes. However, in the third period, it begins to experience a rise and goes on to become positive in the fifth period. After there is a shock to alternative and nuclear energy, gross domestic product per capita witnessed a sharp decline. In the third period, its response becomes stable, although it remains negative. Gross domestic product per capita is unaffected by a shock to electricity production from hydroelectric sources in the first period. However, it turns negative in the subsequent periods.

Initially, after a shock to Net official development assistance received, gross domestic product per capita witnesses a sharp increase before levelling up in the third period. Gross domestic product per capita experiences a steep decline following a shock to net taxes on products before becoming stable in the second period. In addition, it is seen that the response of gross domestic product per capita to a shock to external debt is negative.

4.5. Variance Decomposition (VD)

After obtaining the IRFs for gross domestic product per capita, this study goes ahead to determine its variance decomposition (VD). Table 6 presents the result and it shows that in Period 1, the variation to gross domestic product per capita is entirely due to a shock to itself. Further down the time periods, this variation is attributed to other shocks. In Period 2, the share of the variation caused by gross domestic product per capita shock drops by almost 50%. In that same period, net official development assistance received and combustible renewables and wastes shock account for a significant portion of the variation which is 21.92% and 10.08% respectively. In period 3, net official development assistance received shock accounts for most of the variation in gross domestic product per capita and this pattern continues till Period 10. In Period 10, 29.76%, 15.49% and 15.39% of the variation in gross domestic product per capita is attributed to net official development assistance received, electricity production from hydroelectric sources and alternative and nuclear energy shocks respectively, which account for more than 60% of the variation in gross domestic product per capita.

Table 5: Pairwise granger causality test

Null hypothesis	F-statistic	Prob.	Decision	Causality
LNCOREW does not granger cause LNGDPPC	0.45226	0.6409	Accept	None
LNGDPPC does not granger cause LNCOREW	1.39569	0.2650	Accept	
LNALNUE does not granger cause LNGDPPC	1.25789	0.3004	Accept	Unidirectional
LNGDPPC does not granger cause LNALNUE	9.63044	0.0007	Reject	
LNHYDRO does not granger cause LNGDPPC	0.16484	0.8489	Accept	Unidirectional
LNGDPPC does not granger cause LNHYDRO	10.8212	0.0004	Reject	
LNNETOD does not granger cause LNGDPPC	0.91778	0.4115	Accept	Unidirectional
LNGDPPC does not granger cause LNNETOD	7.91546	0.0020	Reject	
LNTAXES does not granger cause LNGDPPC	3.69340	0.0431	Reject	Unidirectional
LNGDPPC does not granger cause LNTAXES	0.57867	0.5698	Accept	
LNEXTDT does not granger cause LNGDPPC	1.60022	0.2204	Accept	Unidirectional
LNGDPPC does not granger cause LNEXTDT	5.40273	0.0106	Reject	

