Theoretical and Applied Economics
Volume XXIX (2022), No. 4(633), Winter, pp. 185-196

Energy consumption and economic growth nexus in Africa: New insights from emerging economies

Obukohwo Oba EFAYENA
University of Nigeria, Nigeria
economix4life@gmail.com
Enoh Hilda OLELE
Delta State University, Nigeria
oleleehilda@gmail.com
Ngozi Patricia BUZUGBE
Delta State Polytechnic, Nigeria
buzugbengozi@gmail.com

Abstract. *With a potential energy crisis on the horizon in terms of huge energy demand-supply gap, the nature of the energy consumption level-economic growth nexus in 10 emerging economies in Africa. Utilizing a non-linear modeling technique between 1980 and 2020, the study found that Nigeria, South Africa, Ghana, Ethiopia, and Kenya have causal and co-integrated relationships. Several forms of causality were found across countries and timeframes. Among other policy implications, the study specifically shows that possibly due to country-specific characteristics, energy policies may not impact economic growth in Angola, Côte d'Ivoire, Benin, Congo DR and Cameroon. The need to design growth-stimulating energy policies was re-emphasized.*

Keywords: Africa, economic growth, energy, consumption, ARDL.

JEL Classification: C23, Q43.

1. Introduction

The energy sector of any economy is highly correlated and interconnected to the level of its growth and development. Energy is the wheel in which other economic endeavours revolve and operate. For instance, the efficiency and effectiveness of sectors such as industrial, health, education, security, and agriculture depend on a well-organized and coordinated energy sector which optimally utilize economic resources (Augutis et al., 2011). Thus, an efficient energy sector in any economy is a pre-requisite for growth and sustainable development in both short and long run (Pokharel, 2007). In the global scene, international competitiveness is a function of a well-coordinated energy sector which is clearly seen in the operation of the sector. When the energy sector is properly organized and coordinated, it ensures local competitiveness and its spillover effects. Thus, energy consumption as a percent of per capita is a variable that can be used to capture the trajectory of growth and development of any country.

Africa is a region that is richly endowed with several sources of energy. The region has a large hub of hydro, biomass, solar, wind among other energy sources. Africa has the capacity and potential of being a global energy giant if the energy resources at its disposal are fully harnessed and utilized. In that case, local energy demand will be fully met with extra leftover energy supply. Since energy supply will exceed its local demand, it will result in international energy trade to other regions in the world where energy is in short supply. Despite these capacities and potentials, Africa still lags behind comparatively in accessing energy for consumption purposes. The International Energy Agency (2014) reported that the region has the lowest access to energy globally. A considerable number of households especially in rural areas highly depend on crude and local sources (for instance, charcoal and firewood) of energy for daily consumption. The World Bank (2021) reported that a large percent of the estimated 600 million people that will lack access to clean energy by 2030 will be in Africa. Some 900 million residents in Africa do not access clean energy sources (World Bank, 2021). This is even more worrisome given that developed or advanced economies have a higher energy demand in addition to a higher consumption level when compared to developing economies. The pattern of energy consumption in Africa has the potential to contribute more to environmental degradation if not properly put in check. It is also important to examine if the energy consumption has contributed to economic growth, thus establishing whether or not the consumption pattern should be sustained.

The Covid-19 health pandemic has further aggravated the energy crisis in Africa. This is evident in the slow growth process witnessed in the African energy sector in terms of production, access and consumption (IEA, 2020a). It was established that resources that would have been utilized to spur growth of the African energy sector have been eroded by contingencies which emerged from the health crisis (IEA, 2020b). The region is now sliding into a potential energy crisis with economic implications that have regional and country-specific effects. It is thus imperative to unlock the energy consumption-growth nexus in Africa in order to ascertain aspects that need urgent attention as regards energy and economic growth policies.

