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(6), 43-49.

Biomass Energy Consumption and Economic Growth: An Assessment of the Relevance of Sustainable Development Goal – 7 in Nigeria

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Received: 04 September 2020 **Accepted:** 25 June 2021 **DOI:** https://doi.org/10.32479/ijeep.10565

ABSTRACT

In many developing and emerging economies of the world, renewable and non-renewable energy use has been a contentious issue in maintaining a sustainable economy. Renewable energy is popular because of increased oil demand and cost, dependence on external sources of energy and emissions leading to environmental destruction. Particularly in Nigeria, due to poor electricity supply and inadequate access to the use of clean energy; houses and firms have been subjected to the use of fossil fuels which results in increased carbon emissions and productivity distortion. In the light of this, the need for clean energy as identified by United Nations Sustainable Development Goal - 7, describes the need for access to affordable, dependable and clean energy for all. Therefore, this study investigates the relationship between Nigeria's consumption of biomass energy and economic growth sustainability. The data used for this study covers a sample period of 1981–2017 annual time series dataset on these variables: GDP growth rate, labour force, gross fixed capital formation, biomass energy consumption and international crude oil price, as sourced from World Bank World Development Indicators. Using Autoregressive Distributed Lag and Granger Causality, this study identifies the quantitative significance of biomass energy consumption in contributing to economic growth sustainability in Nigeria. Therefore, the implication of the findings highlight that for Nigeria to grow and sustain its economy, there is need to invest more in clean energy sources to growth and sustain the economy.

Keywords: Energy, Sustainable Economy, Biomass
JEL Classifications: Q40, Q01, Q42

1. INTRODUCTION

Nigeria is regarded as one of the Africa's fastest growing economies that is endowed with various energy sources but still largely deficient in providing stable power supply for the economy use. The factors considered to be common barriers in the energy sector include inadequate use of technology to engage in research and development, inadequate financial investment on renewable energy which requires large capital and socio-cultural behaviour of citizens whose preference for energy use is coal. Meanwhile, in terms of CO_2 emission in the global community, Nigeria is ranked 38. This can be attributed to the greenhouse gas emission caused by the expensive energy consumption that accompanied growth in the economy (Okorie et al., 2020). In addition, unsustainable operating practices by multinationals and ineffective government policies have resulted in more socio-economic issues in the country and complex environmental destruction. No doubt, emissions have negative impact on gross domestic product in Nigeria just like in any economy. This is because emissions of carbon reduce productivity and output, which in turn adversely affect economic growth (Akinyemi et al., 2017).

In the past, the Nigerian government has put in place several policies to improve their energy sector's performance. Some of these policies include the National Energy Policy in 2003, which was aimed at creating a reliable energy supply mix through diversification of electricity supply based on an economy in which renewable energy increases its share of energy usage and provides affordable access to energy across Nigeria. Also, the 2007 Nigerian Biofuel Policy and Incentives aimed at reducing the dependence of the nation on imported gasoline and reducing emissions, and the Renewable Electricity Action programme of 2006 provided strategies for the nation in terms of energy development. However, inspite of all these policies, the Nigerian energy industry performance is still not encouraging. For instance, while the country has large deposit of crude oil, hydro, coal, natural gas, petroleum, biomass and solar resources, it has the potential to generate 12,522 megawatts (MW) of electricity from existing plants. However, only around 4,000 MW is generated and over 20 million households are still without electricity, while the current rate of rural access is only around 36% (Olopade et al., 2020). Meanwhile, as the most populous country in Africa since its independence in 1960, the country has significantly grown over the years to over 186 million with an estimate of around 59.3% of the population having access to electricity (Matthew et al., 2019).

