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EFFECT OF NON-RENEWABLE ENERGY ON SELECTED MANUFACTURING SECTOR OUTPUTS IN NIGERIA

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Abstract

Despite several reforms in energy sector, some manufacturers still depend on alternative sources of energy such as generators and other machines powered by either gas or petroleum for their productive activities. The study examined the effect of non-renewable energy on selected manufacturing sector outputs in Nigeria on the use of annual time series data covering 1986- 2021. The study employed the ARDL regression technique because the ADF unit root revealed mixture of 1(0) and 1(1) order of integration. The results revealed that petroleum energy (PEC) and hydroelectric consumption (HEC) had insignificant negative effect on both cement manufacturing output (CMO) and food and beverages output (FBO). The findings also revealed that gas energy consumption (GEC) had significant positive effect on both cement manufacturing output (CMO) and food and beverages output. The ARDL-ECM coefficients of 16 percent and 13 percent revealed a poor speed of adjustment path after a shock. The paper Concluded that gas energy has significant impact on selected manufacturing sector output in Nigeria and recommends that manufacturing sector reform measures should take into cognizance petroleum sector dynamics since rent seeking in the petroleum sector was found to affect the manufacturing sector negatively and federal government should invest in alternative sources of energy such as solar and wind considering the fact that other energy sources were found to be important determinants of the output of the selected manufacturing sector in Nigeria.

Keywords*:* Non-Renewable Energy, Cement, Food and Beverages, Gas Energy, Hydro-Energy,

JEL Classification: O47, Q49, Q43, Q11

1. Introduction

Globally, access to reliable and affordable energy is considered as driver of production in the manufacturing sector of an economy, apart from its role in income and employment generation. Non-renewable energy is amongst the major forms of energy that seems to be available and accessible to economic agents such as households and the business units in developing economies. This could be linked to the fact that access to non-renewable energy consumption facilitates the production of output in both heavy and light industries. The most common forms of non-renewable energy sources for manufacturing sector activities in Nigeria include petroleum, electricity and gas energy among others. Interesting, while other countries have limited access to these sources of energy, Nigeria is among nations that are endowed with different forms of non-renewable energy, with many still untapped Ifeanyi (2017). Petroleum energy constitutes one of the major non-renewable energy sources in Nigeria. The global demand for petroleum as a non-renewable energy and its attendant climatic and environmental degradation problem has continued to shape government efforts in harnessing non-renewable sources of energy. Electricity has been identified in literature on energy sources as one the major sources of non-renewable energy that manufacturing sector activities in developed and developing economies rely for higher productivity and output. Ibrahim, Mukhtar and Gani (2017) stated that Nigeria's electricity growth rate and development is abysmally slow and ineffective compared to what is obtainable in most emerging economies. The dismal performance of this sub-sector is considered a limiting factor to large scale production in the manufacturing sector. World Bank (2020) reported that about 76 million or 40.7 per cent of the Nigerian population have no connection to the domestic electricity grid. Bassey-Etuk and Ifeanyi-Nwaoha (2017) report indicated that the total installed capacity of electricity in Nigeria as of December 2013 was about 10,396 MW from 23 power generating stations across the country. Out of this power capacity, the report reveals that 8457.6 MW is from the thermal-based station with an available capacity of 4996 MW, while only about 1938 MW to 1060 MW was from hydro-based power station. The country produced around 30 TWh of electricity in 2014, and distributed in the following manner: Oil 6 TWh, hydroelectricity 6 TWh, Gas.