Following this brief introduction, the second section provides an incisive examination of related literature on the relationship between energy consumption level and growth; the third and fourth sections present the methodology and discussion of model results, respectively. In the fifth section, the study concludes with some policy recommendations. It is expected that the outcomes of this study will stimulate economic growth via energy consumption in Africa.

2. Literature review

It is instructive to appraise the status of energy consumption level and growth globally since its outcome has far-reaching consequences. There are extant empirical studies on the issue. The results vary across countries and regions due to country- or region-specific differentials in energy sources, policies and regulations and political and institutional frameworks. Thus, the outcomes are highly dynamic. Specifically, in investigating the effect that energy consumption exerts growth, there are basically two prominent schools of thought. The leading school is referred to as the growth hypothesis in which energy is considered as both input and output. It is regarded as an input factor in the production process since it is needed in the process. On the other hand, energy can be consumed thus making it an output (Apergis and Payne, 2010; Stern, 2000; Odhiambo, 2009; Iyke, 2015). The second school, neutrality hypothesis, opined that the impact of energy on economic growth and development is negligible or neutral as against the growth hypothesis (Karagol, 2004; Hondroyiannis et al., 2002; Altinay Ozturk et al., 2010). In other words, this school suggests that energy policies and programmes cannot significantly impact economic growth and development.

Several empirical studies have been untaken to validate the viability of these aforementioned schools of thought. The outcomes of these studies have vary across regions, methodologies and scope of the studies. For example, utilizing the autoregressive distributed method on data ranging from 1965 to 2015, Khan et al. (2020) examined the relationship permeating energy consumption and growth. The study asserted that consumption has a long run stimulating influence on growth. Can and Korkmaz (2019) employed the Toda-Yamamoto method in addition to the ARDL method to appraise the energy-economic growth trajectory in Bulgaria in the period 1990-2016. The study concluded that although energy consumption causes economic growth, it was not significant in the long-run. Gessesse and He (2020) found a cointegrating nexus among the variables in the short and long term utilizing the Chinese energy and growth data in an ARDL bounds test framework.

As for Soukiazis et al. (2019), their study utilized a simultaneous equation method, employing data of 28 OECD economies between 2004-2015 and confirmed that energy consumption level positively impacts economic growth. Shafiei and Salim (2014) investigated 29 OECD economies utilizing data for the period 1980-2021. The exploration asserted that the causal relationship is bi-directional when energy consumption level is appraised alongside economic growth. The study of Hung-Pin (2014) investigated fewer OECD countries compared to other studies. Just considering 9 OECD economies in the

1982-2011 period, this study examines the causal relationship in both terms between the consumption level of energy and growth utilizing the ARDL and vector error-correction techniques. Only five of the countries under consideration were found to have cointegration and causality. Kasperowicz (2014) investigated 12 European economies in the 2000-2013 period and found a positive energy consumption-growth nexus across the countries.

The study of Benavides et al. (2017) explored the nature of relationship which exists between growth and level of energy consumption in Austria between 1970 and 2012. It was established that a long run causal relationship that is unidirectional prevails. The study of Esen and Bayrak (2017) was designed to investigate if higher energy consumption levels support growth among economies that highly depend on energy imports or not in the 1990-2012 period. By means of a panel of seventy-five net energy-importing countries, the nature of the nexus was found to be a positive one. Thus, higher energy consumption level can spur growth in the long term.

Interestingly, quite a number of such studies have also been carried out in developing economies to inquire into the nature and direction of the energy consumption-growth nexus. Thapa-Parajuli et al. (2021) investigated the nexus between the consumption level of energy vis-a-vis growth in Nepal between 1980 and 2018. An autoregressive distributed lagged model reveals that the variables are cointegrated and are positively associated during the long term. A one-way causality which moves in the energy consumption-to-economic growth direction was also established. These findings corroborated those of Paudel et al. (2020).