This population growth leads to increase demand for energy and therefore fossil fuel emissions. Emission increase is caused by human activities such as deforestation, fumes from industries and use of generators due to extreme weak energy production in the country as individuals, organisations and industries look for alternative means of power thereby polluting the environment. Policies on populations could be viewed as part of the international climate policy approach. Unlike Nigeria, emerging economies such as China and Russia have contributed substantially to global emission despite having low rates of population growth. Global emission reductions can be achieved via population policies without the economic trade-off central to most other policies (Casey and Galor, 2016). Nigeria has been argued as a country with a high level of pollution and given the adverse consequences of such pollution for the Nigerian economy, it is the case that cleaner, affordable and reliable energy such as biomass may be employed in driving her growth process and also to act as a carbon neutral cycle in the atmosphere. Therefore, an important issue of concern in this study is to what extent does biomass energy consumption contribute to economic growth in Nigeria? Also, what is the relevance of biomass energy source in driving economic growth sustainability in Nigeria for the attainment of United Nations Sustainable Development Goal (SDGs) by 2030?

Therefore, this study is divided into five sections. section one, is the introduction of the study, while section two contains the brief literature. The third section examines the model specification and technique of estimation, as well as variable description and data sources. And, section five focuses on the summary of findings, recommendations and conclusion.

2. BRIEF LITERATURE REVIEW

Over the past few decades, researchers and scholars have been concerned about the nexus between energy consumption and economic growth. This is due to the fact that production and consumption of energy are possible drivers of any sustainable economy, as well as the main factors for socio - economic development and the achievement of higher living standards. Therefore, it is essential to ensure that energy production and consumption are carried out efficiently and mostly on the basis of sustainable technologies that will not affect us in the future. This is important, because the relevance of sustainable energy for economic development is recognized in the SDG - 7, which identify access to sustainable, affordable and modern clean energy as important for economic sustainability. Therefore, an inclusion of biomass energy source in an economy is expected to have significant impact in socio-economic development of an economy and help to reduce emission of greenhouse gases and environmental pollution. Meanwhile, Nigeria being rich in agricultural produce; biomass consumption should add value to the agricultural products, promote rural economic development and reduce poverty in the economy, and by extension reduce dependence on the importation of petroleum products. As a result, this study focuses on biomass energy consumption as alternative source of energy to Nigeria as compared to fossil fuels which emits a high amount of carbon in the atmosphere. While there are various types of energy, it is the case that cleaner and affordable energy is desirable in driving economic growth in Nigeria especially on account of the high level of pollution in Nigeria from dirty energy sources.

Meanwhile, empirical studies on biomass energy and economic growth in Nigeria are still sparse as most studies have largely focussed on renewable energy in general without specifically examining biomass energy and its effect on economic growth and its sustainability (e.g. Ali et al., 2019; Ali, 2018; Destek, 2017; Aslan, 2016; Alege et al., 2016). For instance, based on the study by Bildirici and Özaksoy (2016), the causal link between woody biomass energy consumption and sub - Saharan Africa's economic growth was investigated by applying Autoregressive Distributed Lag (ARDL) approach and Granger causality test for the sample period of 1980–2013. The result indicated that woody energy consumption of biomass can be construed as normal good in South Africa and Seychelles, while woody energy consumption can be interpreted as inferior goods in Angola and Mauritania. For the causality link, the result showed that there is unidirectional causality from the consumption of woody biomass energy to economic growth in Angola, Guinea - Bissau and Niger; this supports the growth hypothesis. While there is evidence to support the feedback hypothesis for Benin, Mauritania, Nigeria and South Africa, which is from economic growth to woody biomass energy consumption. Similarly, the relationship between the use of biomass, carbon emissions and economic growth was examined by Adewuyi (2017) in West Africa by simultaneous equation, they estimated with three stage least square from 1980 to 2010. From the panel results, they found out that Western Africa's economic growth is linked to higher use of biomass, coupled with high carbon emissions. The result also confirmed ineffectiveness of energy and carbon in West Africa. Hence, the need to reduce energy intensity.