Asaleye, Olurinola, Oloni and Ogunjobi (2018) reported that Nigeria's energy production level is less than the energy production in large African economies, paradoxically; the country's total population which invariable defines its energy consumption demand is higher than the population of these countries. This suggests that energy supply despite the pivotal role of non-renewable energy and the increasing demand for manufacturing sector output necessary to meet up with the increase in the country's population, access to reliable and affordable energy, especially electricity appears to be disturbing issue confronting the manufacturing sector in Nigeria. Eniayo (2018) maintained that one of the most challenging factors to development in Nigeria is the poor quality, unreliability, and limited availability of power supply to the manufacturing sector. Organization of Petroleum Exporting Countries (2021) reported the trend of non-renewable energy sector supply revealed that in 2015, Nigeria produced about 2329 b/d, while in 2016, the country produced about 2053 b/d, a decrease of about -11.9%, and a further decline to 1737.4 barrels/day in 2020.This implies that while the demand for energy, including non-renewable energy has been on the increase, the supply on the other hand has been on the decline; hence, the need to assess the magnitude of the effect of the decline in energy supply on the sector in Nigeria

The Nigerian manufacturing sector comprises of firms that engage in the transformation of raw materials into semi-finished or finished goods. The components of the manufacturing sector are; consumer goods and capital goods (Kwode, 2020). The consumer goods sub-sector of the manufacturing sector output encompasses goods produced for primary consumption, while capital goods manufactured goods produced for secondary consumption because these outputs constitute industrial raw materials. The manufacturing sector is considered to among the wealth generating sectors of economy because of its role in the provision of raw materials needed to industrialization and economic diversification. Asaleye, et al., (2018) asserted that on the average, the Nigerian manufacturing companies spend about 40 per cent of the production overhead on electricity per annum. This translates to increases in the cost of operation and prices of goods made in Nigeria when compared with prices of similar goods from other countries.

The government has over the years being increasing its budgetary allocation to the funding of energy sector, and particular on the non-renewable energy sector with the hope that such investments will increase the supply of non-renewable energy and its consumption by different sectors, including the manufacturing sector. It is a bid to meet its rapidly-increasing energy demand also, the government privatized the generation and the distribution divisions of power to reduce the monopoly enjoy by the power supply industry, which has resulted to wastage of resources over the years. The government also came up with the mass metering policy where households and including manufacturing sectors are expected be given free prepaid meters, and the enactment of Petroleum Industry Act (PIA) among others. Obviously, the prevailing trend of falling non-renewable energy generation amidst the increasing demand for energy consumption has not changed. Olarinde and Abraham (2020) stated that despite Nigeria's endowment in energy, including non-renewable energy resources, there has been wide disparity in the country's energy demand to the supply over the last two decades, access to energy services has been continuously challenging. There is the need to examine the extent of the effect of this challenge on the output level of cement and food and beverages as sub-sectors of manufacturing looking at the availability of resources and products in the country.

The debate in contemporary literature revolves around the renewable energy - economic growth nexus, there is scarcity of empirical literature on the relationship between the different components of the non-renewable energy on manufacturing sector output in Nigeria. Ndegwa (2016), Akpan, Ikon, Chukwunonye and Nneka (2016) and Ayodele, Ogunjuyigbe, Ogunmuyiwa and Ojo (2016), among others, have been profoundly skewed towards renewable energy-economic growth nexus, while obviating interest in non-renewable energy. However, Abid and Sebri (2019) stated that the use of aggregate energy data may not be able to identify the impact of a specific energy type on industrial output and for comparisons of the effect of each of energy source. Another issue of concern based on previous studies is that none of the studies used time series data that covered the period 2020 despite the fact that the global Covid-19 pandemic seem to have affected manufacturing sector activities in Nigeria within this period. The aim of the study is to examine the effect of non-renewable energy consumption on manufacturing sector output in Nigeria. Specifically, the paper achieved the following objectives, and they are to;

i. Determine the extent of the contributions of petroleum energy consumption to manufacturing sector output in Nigeria;
ii. Investigate the relationship between hydro-electric energy consumption and manufacturing sector output in Nigeria; and
iii. Investigate the relationship between gas energy consumption and manufacturing sector output in Nigeria

2. Literature Review

2.1 Conceptual Review

Non-Renewable Energy: Non-renewable energy sources are exhaustible in nature if used continuously (Elijah & Nsikak, 2013). Awodumi and Adewuyi (2020) posited that with trends of non-renewable energy such as petroleum and natural gas consumption, it could be argued that Angola and Nigeria are among the least consumers of petroleum in per capita terms among the World economies. However, Olarinde and Abraham (2018) reported that Nigeria has the Africa largest crude oil reserve and sixth largest in the world with an estimated oil reserve of about 36.2 billion barrels. According to the statistics, proven gas reserves are approximately 5,000 billion m^3, while coal and lignite reserves are estimated to be 2.7 billion tons, furthermore the country's hydroelectricity sites have an estimated capacity of about 14,250 MW.