In their case, Hossain and Saeki (2011) analyzed the nexus among Nepal, Iran, India, Pakistan, Sri Lanka and Bangladesh between 1971 and 2007. It was established that a long-run cointegrating relationship exists. This was also the situation in Dhungel (2017). This study utilized a panel of five South Asian countries between 2000 and 2011 by adopting co-integration test between the level of growth and energy consumption. The outcomes reveal a long-run relationship, in addition to a one-way causality from energy consumption to growth.

There are several African empirical studies on the energy consumption-growth nexus. For instance, Olayeni (2012) employing the cointegration technique, examined the effects which energy conservation policies exert on growth in several African countries. It was established that for countries such as Gabon, Cote d'Ivoire and Nigeria, there was an adverse effect, although the effect was absent in Kenya, Benin Republic and Sudan in the period 1971-2008. More specifically, utilizing data between 1980 and 2011 in Egypt, Ibrahiem (2015) establishes that the consumption level of energy positively impacts growth and the causal relationship is bidirectional.

Odhiambo (2021) through a disaggregation of energy sources investigated the effect of consumption level of energy on growth in Botswana using a nonlinear estimation technique (ARDL bound test). The study confirmed causality runs in the economic growth-to-energy consumption direction only. A South African study on energy consumption level and its impact on growth showed that unidirectional causal relationship, in addition to a long run cointegrated relationships existed in prevalent in the economy (Menyah and Wolde-Rufael, 2010). These findings were corroborated by Khobai and Le Roux (2018) in South Africa using data of 1990 to 2014.

As for Twerefou1 et al. (2018), the goal was to explore the causality that permeates the energy consumption level and growth among 17 West African economies. Although the study presented no short term causality, the study establishes that there was long-run causality and the consumption level of energy was found to impact economic growth positively. These findings were similar to those of Ouedraogo (2013) which surveyed the nature and direction of the nexus permeating energy consumption level and growth focusing on ECOWAS economies for the time series 1980-2008 and employed the FMOLS econometric technique. A positive and significant nexus was established. Twenty-two countries were investigated by Attiaoui et al. (2017) between 1990 and 2011 utilizing ARDL framework to show what nature of nexus exists among energy consumption levels and growth. A rigorous analysis resulted in a positive outcome between the variables. The findings of the study were corroborated by da Silva et al. (2018) and Amoah et al. (2020). Specifically, Amoah et al. (2020) employed the DOLS (dynamic ordinary least squares) method in investigating 32 economies in Africa between 1996 and 2017. Whereas, Nyiwul (2017) found that the level energy consumption does not impact growth significantly in Africa.

For the study of Odugbesan and Rjoub (2020), conscientious attempts were made to inquire the nature and intensity, if any, of the level of energy consumption and growth nexus among the MINT (Indonesia, Mexico, Turkey and Nigeria) economies with data ranging between 1993 and 2017. The study confirms a one-way nexus for the Indonesian and Nigerian economies, while a two-way nexus exists in the Mexican and Turkish economies. A long-run relationship existed among the variables in all the countries. As for Fotourehchi (2017), the focus was to scrutinize the nature of energy consumption level-growth nexus for 42 developing economies in the period 1990-2012. The study established a one-way causal relationship which moves in the consumption-to-growth direction. A Nigerian study by Imandojemu and Akinlosotu (2018) showed that in the period 1990-2017, energy consumption level exerts a positive and significantly impacts growth. In addition, that a unidirectional relationship running in the economic growth-to-energy consumption exists.

Conversely, several studies maintained a neutral stance on the energy consumption level and growth relationship, opining that the relationship between the variables in several countries is non-existent or negligible (see Ben-Jebli and Ben-Youssef, 2015; Bélaïd and Youssef, 2017; Menegaki, 2011). This finding has potential impact on energy policies in the several countries investigated.