This study is therefore an attempt in the case of Nigeria to assess the extent to which biomass energy consumption contributes to economic growth and its sustainability in Nigeria for the attainment of United Nations SDGs by 2030? Furthermore, observation from studies on Nigeria's energy and economic growth is the omission of oil price as an explanatory variable in specified models, which is an important variable that affects economic growth in relation to Nigeria given her heavy reliance on oil exports for economic growth. Previous empirical studies on the impact of renewable energy on economic growth have largely omitted this variable. Therefore, this research attempts to bridge the gap in the literature on energy by analysing the relationship between biomass energy consumption and economic growth in Nigeria with the inclusion of oil price as a control variable in the model.

3. METHODOLOGY

This part of the study deals with data and methodology engaged in assessing the relationship between Nigeria`s consumption of biomass energy and economic growth sustainability. To avoid issues of variable bias and minimize errors of misspecification, the study adopts a multivariate framework. The data used for this study covers a sample period of 1981–2017 annual time series dataset on variables: GDP growth rate (GDPR), which is the dependent variable; while biomass energy consumption (BMC), gross fixed capital formation (GFCF), labour force input (LBF) and international crude oil price (OP) are the independent variables. These secondary data are sourced from World Development Indicators (WDI) as published by World Bank (2017). In using the time series dataset, the study applied unit root test to ascertain the stationarity status of the variables. This satisfies the condition that the series have a predictable trend and thereby reduces the possibility of spurious estimates. The outcome of the unit root test informed the choice of the appropriate technique of estimation used in the study.

3.1. Model Specification

The functional form of the model is specified as:

$$GDPGR = f(BMC, GFCF, LBF, OILP) \quad (1)$$

Where:
GDPR – GDP growth rate
BMC – biomass energy consumption
GFCF – gross fixed capital formation
LBF – labour force input
OILP – international crude oil price

The explicit form of model 1 is specified as:

$$GDPR_t = \alpha_0 + \alpha_1 BMC_t + \alpha_2 GFCF_t + \alpha_3 LBF_t + \alpha_4 OILP_t + \mu_t \quad (2)$$

Where:
α_0 – Intercept Term
α_1 – coefficient of biomass energy consumption
α_2 – coefficient of gross fixed capital formation
α_3 – coefficient of labour for
α_4 – coefficient of gross fixed capital formation
μ_t – This is the stochastic error term. It represents other independent variables in the model that are affecting the dependent variable but not taken into account.

3.2. Technique of Estimation

Following the outcome of the unit root test result, the study further adopts the method of ARDL model, or bounds test. This approach as advanced by Pesaran et al. (2001) is more reliable due to its ability to analyse relationships amongst variables. Thus, it is introduced to assess the relationship between Nigeria`s consumption of biomass energy and economic growth sustainability. This is because the method incorporates I(0) and I(1) variables in the same estimation unlike in the case of OLS or any other technique. Not only can it accommodate fractionally integrated variables [I(0) and I(1)], it is also adequate for small sample data from 25 years and above, unlike other co-integration tests that require 30 years and above. Moreover, the ARDL approach simultaneously estimates the short-run and the long-run effects of one variable on the other. Therefore, the representation of the model to achieve the stated objective is specified as follows:

$$\Delta GDPR_t = \lambda_0 + \sum_{i=1}^{m}\lambda_1 \Delta GDPR_{t-i} + \sum_{j=0}^{n}\lambda_2 \Delta BMC_{t-j} + \sum_{k=0}^{O}\lambda_3 \Delta OP_{t-K} + \sum_{l=0}^{p}\lambda_4 \Delta LBF_{t-l} + \sum_{m=0}^{q}\lambda_5 \Delta GFCF_{t-m} + \lambda_6 GDPR_{t-i} + \lambda_7 BMC_{t-j} + \lambda_8 OILP_{t-k} + \lambda_9 LBF_{t-l} + \lambda_{10} GFCF_{t-m} + \mu_t \quad (3)$$

From equation (3), Δ is the first- difference operator the following parameters λ_1, λ_2, λ_3, λ_4 and λ_5 are the long run coefficients, while λ_6, λ_7, λ_8, λ_9 and λ_{10} are the short run coefficients, and the error term is represented with μ_t.