Manufacturing Sector Output:
Olayemi (2012) argued that manufacturing sector plays a principal role in economic development by acting as a catalyst to facilitate structural transformation and diversification of the economy. It also compels an economy to diversify and hence, depend less on imported goods for its economic growth, development and sustenance. Udoh and Ogbuagu (2012) asserted that the manufacturing sector provides employment to about 70 percent of the working population and accelerates the productive capacity of the economy. According to Kwode (2020) pointed out that the manufacturing sector is involved in the production of two categories of goods; consumer goods and capital goods. The manufacturing sector in Nigeria therefore consist of firms that engage in the transformation of raw materials obtained from primary industries into semi-finished and finished products that could be sold locally or exported. Manufacturing firms that engage in the production of cement and food and beverages products are parts of the manufacturing sector of the Nigeria economy. Ohunakin, Leramo, Abidakun, Odunfa and Bafuwa (2013 (2013) stated that in Nigeria, cement production grew rapidly from 2 million tons in 2002 to 17 million in 2011. The cement sub-sector and other sub-sectors of the

manufacturing sector depend on energy supply for their production activities. This suggests the need to assess the extent of the effect of non-renewable energy on the growth level of this sector so that possible policy measures could be taken.

2.2 Theoretical Literature

Neoclassical Growth Theory: The neoclassical growth or endogenous theory was put forward by economists like Romer (1986). The theory is an improvement to the traditional Solow Growth model where technology is considered to have insignificant influence on growth in the economy. The theory states that a minimum quantity of energy is required to carry out the transformation of matter. This implies that non-renewable energy consumption is an essential factor of production that can boost manufacturing sector productivity and output in the economy. The neoclassical growth theory takes the form of the conventional Cobb-Douglas production function which is expressed as follows:

$$Y = AK^{\alpha}L^{\beta} \quad (1)$$

Where, K = stock of capital, L = stock of labour and A = technological progress, while α and β are measures or coefficients of the factor inputs elasticity.

Liberalized Electricity Market Theory:

This study will also adopt the liberalized electricity market theory. Osobase and Bakare (2014) postulated that the liberalized electricity market theory elucidates on the rationality of firms to select their invest choices in alternative power plants which allow production of electricity at different levels of marginal cost. The theory states that, electricity is not storable at reasonable cost; hence, it is optimal for firms to invest in a differentiated portfolio of technologies in order to serve strongly fluctuating demand. Olayemi (2012) observed that before the liberalization of electricity markets decisions on optimal investment and pricing strategies were taken by regulated monopolists, but with liberalization of markets in Europe and US, regulated monopolistic firms have been transformed into competing, but potentially strategically acting firms.

2.3 Empirical Review

The review of empirical literature focuses on the specific objectives of the paper. Ndegwa (2016) study which bordered on non-renewable energy was assessed in Kenya's cement sub-sector for the period 2004 to 2014. Data Envelopment Analysis (DEA) and Tobit regression analysis were employed to analyzed the data. DEA results revealed that firms could improve their level of energy use efficiency, but the scope for improving energy use efficiency varied across different firms. The Tobit regression indicated that only quality of the labour force had a positive and significant effect on energy efficiency score. The strength of this literature is that it uses energy and cement firms in Kenya. There is need to domesticate the study on non-renewable energy in Nigeria; an oil producing economy by estimating its potentials for stimulating the growth of the currently feeble manufacturing sector in the country using the ARDL technique.