A review of previous studies has clearly shown inconclusiveness in the energy consumption level-economic growth nexus, with some studies opining the existence of a positive relationship or nexus, and others maintaining a negative or at worse a neutral stance. There are also conflicting conclusions in the nature of causal nexus/relationship among energy consumption levels and growth. While some studies establish that the causal relationship is bidirectional, others asserted a unidirectional or no causality in the relationship. With these conflicting outcomes, it becomes necessary to critically inquire into the nature of energy consumption level-growth nexus in Africa with the ultimate goal of stimulating sustainable development in the region in general and individual economies in particular. Energy policies that are regional- or country-specific can also be firmly based on the outcomes of such inquiry

3. Methodology

3.1. The empirical model

The study follows those of Akinlo (2008) and Twerefou et al. (2018) in specifying the energy consumption level-growth model below:

$$RGDPPC_{it} = \gamma_i + \delta_1 TEC_{it} + \varepsilon_{it} \quad (1)$$

Where RGDPPC is per capita GDP and TEC is the volume of energy consumption level of country *i* at time *t*. The existence or otherwise of a long-run cointegrating relationship between the level of energy consumption and growth was tested utilizing the ARDL bounds test developed by Pesaran et al. (2001).

Basically, utilizing the ARDL technique has obvious advantages. The method generates viable estimates regardless of the level of stationarity of the variables. It performs perfectly for variables that are stationary at levels, first difference or a combination of both. According to Narayan (2005), this method also provides high power estimations from small samples. We thus specify the following ARDL model.

$$RGDPPC_t = \lambda_1 + \sum_{i=1}^{p1} \theta_{1i} \Delta \mathrm{RGDPPC}_{t-i} + \sum_{j=0}^{q1} \alpha_{1j} \Delta TEC_{t-j} + \beta_1 RGDPPC_{t-1} + \beta_2 TEC_{t-1} + \mu_t \quad (2)$$

Where, the first difference operator (Δ) constitutes the core of equation (2). The cointegrating relationship among the variables can be obtained through an examination of the F-statistics. Null hypothesis of the relationship is thus stated as H_0: $\lambda_1 = \lambda_2 = 0$ and the alternative hypothesis is given as H_1: $\lambda_1 \neq \lambda_2 \neq 0$.

Pesaran, et al. (2001) proposed that given two sets of critical variables constituting the bounds, if the F-statistics exceeds the upper bound, the given null hypothesis of no cointegrating relationship is rejected, but if the F-statistics is below the lower bound, the null hypothesis is accepted. In the case where the F-statistics lies between the lower and the upper bounds, the result is inconclusive. Where there is at least a cointegrating relationship, the short run and long run models specified below will be estimated.

$$RGDPPC_t = \sigma_2 + \sum_{i=1}^{p2} \rho_{2i} \Delta \mathrm{RGDPPC}_{t-i} + \sum_{j=0}^{q2} \theta_{2j} \Delta TEC_{t-j} + \mu_{2t} \quad \text{[Shortrun dynamics]} \quad (3)$$

$$RGDPPC_t = \sigma_3 + \sum_{i=1}^{p3} \rho_{3i} \Delta \mathrm{RGDPPC}_{t-i} + \sum_{j=0}^{q3} \theta_{3j} \Delta TEC_{t-j} + \omega \varepsilon_{t-1} + \mu_{2t} \quad \text{[Longrun dynamics]} \quad (4)$$

Where ω is the error correction term. This coefficient of this variable ω is expected to be negative since it captures the speed of adjustment to equilibrium. The study further adopted causality tests using the Engle and Granger (1978) procedure in order to ascertain the causal nexus between the variables of interest.

3.2. Data and sources

This study employs data of 10 economies in Africa. The choice of these countries hinges on the data availability especially energy data. The study spans through the period 1980-2020. The countries employed include Cameroon, Angola, Benin, South Africa, Congo DR, Côte d'Ivoire, Kenya, Ethiopia, Nigeria and Ghana. These countries can also be classified as emerging in Africa based on their growth trajectory. The level of energy consumption (TEC) is proxied by primary energy consumption index, while the growth variable is captured by real GDP per capita (RGDPPC). The data utilized in this study were derived from the EIA and the World Development Indicators (WDI) databases.