3.2.1. Wald F-test

To establish the long run relationship amongst the variables of interest, the Wald test is applied on equation (3), where

$$H_o = \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = \lambda_8 = \lambda_9 = \lambda_{10} = \lambda_{11} = \lambda_{12} = 0$$

$$H_1 = \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq \lambda_7 \neq \lambda_8 \neq \lambda_9 \neq \lambda_{10} \neq \lambda_{11} \neq \lambda_{12} \neq 0$$

The null (H_0) hypothesis argues that there is no co-integration among the variables, while the alternative (H_1) represents the hypothesis of co-integration. If the calculated F-statistic exceeds the upper critical bounds value, then the H_0 is rejected. If the F-statistic falls within the bounds then the test is inconclusive. Lastly, if the F-statistic falls below the lower critical bounds value; it implies that there is no co-integration.

3.2.2. Error correction term

The short-run error correction coefficient measures the discrepancy between the actual values and the estimated values. It additionally shows the speed of adjustment from the short-run dynamics to the long-run equilibrium value. For the coefficient of the error correction term to be significant and reliable, it must be negatively signed and within the magnitude of zero and 1. Therefore, the error correction of the ARDL model is specified as follows:

$$\Delta GDPR_t = \lambda_0 + \sum_{i=1}^{m}\lambda_1 \Delta GDPR_{t-i} + \sum_{j=0}^{n}\lambda_2 \Delta BMC_{t-j}$$
$$+\sum_{k=0}^{O}\lambda_3 \Delta OILP_{t-K} + \sum_{l=0}^{p}\lambda_4 \Delta LBF_{t-l} + \sum_{l=0}^{p}\lambda_5 \Delta GFCF_{t-m}$$
$$+\eta ECM_{t-1} + \mu_t \quad (4)$$

where Δ represents the difference operator, ECM_{t-1} is the lagged error correction term derived from the long-run co-integrating relationship from the specified bounds test model (3). In equation (4), η is the estimated value of the adjustment speed of ECM. And as consistent with the literature, the ECM is expected to be negatively signed and significant for co-integrating relation to be established in the long run of the model.

3.2.3. Granger causality test

The granger causality test shows the causal relationship between each of the independent variables and the dependent variable in a time series. It is a statistical hypothesis test for determining whether 1-time series is useful in predicting another. Both null hypothesis and alternative hypothesis are used. The null hypothesis states that the variable does not granger cause the other variable while the alternative hypothesis states that the variable granger cause the other variable. The probability value is used to determine whether or not one variable granger causes the other. If the probability value against the other is <0.05 at a 5% level of significant then we reject the null hypothesis and accept the alternative hypothesis that the variable does granger cause the other. If both variables granger cause one another then, there is a bidirectional causation. This test is included in the study to assess the link between variables of interest.

3.3. Definition of Variables

Real gross domestic product growth rate (GDPR)- This represents the percentage increase in GDP from quarter to quarter. It is included in the model to explain whether the economy is growing quicker or slower than the previous quarter.

Biomass consumption (BMC)- this is the quantity of biomass that is finally consumed in a country from the burning of organic materials directly and sending it through a steam turbine which then generates electricity and is used by both firms and household.

Crude oil price (OILP)- This refers to the spot price of a barrel of benchmark crude oil, a reference price for buyers and sellers of crude oil. It is measured as the Brent spot price in US dollars per barrel. This is important since Nigeria is an oil dependent economy.

Labour Force Participation Rate (LPR)- This is the proportion of a country's working-age population that engage actively in the labour market either employed or seeking for employment. Nigeria is seen as the most populous country in Africa which is meant to account for a large number of labour force. Labour force participation is important in an economy as it entails supply of labour to industries and also determines the amount of goods and services that will be produced in a country.