Femi, Victor and Sunday (2020) assessed the relationships between various energy sources and manufacturing output. The study used *expost-facto* design and the mode was estimated using Autoregressive Distributed Lag (ARDL) technique. The results showed that hydroelectricity and gas have positive and statistically significant long run relationships with manufacturing output in Nigeria, while coal, although had a positive relationship with manufacturing output, is statistically significant at 10% level. The short run results reported positive and significant relationships between the contemporaneous values of hydroelectricity, coal, gas and manufacturing output in Nigeria but the previous year value of hydroelectricity had a significant negative relationship with manufacturing output. The study recommended among others that Nigerian manufacturing firms should make use of them as their main energy input.

Similarly, while evaluating the electrical energy use patterns in the Nigerian food and beverage industry, Ayodele, et al., (2016) correlational design covering a period of 2010 to 2013. Descriptive statistics and regression were used for data analysis. Study findings indicated that 87% and 89% of electrical energy needs of industry A and B were attributed to diesel generators account, respectively. Also, the average electrical energy use index for industries A and B were 0.70 and 0.76, respectively. The strength of this paper has to do with the inclusion on food and beverages and how energy usage can affect the firms, but its major weakness is that it failed to specifically focus on how non-renewable energy affects food and beverages output in Nigeria which is the concern of this paper.

Oluwafemi, et al., (2021) studied the impact of energy on economic in comparison of different flues in cement production in Nigeria. Data needs included the specific energy consumption data, and data collected on the forms, and types of energy used at different units of cement manufacturing processes. The Analysis of Variance (ANOVA) was used to determine the effectiveness, availability, cost, environmental, and health impact of energy. The findings revealed that coal is the cheapest energy source but environmental issues exonerate it from being the choice energy source, but Natural gas had better production output while minimizing pollution and health issues. The findings further showed that Factory B was the most energy-efficient in terms of output and cost of production. This study is relevant to the present research because it concentrated on energy and cement production in Nigeria, but its major weakness is that it was o not delimited to non-renewable energy sources.

In their study, Mandara and Sungau (2020) examined the role of energy resource to production output in cement companies in Tanzania using time series data for 2005 to 2014. The study used the Multiple OLS technique of analysis. The findings revealed that energy resources have positive and significant effect on production output in cement organizations and recommended that cement organizations should consider energy resource as a key and an important resource in production of cement. The strength of this study lies on the inclusion of cement companies and the use of time series data, but its weakness is that it used OLS technique that does not take into cognizance lag values of the variables and the study Area was Tanzania, not Nigeria.

3 Methodology

3.1 Research Design

This study employed the expost-facto design approach which assumes that the data collection process cannot be manipulated by the researcher because the study is carried out after the action.

3.2 Data and Sources

The study used annual time series or secondary data on energy consumption and manufacturing sector output in Nigeria covering the period 1986 to 2021. The data were sources from World Development Indicators (WDI) and Central Bank of Nigeria publications on manufacturing sector outputs. The period 1986 was selected based on the fact that major economic reforms in the energy and real sectors of the economy started in 1986 when the Structural Adjustment Programme (SAP) was introduced. The years 2021 on the other hand was used because almost all sectors, including the manufacturing sector in Nigeria were affected by the Global covid-19 pandemic that ravaged the global economy.

4. Results and Discussion

Table 1: Descriptive Statistics

Statistics	CMO	FBO	GEC	HEC	PEC
Mean	281.2022	2427.050	13.93472	7.275000	1163.637
Median	234.5650	2337.440	13.18000	7.595000	1155.041
Maximum	617.6300	3104.000	24.52000	9.960000	1419.975
Minimum	87.13000	1893.220	4.790000	4.480000	772.0540
Std. Dev.	168.4903	363.1214	6.744427	1.436357	158.9968
Skewness	0.831661	0.362688	0.308125	-0.040151	-0.576085
Kurtosis	2.406816	1.761758	1.667118	1.854526	3.316059
Jarque-Bera	4.677764	3.089124	3.234507	1.977840	2.141082

Probability	0.096435	0.213405	0.198443	0.371978	0.342823
Sum	10123.28	87373.81	501.6500	261.9000	41890.92
Sum Sq. Dev.	993614.5	4615001.	1592.055	72.20930	884799.9
Observations	36	36	36	36	36