4. Empirical discussion

4.1. Unit root test

To ascertain the suitability of the ARDL model, unit root test was carefully utilized to establish the data properties of each variable. A unit root test evaluates the stationarity of a dataset. This has implications on the forecasting power of the model specified. In this study, the test was necessary to ensure that the variables comply with the assumptions of the ARDL technique (Pesaran, et al., 2001). Table 1 reports the ADF results. The outcomes as shown in Table 1 clearly show that the employed data of all the countries under study were stationary at least at their first differences.

Table 1. *Stationarity test*

Country	EC		RGDPPC	
	I(0)	I(1)	I(0)	I(1)
Angola	-0.487	-2.987**	-0.271	-2.349**
Côte d'Ivoire	-1.995*	-4.675***	-1.041	-2.993***
Ghana	-0.049	-2.754**	-2.517**	-7.361***
Ethiopia	-1.287	-4.529***	-0.771	-1.958*
South Africa	-0.991	-2.613**	-1.411	-4.362***
Benin	-1.869*	-3.707***	-0.170	-1.964*
Congo DR	-0.117	-2.011**	-1.988*	-4.072***
Kenya	-0.845	-1.927*	-1.351	-3.189***
Nigeria	-1.074	-3.009***	-0.083	-2.087**
Cameroon	-2.538**	-1.979*	-1.295	-4.620***

Note: I(0) and I(1) denote level term and first differences respectively; *, **, *** denotes statistical significance at the 10%, 5% and 1% level, respectively.
Source: Authors' compilation.

Given the above findings, it is necessary to estimate the ARDL model in order to establish if a cointegrating relationship exists among the variables.

4.2. Autoregressive distributed lagged cointegration test

As cursory examination of Table 2 revealed that there is cointegration between growth and level of energy consumption in Ghana, Ethiopia, South Africa, Kenya and Nigeria. This is a clear indication of long-run cointegrating relationship between energy consumption level and growth in these countries.

Table 2. *ARDL cointegration test*

		Bounds (5 percent)	
Country	**F-Statistics**	**I(0)**	**I(1)**
Angola	0.06		
Cote d'Ivoire	1.31		
Ghana	7.58		
Ethiopia	5.86		
South Africa	13.35	**3.31**	**4.16**
Benin	1.38		
Congo DR	2.06		
Kenya	11.27		
Nigeria	9.12		
Cameroon	1.69		

Source: Authors' compilation.

There is thus need to estimate an error correction model for each of these countries to capture the rate at which an equilibrium is regained in case of a shock.

4.3. Long-run relationships and diagnostic tests

The long-run statistics of individual countries, as well as, diagnostic tests to ensure the viability of any economic policy drawn from the study are presented clearly in Table 3.

Table 3. *Causality tests*

	Short-run Granger Causality		**Long-run Granger Causality**		**Strong Granger Causality**	
Null Hypothesis	**Δ(TEC) ↓ Δ(GDPPC)**	**Δ(GDPPC) ↓ Δ(TEC)**	**Δε ↓ Δ(GDPPC)**	**Δε ↓ Δ(TEC)**	**Δ(TEC), Δε ↓ Δ(GDPPC)**	**Δ(GDPPC), Δε ↓ D(TEC)**
Nigeria	1.26 (0.31)	2.18 (0.52)	0.13 (0.73)	9.37*** (0.00)	3.02 (0.61)	8.95*** (0.00)
South Africa	0.60 (0.28)	0.37 (0.72)	2.19 (0.41)	15.49*** (0.00)	0.42 (0.23)	3.28 (0.22)
Ghana	2.19 (0.61)	1.63 (0.43)	14.03*** (0.00)	0.46 (0.55)	13.72*** (0.00)	1.87 (0.35)
Ethiopia	0.52 (0.64)	2.65** (0.04)	11.92*** (0.00)	2.73 (0.32)	3.10 (0.31)	3.49 (0.25)
Kenya	0.33 (0.53)	4.12** (0.04)	9.50*** (0.00)	0.54 (0.45)	2.91** (0.02)	0.66 (0.31)

Note: **, *** denote significance at the 5% and 1% level, respectively; Δ denotes first difference; values in parenthesis are p-values of variables; SBC determines number of optimal logs.
Source: Authors' compilation.