Gross fixed capital formation (GFCF)- This is defined as the acquisition and creation of assets by producers for their own use minus disposals of produced fixed assets (Adediran et al., 2019). It is included in the model because physical assets such as plants, machineries and equipment; construction of roads, bridges and railways need energy to power them to run effectively.

The empirical analysis is conducted using secondary data. The years covered in this study is between 1981 and 2017. The variable descriptions, measurements and sources are summarized in the Table 1 below.

4. RESULTS AND DISCUSSION

4.1. Descriptive analysis

The variables used for this study are summarized in terms of their descriptive statistics in the Table 2 below:

Table 2 displays the descriptive statistics of all variables used for the data analysis. These variables are namely, GDP growth rate

Table 1: Description of variables, measurements and sources

Variable	Variable name	Definition	Measurement	Source
RGDP	Real gross domestic product growth rate	This demonstrates the percentage increase in the economic activities of a country from one quarter to another.	Measured in %	World Bank
BMC	Biomass energy consumption	Energy gotten the burning of woody, non-woods and animal waste products used for electricity and heating.	Domestic Material Consumption (Tonnes)	International Resource Panel
OILP	International crude oil price	spot price of a barrel of benchmark crude oil in US$.	Measured in US$.	OPEC
LPR	Labour Force	Proportion of population engaged in production of goods and rendering of services.	Measured in % of total population	World Bank
GFCF	Gross fixed capital formation	Improvements in fixed capital nationally.	Measured in %	World Bank

Source: Authors' computation

(GDPR), Biomass Consumption (BMC), Gross Fixed Capital Formation (GFCF), Labour Force (LBF) and Oil Price (OILP). From the Table, the mean of GDP growth rate is 3.20%. This mean is quite low relative to the maximum value of GDP growth rate of 15.32%. The median of GDP growth rate is 4.23, and the minimum is −13.12, while Real GDP growth rate in addition has a standard deviation of 5.61. Similarly, the maximum values of GDPR, BMC, GCFC, LBF and OILP are: 15.32, 0.51, 89.38, 60562.25 and 109.45 respectively. While, the minimum values of the variables are: −13.12, 0.28, 14.16, 23365.85 and 12.28 respectively. Also, standard deviation which is a measure of spread or dispersion in the series, show from the Table that the standard deviation for GDPR, BMC, GFCF, LBF and OILP are 5.61, 0.05, 19.62, 10807.54 and 29.83 respectively. Then, Skewness which is a measure of asymmetry of the distribution of the series around their mean at −0.87, indicates a negative skewed distribution of GDP growth rate. Similarly, Kurtosis which is used to measure the peak or flatness of the distribution of series, explains that if the kurtosis of the series is above three, then the distribution is peaked or leptokurtic relative to the normal. Kurtosis of 4.45 indicates a peaked data distribution of GDP growth rate, this describes the normal distribution characteristic of the series.

4.2. Test for Stationarity

Stationarity test investigates the evidence of presence or absence of unit root in the series. A stationary or integrated series is one that time-invariant (a change in time does not distort the shape of the distribution). Stationary series enhance reliability of research outcomes. Hence, the Augmented Dickey- Fuller (ADF) test was conducted to ascertain the stationarity level of the variables in a model.

4.2.1. Unit root test

The result of the ADF stationary test, presented in Table 3 shows that GDPR and GFCF are stationary at level, while the remaining variables: BMC, LBF and OILP are differenced once to achieve stationary status of the series at intercept and trend specification. This justifies the application of the Autoregressive Distributive Lag (ARDL) as advanced by Pesaran et al. (2001) in estimating the parameters of the model.

4.3. ARDL Bounds Cointegration Test

The F-bounds test shown in Table 4 indicates evidence of co-integrating relationship among the variables captured in the model which suggests that they do not exhibit a tendency to drift over the long-run. This is evidenced by the observed F-value (3.315896) being greater than the lower (2.86) and upper (3.38) critical bounds at 5% level of significance.