Source: Author's Computation using E-Views 10.0

The results of descriptive analysis in Table 1 revealed an approximate mean value of 281.20 for Cement Manufacturing Output (CMO), 2427.05 for Food and beverages output (FBO),13.18 for Gas energy consumption (GEC),7.28 for hydroelectricity energy consumption (HEC) and 1163.63 for petroleum energy consumption. This means that FBO contributed more to manufacturing sector output than CMO sub-sector of the economy with the period. National Bureau of Statistic (2014) reported that food beverages are by far the greatest contributor to the manufacturing sector output in 2013 as it contributed about output 52.74% of the total manufacturing sector output. More, so it was found that petroleum energy had higher effect on Cement Manufacturing and Food and Beverages outputs of the manufacturing sector of the economy. The findings also revealed that HEC with a coefficient of -0.04151and PEC with an estimated coefficient of -576085 indicated revealed that the variables were skewed leftward, while CMO with a coefficient of 281.20, FBO with a value of 2427.05 and GEC with a coefficient of 13.93 are skewed rightward. Therefore, since the distribution consisted on some variables skewed leftward, while others skewed rightward, the conclusion that the distribution was normally distributed. The Jarque-Bera statistic revealed a probability value of 0.096435 which is greater than 0.05; hence the conclusion is that the variables are normally distributed.

Table 2: Unit Root Test

Variable	PP-Statistics	Critical Value	Order of Integration
CMO	-4.312376	-2.951125**	1(1)
FBO	-2.680168	-2.948404*	1(1)
PEC	-7.759879	-3.548490*	1(0)
HEC	-9.156591	-3.548490**	1(1)
GEC	-6.335043	-3.548490*	1(0)

Test with intercept and trend, ** significance at 1%, ** significance at 5%*

Source: Author's Computation using E-Views 10.0

The Phillips-Perron unit root test indicated that Cement Manufacturing Output (CMO), Food and Beverages Output (FBO) and hydro-electricity energy (HEC) were found to be integrated at order 1(1), while, petroleum energy and Gas energy consumption (GEC) were integrated at level 1(0) respectively. The variables have different order of integration; hence the need for the application of the ARDL regression as the most appropriate estimation technique.

Table 3: Bounds Test for Cointegration Result

Model 1	Value	Sig. Level	1(0)	1(1)
F-Statistic	3.112011	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Model 2				
F-Statistic	1.952020	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: Authors Computation using E-views 10.0

The functional relationship between non-renewable energy (NRE) and the dis-aggregated components of manufacturing outputs, specifically Cement Manufacturing Output (CMO) and Food and Beverages Manufacturing Output (FBO) are specified using the ARDL techniques. The functional or implicit form of the relationship between non-renewable energy and cement manufacturing output (CMO is expressed as follows:

$$CMO = f(HEC, PEC, GEC) \quad (2)$$

In its explicit form, the model is expressed as follows:

$$\ln(\mathrm{CMO})\,t = \beta_0 + \beta_1 lnCMOt - i + \beta_2 lnHEC_{t-1} + \beta_3 lnPEC_{t-1} + \beta_4 lnGEC_{t-1} + \sum_{t=1}^{p} \lambda_j lnCMO_{t-1} + \sum_{t=1}^{p} \varphi_j \ln HEC_{t-1} + \sum_{t=1}^{p} \emptyset_j lnPEC_{t-1} + \sum_{t=1}^{p} \theta_j lnGEC_{t-1} + \delta ECM_{t-1} + \varepsilon t \quad (3)$$

While the implicit relationship between non-renewable energy and food and beverages manufacturing output (FBO) are as follows:

$$FBO = f(HEC, PEC, GEC) \quad (4)$$

The explicit form of the model is expressed as follows:

$$\ln(\mathrm{FBO})\,t = \beta_0 + \beta_1 lnFBO_{t-1} + \beta_2 lnHEC_{t-1} + \beta_3 lnPEC_{t-1} + \beta_4 lnGEC_{t-1} + \sum_{t=1}^{p} \lambda_j lnFBO_{t-1} + \sum_{t=1}^{p} \varphi_j \ln HEC_{t-1} + \sum_{t=1}^{p} \emptyset_j lnPEC_{t-1} + \sum_{t=1}^{p} \theta_j lnGEC_{t-1} + \delta ECM_{t-1} + \varepsilon t \quad (5)$$