The causal relationships expressed in Table 3 have several policy implications that are essential for energy policies in Sub-Saharan Africa. For example, the causal relationships establish a short-run one-way causality between energy consumption level and growth in Ethiopia and Kenya. The causality clearly runs in the economic growth-to-energy consumption direction. Whereas, a long-run one-way causality which runs in the energy consumption-to-economic growth direction exists in Ghana, Ethiopia and Kenya. Conversely, a long-run one-way causality which runs from economic growth to energy consumption exists in South Africa and Nigeria. The results also showed that a strong and one-way causality which only runs in the energy consumption-to-economic growth direction exists for Ghana and Kenya, while such a strong and one-way causality which moves in the economic growth-to-energy consumption direction exists for Nigeria only.

It thus becomes imperative to estimate the long-run dynamics that permeate the energy consumption level-growth nexus among the countries. The long-run estimation along with diagnostic tests are presented clearly in Table 4. The results have several policy implications.

Table 4. *Long-run dynamics and diagnostic tests*

	Long-run Statistics	Diagnostic Test		
Country	**ECT(-1)**	**Normality p-value**	**Serial Correlation p-value**	**Heteroscedasticity p-value**
Nigeria	-1.43**	0.20	0.01	0.11
South Africa	-0.61*	0.00	0.26	0.40
Ghana	-0.82**	0.07	0.51	0.81
Ethiopia	-1.35**	0.00	0.41	0.67
Kenya	-1.27**	0.51	0.27	0.15

Note: *, ** denote significance at the 10% and 5% level, respectively; ECT denotes error correction term.
Source: Authors' compilation.

The results presented in Table 4 show that Nigeria, Ethiopia and Kenya have ECT(-1) coefficients above a 100 percent and are statistically significant. These results imply that when there is a shock, it will take these countries a much longer period for equilibrium to be regained. This calls for urgent energy policies to be implemented to ensure speedy adjustment to equilibrium.

The Breusch-Godfrey Serial Correlation LM (Lagrange multiplier) and Breusch-Pagan-Godfrey heteroskedasticity tests were employed to check for serial correlation and heteroskedasticity, respectively. As clearly seen in Table 4, the diagnostic tests reveal that the models estimated passed the normality, serial correlation and heteroscedasticity criteria and can thus be utilized for policy formulation and appraisal.

5. Conclusion

This study analyzes the relationship permeating energy consumption level and growth in Africa utilizing the data of 10 African economies between 1980-2020. The importance of such a study is highly appreciated given the relative low energy accessibility and other energy challenges in Africa. By re-examining the energy consumption-growth relationship, this study presented new insights into the African energy sector. Through the utilization of appropriate econometric methods, the study establishes that the growth hypotheses which opined that causal relationship only runs from energy consumption to growth exists for several of the countries examined. This finding reiterates the importance of designing and implementing well-coordinated energy policies in Africa since these have the potential of influencing economic growth positively. In other words, energy conservation policies can reduce any tradeoff between the level of energy consumption level and growth in Africa. Energy policies in Africa should be designed to ensure that that attainment of a greener environment. In the same thought process, the various economies in the continent should put conscientious efforts in reducing the greenhouse effects by providing cleaner energy for local utilization and these should be made easily accessible. For countries such as Cote d'Ivoire, Benin, Congo DR and Cameroon, policy projects and programmes should be targeted at developing their energy sector to maximize their energy potentials.

References

Akinlo A.E., 2008. Energy consumption and economic growth: Evidence from 11 Sub-Sahara African countries. *Journal of Energy Economics*, *30*(2), pp. 2391-2400.