4.4. Long-run Result

From the dynamic long-run ARDL estimation, it is observed that present rate of GDP growth rate is greatly determined by its previous or lagged values. The result indicates that the condition of GDP growth rate in the past two periods (lag 2) sustains an increase in the current state of GDP growth rate. The R-squared (0.801138) and Adjusted R-squared (0.602276) show that the explanatory variables jointly explain about 92% and 86%, respectively, of variations in unemployment rate in Nigeria and the Prob. (F-statistic) of 0.000005 indicates high level of significance. The Durbin-Watson statistic (2.142776) suggests absence of serial auto-correlation of errors in the model.

From the regression estimates, the coefficient of the second period from Table 5 is given as 0.663371, which is statistically significant. This means that a one unit change in period one of GDPR results in a 0.663371 unit change in current period of GDPR. The coefficient of current period, first period and third period of BMC are 68.29425, 86.81721 and -96.65712 respectively, which are also statistically significant given that their P-values are less than 0.05. The sign also agrees with the apriori expectation that biomass should increase the growth rate on the economy. That is, 1-unit increase in BMC will lead to 68.29 increase in growth rate. The coefficient of the gross fixed capital formation (GFCF) is −0.93644 and it is statistically significant at 5% at current period, this means that a 1unit increase in gross fixed capital formation (GFCF) would bring about 0.93 decrease in growth rate. This sign does not go in line with my apriori expectation. Whereas, first, second and third periods of GFCF are −0.327303, 0.272068 and 0.243061 which are statistically insignificant. Similarly, the coefficient of the labour force (LBF) at current period is 0.011731 and is statistically significant at 5%, this means that a 1 unit increase

Table 2: Descriptive statistics of variables

	GDPGR Growth Rate (In %)	BMC (Tonnes)	GFCF (In %)	LBF	OILP (In US $)
Mean	3.20	0.39	36.68	38530.07	40.65
Median	4.23	0.36	36.58	37423.73	28.10
Maximum	15.32	0.51	89.38	60562.25	109.45
Minimum	−13.12	0.28	14.16	23365.85	12.28
Std. Dev.	5.61	0.05	19.62	10807.54	29.83
Skewness	−0.87	0.78	0.95	0.38	1.17
Kurtosis	4.45	2.82	3.56	2.07	3.09
Observations	37	37	37	37	37

Source: Authors' computations

Table 3: Unit Root test

Variables	Series at Levels			Series at First Difference			Order of integration
	ADF Statistic of the series	Critical value at 5%	Remarks	ADF Statistic of the series	Critical value at 5%	Remarks	
GDPR	−3.87	−3.54	Stationary	−10.23	−3.54	Stationary	I (0)
BMC	−1.54	−3.54	Non-stationary	−15.93	−3.54	Stationary	I (1)
OILP	−2.02	−3.54	Non-stationary	−5.20	−3.54	Stationary	I (1)
GFCF	−3.65	−3.54	Stationary	−5.30	−3.55	Stationary	I (0)
LBF	1.57	−3.54	Non-stationary	−5.84	−3.54	Stationary	I (1)

Source: Authors' Computation with EViews (2020) in labour force would bring about a 0.01 increase in growth rate. This goes in line with the apriori expectation. Also, coefficient for first period, second period and third period are −0.007481, −0.009443 and 0.004291 respectively, which are statistically significant. Also, the coefficient of oil price (OILP) is −0.092426, but is statistically insignificant at 5% at current period, this means that a 1unit increase in world oil price would bring about a 0.09 decrease in growth rate. This does not go in line with the apriori expectation.