Therefore, from model 4 and 5, the variables are:
CMO= Cement Manufacturing output as a sub-sector of the manufacturing sector output
FBO= Cement Manufacturing output as a sub-sector of the manufacturing sector output
HEC = Hydro electric energy consumption
PEC= Petroleum Energy consumption
GEC= Gas energy consumption
$\beta_1 - \beta_4$ = Long-run slope parameters
λ, φ, ϕ, θ = Short-run slope parameters
ECM_{t-i} = Error Correction Mechanism
δ = Parameter that measures the speed of adjustment process after a shock.

Thus, from model 4 and 5, the *a-priori* expectation based on theoretical postulation in economics is that the estimates of HEC > 0, PEC > 0, and GEC > 0 respectively. This implies that the coefficient of hydroelectricity energy consumption, petroleum energy consumption, and gas energy consumption are expected to have positive effect on outputs of cement and food and beverages sub-sectors of the manufacturing sector in Nigeria.

The study follows the single equation modeling, while the Autoregressive Distributive Lag (ADRL) modeling technique was employed in technique for model estimation. However, to check the econometric characteristics of the data, the unit root test or stationarity test using the Augmented Dickey-Fuller (ADF) technique was employed. This was important because unit root test result provides empirical evidence on the order of integration of each variable. Gujarati (2013) stated that the first empirical work in time series data analysis is the assumption that the underlying time series is stationary. Hence, the test is basically required to ascertain the number of times a variable or series has to be differenced to achieve stationarity. The next text conducted was the cointegration test. This test is use to analyze the long-run relationships and short-run dynamic interactions among the variables of interest, the paper will adopt the autoregressive distributed lag ARDL or bound test of co-integration analysis.

The assumption in econometric analysis is that the ARDL co-integration approach developed by Pesaran and Shin (1990) and Pesaran, Shin and Smith (2001) have some advantages over the traditional co-integration techniques. One unique feature of this test is that it can accommodates two set of critical values where there is the low and upper value bounds for all classification of explanatory variables into pure I (1), purely I(0) or mutually co-integrated. This test also follows the F-statistic and its decision rules are that; when F-statistic coefficient falls below the lower bound of 1(0) orders of integration, the conclusion is that there is no long-run relationship, if it falls above the 1(1), it implies that there is a long-run relationship between the variables, but when the coefficient of F-statistics is in-between 1(0) and 1(1) bounds, the results are inconclusive. Olofin and Salisu (2017) observed that there is cointegration if the estimated F-statistic is more than the upper bound; there is no cointegration if it is less than the lower bound; and the test is ambiguous if it lies in between the two bounds. Thus, after these preliminary tests were carried out, the study was estimated using the ARDL estimation technique.

The paper adopted the lower and upper co-integration bounds test involving the F-test for critical bounds as captured by Pesaran, et al., (2001) The lower bound method assumes that all variables are I(0) while upper bound critical values assume all variable are I(1).The bounds co-integration test results in Table 3 shows that the F-statistic for model 1 revealed a coefficient of 3.112011 and K=3. This F-statistic coefficient falls within the lower 1(0) and upper 1(1) bounds 1(1), hence the results are inconclusive based on the rule of thumb. In order words, there was no evidence of cointegration in the estimated model. However, Salisu (2019) pointed out that when the coefficient of the F-statistic of the bounds co-integration test falls in between the lower bound 1(0) and upper bound 1(1), both the short-run and long-run forms of the model should be estimated. This therefore suggests that both the Error Correction Models and the long-run form of model 1 showing the relationship between PEC, HEC and GEC and Cement Manufacturing Output (CMO) of the manufacturing sector of the economy should be estimated.

On the contrary, the F-statistic for model 2 revealed an estimated coefficient of 1.952020 and K=3. This indicated that the estimated value of the F-statistic falls below the theoretical value of the lower bound of 1(0). Therefore, based on the rule of thumb, the study concluded that there is no long-run relationship between non-renewable energy explanatory variable (PEC, HEC and GEC) and food and beverages food output (FBO) in Nigeria within the period. The inconclusiveness of the bounds cointegration test results necessitated the estimation of both the models using the ECM technique.