Altinay, G. and Karagol, E., 2004. Structural break, unit root, and the causality between energy consumption and GDP in Turkey. *Energy Economics*, *26*(6), pp. 985-994.

Amoah, A., Kwablah, E., Korle, K. and Offei, D., 2020. Renewable energy consumption in Africa: The role of economic well-being and economic freedom. Energy, *Sustainability and Society*, *10*(32), pp. 1-17.

Apergis, N. and Payne, J.E., 2010. Energy consumption and growth in South America: Evidence from a panel error correction model. *Energy Economics*, *32*(6), pp. 1421-1426.

Attiaoui, I., Toumi, H., Ammouri, B. and Gargouri, I., 2017. Causality links among renewable energy consumption, CO_2 emissions, and economic growth in Africa: Evidence from a panel ARDL-PMG approach. *Environ. Sci. Pollut. Re*., *24*(14), pp. 13036–13048

Augutis, J., Krikštolaitis, R., Pečiulytė, S. and Konstantinavičiūtė, I., 2011. Sustainable development and energy security level after Ignalina NPP shutdown. *Technological and Economic Development of Economy*, *17*(1), pp. 5-21.

Bélaïd, F. and Youssef, M., 2017. Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: Assessing the evidence from Algeria. *Energy Policy*, *102*, pp. 277-287.

Benavides, M., Ovalle, K., Torres, C. and Vinces, T., 2017. Economic growth, renewable energy and methane emissions: Is there an environmental Kuznets curve in Austria? *International Journal of Energy Economics and Policy*, *7*(1), pp. 259-267.

Ben-Jebli, M. and Ben-Youssef, S., 2015. Output, renewable and non-renewable energy consumption and international trade: evidence from a panel of 69 countries. *Renewable Energy*, *83*, pp. 799-808.

Can, H. and Korkmaz, O., 2019. The relationship between renewable energy consumption and economic growth: The case of Bulgaria. *International Journal of Energy Sector Management*, pp. 1-18.

Dhungel, K.R., 2017. Linkages between electricity consumption and economic growth: Evidences from South Asian economies. Hydro Nepal: *Journal of Water, Energy Environment*, *20*, pp. 18-22.

Engle, R.F. and Granger, C.J., 1987. Co-integration and error-correction-representation, estimation and testing. *Econometrica*, *55*(2), pp. 251-278.

Esen, O. and Bayrak, M., 2017. Does more energy consumption support economic growth in net energy-importing countries? *Journal of Economics, Finance and Administrative Science*, *22*(42), pp. 75-98.

Fotourehchi, Z., 2017. Renewable energy consumption and economic growth: A case study for developing countries. *International Journal of Energy Economics and Policy*, *7*(2), pp. 61-64.

Gessesse, A.T. and He, G., 2020. Analysis of carbon dioxide emissions, energy consumption, and economic growth in China. *Agricultural Economics*, *66*, pp. 183-192.

Hondroyiannis, G., Lolos, S. and Papapetrou, E., 2002. Energy consumption and economic growth: Assessing the evidence from Greece. *Energy Economics*, *24*(4), pp. 319-336.

Hossain, M.S. and Saeki, C., 2011. Does electricity consumption panel granger cause economic growth in South Asia? Evidence from Bangladesh, India, Iran, Nepal, Pakistan and Sri-Lanka. *European Journal Social Sciences*, *25*, pp. 316-328.

Hung-Pin, L., 2014. Renewable energy consumption and economic growth in nine OECD countries: Bounds test approach and causality analysis. *The Scientific World Journal*, pp. 1-6.

Ibrahiem, D.M., 2015. Renewable electricity consumption, foreign direct investment and economic growth in Egypt: An ARDL approach. *Procedia Economics and Finance*, *30*, pp. 313-323.

Imandojemu, K. and Akinlosotu, N.T., 2018. Renewable energy consumption and economic growth in Nigeria: A co-integration and granger causality approach. *CBN Bullion*, *42*(2), pp. 50-67.