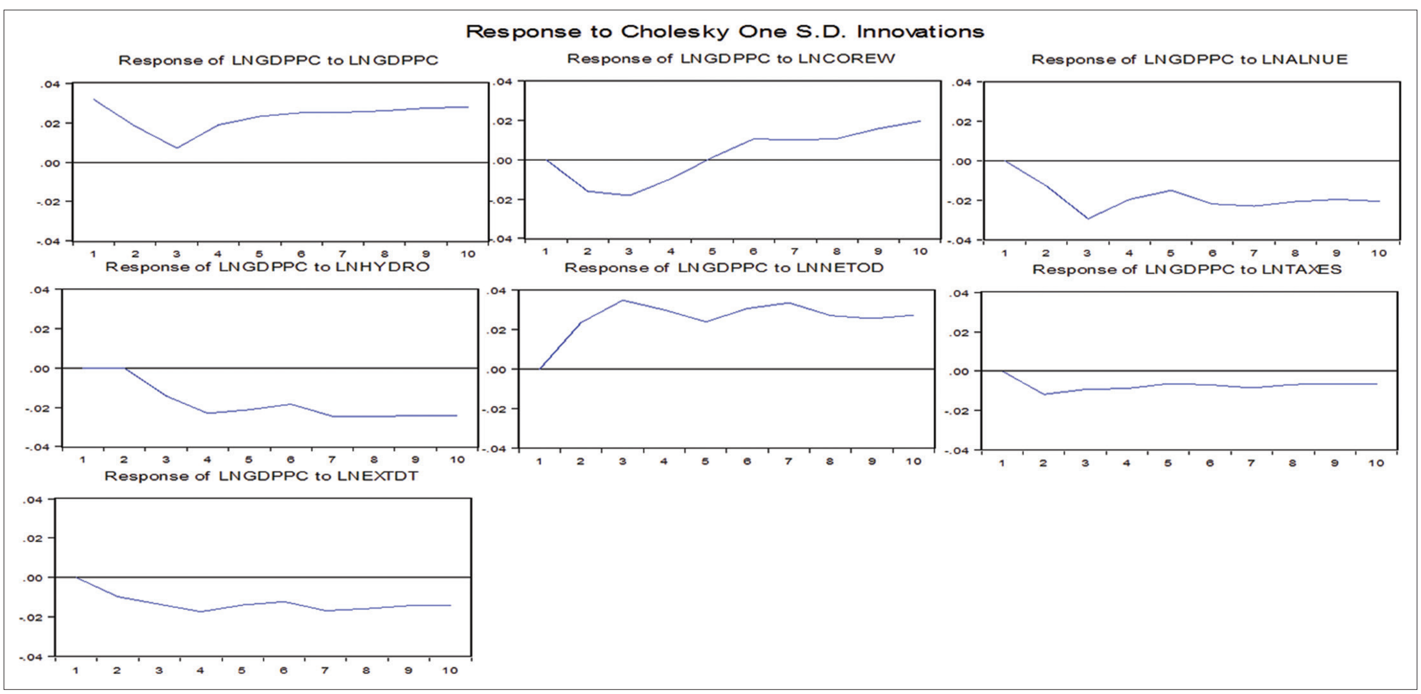
Source: Authors' computation via E Views 10

Table 6: Variance decomposition of LNGDPPC

Period	S.E.	LNGDPPC	LNCOREW	LNALNUE	LNHYDRO	LNNETOD	LNTAXES	LNEXTDT
1	0.031756	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.050520	52.47670	10.08269	6.324804	9.27E-05	21.92322	5.465196	3.727295
3	0.074124	25.30278	10.73332	18.63761	3.694274	32.40070	4.096656	5.134657
4	0.090231	21.46517	8.407405	17.28343	9.001069	32.95313	3.719407	7.170378
5	0.100831	22.50783	6.746559	16.05354	11.61277	32.04404	3.377349	7.657921
6	0.113467	22.66838	6.216855	16.40277	11.78809	32.65459	3.048219	7.221101
7	0.127427	21.92036	5.545049	16.25144	13.04742	32.87856	2.871500	7.485668
8	0.138268	22.18331	5.309401	16.03804	14.32551	31.79167	2.681258	7.670811
9	0.148294	22.72895	5.750867	15.68034	15.07325	30.63809	2.525362	7.603135
10	0.158563	22.98264	6.565083	15.38946	15.49003	29.76037	2.376495	7.435926