Table 4:Error Correction Model (ECM) Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.855087	9.917697	0.691197	0.4949
D(PEC)	-0.097730	0.094125	-1.038298	0.3077
D(HEC)	-5.589883	10.73279	-0.520823	0.6064
D(GEC)	4.418102	6.470655	2.910862	0.00067
ECM (-1)	-0.173992	0.222749	0.332178	0.2421
R-squared	0.409550	Mean dependent var		8.458824
Adjusted R-squared	.722801	S.D. dependent var		50.43568

S.E. of regression	52.52996	Akaike info criterion	10.89570
Sum squared resid	80022.51	Schwarz criterion	11.12016
Log likelihood	180.2269	Hannan-Quinn criter.	10.97225
F-statistic	0.377965	Durbin-Watson stat	1.726477
Prob(F-statistic)	0.000002		

Source: Authors Computation using E-views 10.0

The results of the Error Correction Model (ECM) of the relationship between non-renewable energy and cement manufacturing sector output (CMO) shows a coefficient of -0.173992, indicating that the proportion of the deviations from disequilibrium is corrected by approximately 17.40 percent annually. The results revealed that petroleum energy had a coefficient of -0.097730 and p-value of 0.30771 or p>0.05; hence the null hypotheses was accepted and the conclusion is that petroleum energy consumption (PEC) had insignificant negative effect on cement manufacturing output (CMO) in Nigeria. It was found out that a unit increase in PEC led to a 9.77 percent decrease in CMO. The results revealed that hydro energy consumption had a coefficient of -5.589883 and p-value of 0.6064 which means that p>0.05. The HO was accepted and the conclusion is that HEC had an insignificant negative effect on cement manufacturing sector output. This could be attributed to the view of Chanchangi, Adu, Ghosh, Sundaram and Mallick (2022) that electricity production and supply, excluding hydroelectric, has started increasing, yet the country has not reach energy target.

The results revealed that Gas energy consumption (GEC) had a coefficient of 4.418102 and p-value of 0. 0002 or p<0.05, the conclusion is that GEC had a significant positive effect on cement manufacturing output (CMO). Adamu and Darma (2016) in their study found a significant long-run relationship between gas energy and economic growth in Nigeria. A study by Oluwafemi et al., (2020) also revealed that natural gas energy provides better production output while minimizing pollution and health issues. The adjusted R square coefficient revealed that only 48.15 percent of the changes in CMO were due to changes in non-renewable energy, most of the changes were due to other factors captured by the error Term. However, the error terms were not serially correlated which means the model is not spurious.

Table 5:Error Correction Model (ECM) Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.784408	9.739134	0.593935	0.5572
D(PEC)	-0.088860	0.093031	-0.955168	0.3474
D(HEC)	-8.529704	10.86698	-0.784920	0.4389
D(GEC)	5.300481	6.252159	0.847784	0.0035
ECM (-1)	0.208232	0.202806	1.026752	0.3130
R-squared	0.479401	Mean dependent var		8.458824
Adjusted R-squared	0.447578	S.D. dependent var		50.51082
S.E. of regression	51.69848	Akaike info criterion		10.86379
Sum squared resid	77509.24	Schwarz criterion		11.08825
Log likelihood	-179.6844	Hannan-Quinn criter.		10.94034
F-statistic	0.625305	Durbin-Watson stat		1.748030
Prob(F-statistic)	0.648227			

Source: Author's Computation using E-views 10.0

The results of the Error Correction Model (ECM) of the relationship between non-renewable energy and food and beverages manufacturing sector output (FBO) revealed a coefficient of -0.208232 and a p-value of 0.3130. This implies that the adjustment path shows that when a shock occurs in the model about 20.82 percent of the disequilibrium is corrected annually, indicating a poor speed of adjustment. The findings shows that petroleum energy had a coefficient of -0.088860 and p-value of 0.3474.This implies that p<0.05, the HO hypothesis was accepted and the conclusion is that PEC had insignificant negative effect on FBO. Also, it was revealed that hydro energy consumption had a coefficient of -8.529704 and p-value of 0.4389 or p>0.05. The null hypothesis was accepted and the conclusion is that hydro energy consumption had insignificant negative effect on FBO. Femi et al., (2020) in their study reported positive and significant relationships between the hydroelectricity and gas and manufacturing output in Nigeria.