From the ARDL test it was found that biomass consumption in the current period and the immediate previous period are both significant for GDP growth rate in Nigeria. Consequently, biomass consumption influences the Nigeria economy positively. Also, the second period lag of biomass consumption which is insignificant has a negative impact on the economic growth of Nigeria, while the third period lag of biomass consumption is significant but has a negative effect on economic growth. The implication of this is that biomass energy is significant in economic growth and sustainability. This is similar to the previous argument based on research carried out by Ali et al. (2018) and Bildirici and Özaksoy (2016), which showed that Nigeria should promote the use of renewable energy such as biomass energy which is significant towards economic growth. However, this study is an improvement on those studies, because it demonstrates how biomass energy consumption can increase the Nigerian growth rate and its sustainability. Since, biomass consumption may improve economic growth by adding value to agricultural products in Nigeria and thus promote economic development in rural areas. Also, through biomass, adequate renewable energy derived will reduce petroleum import dependence of Nigeria. Furthermore, it is an alternative energy source that is vital to a nation's growth which could help to reduce greenhouse gas emissions and pollution of the environment.

Table 4: Bound test result

F-bounds test		Null hypothesis: No levels relationship		
Test statistic	**Value**	**Significance level (%)**	**I(0)**	**I(1)**
F-statistic	3.315896	10	2.45	3.52
K	4	5	2.86	3.38
		2.5	3.25	4.49
		1	3.74	5.06

Source: Authors' computation with EViews (2020)

Table 5: Long-run results

Variables	Coefficient	Std. error	t-statistic	Prob.*
GDPR(−1)	0.071691	0.183081	0.391578	0.7005
GDPR(−2)	0.663371	0.178732	3.711535	0.0019
BMC	68.29425	27.81834	2.455008	0.0259
BMC(−1)	86.81721	27.62192	3.143054	0.0063
BMC(−2)	−7.506902	19.29995	−0.38896	0.7024
BMC(−3)	−96.65712	26.51189	−3.645802	0.0022
GFCF	−0.93644	0.187938	−4.982699	0.0001
GFCF(−1)	−0.327303	0.246002	−1.330489	0.2020
GFCF(−2)	0.272068	0.206044	1.320439	0.2053
GFCF(−3)	0.243061	0.145168	1.674339	0.1135
LBF	0.011731	0.002652	4.424112	0.0004
LBF(−1)	−0.007481	0.002503	−2.988498	0.0087
LBF(−2)	−0.009443	0.003741	−2.524125	0.0226
LBF(−3)	0.004291	0.001989	2.157133	0.0465
OILP	−0.092426	0.045759	−2.019826	0.0605
OILP(−1)	−0.107435	0.078379	−1.370715	0.1894
CONSTANT	35.83067	16.31177	2.196615	0.0431
R-squared	0.801138	Mean dependent var		4.508047
Adjusted R-squared	0.602276	S.D. dependent var		3.972721
S.E. of regression	2.505409	Akaike info criterion		4.981166
Sum squared resid	100.4332	Schwarz criterion		5.752094
Log likelihood	-65.18923	Hannan-Quinn criter.		5.240559
F-statistic	4.028618	Durbin-Watson stat		2.142776
Prob(F-statistic)	0.004085			

Source: Authors' computation with EViews (2020)

4.5. Error Correction Model (ECM) Results

The short-run results presented in Table 6 shows strong negative effect of lagged values of GDP growth rate on its current values. The adjustment or error correction mechanism, with a coefficient of 0.685511, indicates that about 68.5% of past errors are corrected in the current period. This implies a high speed of convergence from short-run to long-run equilibrium condition.

4.6. Granger Causality Estimates

Table 7 shows evidence of causality between biomass energy consumption and economic growth. From the Table, the results show that GDPR does not granger cause BMC as the F-statistic of 2.93416 is statistically insignificant (P = 0.0961). Also, BMC does not granger cause GDPR as the F-statistic of 0.71926 is statistically insignificant (P = 0.4025). The null hypothesis of no causality is rejected at the 10% level. Therefore, there is a unidirectional causality between BMC and GDPR.