Source: Authors' computation using EViews 10 software

Figure 1: Impulse response functions of gross domestic product per capita



5. CONCLUSION AND POLICY RECOMMENDATIONS

It is seen that, sustainable energy (except combustible renewables and wastes) and the various financing options (except net official development assistance received) would contribute negatively to the growth of the Nigerian economy. At first, combustible renewables and wastes negatively affects economic growth and this may be as a result of the indiscriminate felling of trees by its users as a source of energy. Felling of trees without replanting may bear a negative influence on the environment, the people and in turn, the economy. However, its contribution to economic growth later becomes positive. Perhaps, this may be due to the overshadowing positive effect of the use of this source of energy which in the long run is cheaper. Wood fuel is a component of combustible renewables and wastes and it is a cheaper alternative to energy for both rural and urban dwellers. By using the relative cheaper energy source, the economy is boosted. However, caution must be taken so as not to witness a counter-effective reaction of this energy source due to deforestation. Rather, policy measures should be put in place in order to discourage deforestation and encourage afforestation, which would, in turn, contribute to the sustainability of this energy source. In addition, monitoring bodies should be set up in order to guard against the felling of trees without proper approval from the appropriate authorities.

It is also seen that both alternative and nuclear energy and electricity production from hydroelectric sources contribute negatively to the economy. The reason for the negative contribution of electricity generated from hydro sources to economic growth in Nigeria may be attributed to the negative spill-over effects of making use of hydropower. Some of these negative spill-over effects include an inadequate number of hydro-electric plants in Nigeria the poor maintenance and upgrade to modern technologies, inability to meet growing electricity demand under the present capacity of hydro-electric plants. The negative contribution of alternative and nuclear energy to economic growth in Nigeria may be attributed to its under-development and poor usage in Nigeria. Due to its low production, this source of energy is expensive in Nigeria, both to producers and consumers and as a result, it may contribute negatively to the economy.

This result calls for a swift response on the part of the government and other stakeholders in the Nigerian energy sector. Being a country surrounded by large bodies of water and having rainy reasons, Nigeria stands a lot to benefit from making use of hydro-electricity. Not only is hydropower sustainable, but it is also eco-friendly and relatively cheaper than some other sustainable sources of energy such as solar energy. All of the factors hampering the efficient and effective production of hydro-electric energy must be reviewed in details and mitigated so that Nigeria could reap the benefits of the hydro-electricity. For alternative and nuclear energy, since it provides immense benefit and would help to cater for the growing energy needs of the Nigerian population, the Nigerian government and all concerned stakeholders should develop the country's infant nuclear industry so as to ensure its availability at an affordable price. The results show that the contribution of Net official development assistance received to economic growth in Nigeria is positive. The reason for this may be because this source of financing is monitored by the donor countries or organisations. However, despite the positive contribution of net official development assistance received to economic growth, great care must be taken when dealing with it as some economists have argued that dependence on foreign financing could hamper the growth and development in developing countries.

It is also seen that both taxes and external debt contribute negatively to economic growth in Nigeria. The negative contribution of tax to economic growth may stem from cases of tax avoidance and tax evasion. With high taxes, people are encouraged to alter their financial books and take advantage of loopholes in tax laws. Some people evade taxes altogether. In order to reduce cases of tax avoidance and tax evasion, taxes levied should not be above the ability and willingness of the taxpayers. In addition, the government should operate an effective taxation system that would ensure proper remittance of collected tax funds to the government so that tax benefits are reaped by both the public and the private sectors. Tax laws should also be made clear and the process should be transparent.

It is revealed that the contribution of external debt to economic growth in Nigeria is negative. The reason for this may be as a result of the negative effect of a debt burden. Since debts would have to be paid back, they are shifted to the citizens in the form of higher taxes. In turn, higher taxes, as the results have shown, lead to a negative effect on economic growth. It is recommended that loans should be taken only after proper and careful consideration by economic experts. Funds borrowed should also be used to embark on projects that have a high return or on projects that help to facilitate economic activities.

This study has thus been able to achieve its set objectives by establishing the existence of a long-run relationship amongst the variables of interest. From the results obtained from the study, it is possible for Nigeria to be able to achieve the 7th Sustainable Development Goal (Affordable and Clean Energy) before the SDGs timeline elapses in the next 12 years by 2030. This would be made possible if all stakeholders get involved in the sustainable energy movement.

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