Furthermore, it was revealed that gas energy consumption had a coefficient of 5.3004581 and p-value of 0.0035 or p<0.05; the null hypothesis was rejected and the conclusion is that gas energy had significant positive effect on food and beverages output (FBO). The positive effect of gas energy to FBO could be attributed to the fact that gas is relatively cheaper compared to other sources of non-renewable energy used in the manufacturing sector. Ayodele, et al., (2016) study revealed that diesel generators and hydroelectricity account for 87 percent and 89 percent energy needs of food and beverages industry in Nigeria. The coefficient of Adjusted R-square shows that 44.76 percent of the changes in food and beverages output (FBO) were attributed to changes in non-renewable energy consumption, while the reaming changes were due to other sources of energy captured by the error term. This suggests that other energy sources not captured in the model had more effect on FBO than the explanatory variables of non-renewable energy used in the mode.

Table 6: Robust Tests

Statistics	Tests	Model 1		Model 2	
		Coeff.	Prob.	Coeff.	Prob.
Breusch-Godfrey-Serial Correlation	F-Statistic	0.851414	.4375	0.435640	.6523
Heteroscedasticity-Test	F-Statistic	0.290870	.8816	0.414730	.9007

Source: Author’s Computation using E-Views 10.0

The residual test was carried out for serial correlation and heteroscedasticity based on the decision rule that if the probability value of the test statistic is found to be greater than 0.05(p>0.05), the null hypothesis of no serial correlation of no heteroscedasticity is accepted. The Breusch-Godfrey serial correlation F-statistic test in Table 4 revealed a p-value of 0.4375 for model 1 and 0.6523 for model 2, which means p>0.05. Hence, the conclusion is that the error terms in the models do not correlate. The F-statistic for the heteroscedasticity revealed a p-value of 0.8816 and 0.9007 for model 1 and model 2 were found to be greater than 0.5, leading to the acceptance of the null hypothesis of no heteroscedasticity. That is, estimated modes were found to be homoscedastic in nature.

5.Conclusion and Policy Recommendations

The epileptic nature of non-renewable energy supply and the dismal contribution of the manufacturing sector output share to the Gross Domestic Product (GDP) of the Nigerian economic is an issue of concern. This study attempts to examine the effect of non-renewable energy on selected manufacturing sector output in Nigeria. The findings revealed that petroleum energy (PEC) had insignificant negative effect on cement manufacturing sector output (CMO) and food and beverages manufacturing output (FBO) in Nigeria. The results also revealed that hydroelectric consumption (HEC) had insignificant negative effect on manufacturing sector output in Nigeria, and that gas energy consumption (GEC) had significant positive effect on manufacturing sector output. The implication of the finding is that any policy that increases gas energy supply will significantly increase the level of manufacturing sector output, while policy that increases petroleum energy will significantly have positive effect on the manufacturing sub-sector of the Nigerian economy.

Based on the findings of the study and its policy implications, the following recommendations have been made among others:

i. Policy makers should ensure manufacturing sector reform measures that are targeted at increasing the level of manufacturing sector output should take into cognizance petroleum sector dynamics since rent seeking in the petroleum sector is found to affect the manufacturing sector negatively.
ii. There is need for the federal government of Nigeria to ensure that alternative sources of energy such as solar and wind are developed and made functional considering the fact that energy source was found to be an important determinant of the manufacturing output level so as to boost output in this sub-sector of the economy.
iii. There is need for greater investment in the supply of gas energy as a form of non-renewable energy owing to its positive multiplier effect on the output level of both cement manufacturing and food and beverages firms in the manufacturing sector of the economy for higher output.

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