4.7. Diagnostics

The goodness of fit characteristic of the ARDL model was examined using the Breusch-Godfrey LM test, Breusch-Pagan-Godfrey, and Jarque-Bera test. The results indicate no higher order autocorrelation, no heteroskedasticity, and evidence of normality respectively. The results suggest the estimates obtained from the analysis are suitable for policy decisions Table 8.

Table 6: Short-run estimates

Variable	Coefficient	Std. error	t-statistic	Prob.
GDPR (−1)	−2.551340	0.199227	−6.381136	0.0000
BMC	0.216462	0.063986	2.208312	0.0077
OILP	0.032388	0.004838	7.067524	0.0000
CointEq(−1)	0.685511	0.075641	8.366252	0.0000
R-squared	0.813077			
Adjusted R-squared	0.781603			
Durbin-Watson stat	2.031665			

Source: Authors' computation with EViews (2020)

Table 7: Granger causality estimates

Pairwise Granger Causality Tests			
Sample: 1 38			
Lags: 1			
Null Hypothesis:	**Obs.**	**F-statistic**	**Prob.**
GDPR does not Granger Cause BMC	36	2.93416	0.0961
BMC does not Granger Cause GDPR		0.71926	0.4025

Source: Authors' computation with EViews (2020)

Table 8: Diagnostic tests

Diagnostic Tests	F-statistic	P-value	Chi (χ^2) /T-statistic	P-value
Breusch-Godfrey LM test	0.163661	0.6924	0.298387	0.5748
Breusch-Pagan-Godfrey	1.263410	0.3352	9.85736	0.2928
Jarque-Bera test	–	–	1.615543	0.40277

Source: Authors' computation with EViews (2020)

5. SUMMARY OF FINDINGS

This study investigates biomass consumption in Nigeria and how it may contribute to economic growth in the context of Nigeria who is heavily reliant on crude oil imports for her energy needs. This study sought to achieve two research objectives using different tools of econometric analysis. The research objectives gave rise to two testable research hypotheses. The hypotheses were those of contribution of biomass to economic growth and causality between biomass consumption and Real GDP growth rate. The ADF unit root test performed on the variables revealed that while some variables were I(0), others were I(1). Hence ARDL bounds test was more appropriate to test for co-integration as a precursor to testing the hypothesis of the contribution of biomass consumption to Real GDP growth. Aside the long run model, ARDL short run model was estimated in the study in which biomass consumption is positive and significant for GDP growth rate in Nigeria amongst other findings.

6. RECOMMENDATIONS

For Nigeria to attain the United Nations SDGs by 2030, there is no doubt that clean energy has an important role to play in the growth and sustainability of the economy. This is a major reason this study embarks on the assessment of the relevance of SDGs – 7 in Nigeria, which describes the need for access to affordable, dependable and clean energy for all. Therefore, this study investigates the relationship between Nigeria's consumption of biomass energy and economic growth sustainability. As a result, findings from this study recommends that there is need for the Nigeria government to invest in research and development of biomass so as to produce biomass efficiently which will lead to an increase in industrial output thereby leading to sustainable economic growth. Also, the Nigeria government should prioritize biomass consumption over other energy sources as the government continues to diversify the economy, since the foreign exchange earnings from crude oil may be used in other areas of the economy.

7. CONCLUSION

This study examined biomass consumption as a form of energy and its effect on economic growth in Nigeria from 1981 to 2017. In the study, while biomass energy consumption has a positive and significant impact on GDP growth rate in Nigeria, Granger causality reveals that no causality exists between biomass consumption and GDP Growth rate. Therefore, the study highlights the importance of biomass energy in economic growth and sustainable development in Nigeria. This is necessary as the need for clean energy as identified by United Nations SDG - 7, describes the need for access to affordable, dependable and clean energy for all.

8. ACKNOWLEDGEMENT

The authors acknowledge the article publication sponsorship assistance of the Management of Covenant University, Ota, Nigeria. Also, the review input and editing procedure by Centre for Policy Centre for Economic Policy and Development Research (CEPDeR) at Covenant University, Ota, Nigeria.

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