International Energy Agency, IEA, 2014. *Africa energy outlook: A focus on energy prospects in sub-Saharan Africa*. World Energy Outlook 2014, IEA, Paris, November.

IEA, 2020a. *The Covid-19 crisis is reversing progress on energy access in Africa*, IEA, Paris.

IEA, 2020b. *World Energy Outlook 2020*, IEA, Paris.

Iyke, B.N., 2015. Electricity consumption and economic growth in Nigeria: A revisit of the energy growth debate. *Energy Economics*, *51*, pp. 166-176.

Kasperowicz, R., 2014. Economic growth and energy consumption in 12 European countries: A panel data approach. *Journal of International Studies*, *7*(3), pp. 112-122.

Khan, M.K., Khan, M.I. and Rehan, M., 2020. The relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. *Financial Innovation*, *6*(1), pp. 1-13.

Khobai, H. and Le Roux, P., 2018. Does renewable energy consumption drive economic growth: Evidence from granger-causality technique. *International Journal of Energy Economics and Policy*, *8*(2), pp. 205-212.

Menegaki, A.N., 2011. Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. *Energy Economics*, *33*(2), pp. 257-263.

Menyah, K. and Wolde-Rufael, Y., 2010. Energy consumption, pollutant emissions and economic growth in South Africa. *Energy Economics*, *32*(6), pp. 1374-1382.

Narayan, P.K., 2005. The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics*, *37*(17), pp. 1979-1990.

Nyiwul, L., 2017. Economic performance, environmental concerns, and renewable energy consumption: Drivers of renewable energy development in Sub-Sahara Africa. *Clean Technologies and Environmental Policy*, *19*(2), pp. 437-450.

Odhiambo, N.M., 2009. Energy consumption and economic growth nexus in Tanzania: An ARDL bounds testing approach. *Energy Policy*, *37*(2), pp. 617-622.

Odhiambo, N.M., 2021. Energy consumption and economic growth in Botswana: Empirical evidence from a disaggregated data. *International Review of Applied Economics*, *35*, pp. 3-24.

Odugbesan, J.A. and Rjoub, H., 2020. Relationship among economic growth, energy consumption, CO_2 emission, and urbanization: Evidence from MINT countries. *SAGE Open*, pp. 1-15.

Olayeni, O.R., 2012. Energy consumption and economic growth in sub-Saharan Africa: An asymmetric cointegration analysis. *International Economics*, *129*, pp. 99-118.

Ouedraogo, N.S., 2013. Energy consumption and economic growth: Evidence from the economic community of West African States (ECOWAS). *Energy Economics*, *36*, pp. 637-647.

Ozturk, I., Aslan, A. and Kalyoncu, H., 2010. Energy consumption and economic growth relationship: Evidence from panel data for low and middle income countries. *Energy Policy*, *38*(8), pp. 4422-4428.

Paudel, R.C., Thapa-Parajuli, R. and Alharthi, M., 2020. Electricity consumption and export performance: Evidence from Nepal. *International Journal Energy Economic Policy*, *10*, pp. 529-530.

Pesaran, M.H., Shin, Y. and Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), pp. 289-326.

Pokharel, S., 2007. An econometric analysis of energy consumption in Nepal. *Energy Policy*, *35*(1), pp. 350-361.

Shafiei, S. and Salim, R.A., 2014. Non-renewable and renewable energy consumption and CO_2 emissions in OECD countries: A comparative analysis. *Energy Policy*, *66*, pp. 547-556.

Da Silva, P.P., Cerqueira, P.A. and Ogbe, W., 2018. Determinants of renewable energy growth in Sub-Saharan Africa: Evidence from panel ARDL. *Energy*, *156*, pp. 45-54.

Soukiazis, E., Proenca, S., and Cerqueira, P.A., 2019. The interconnections between renewable energy, economic development and environmental pollution: A simultaneous equation system approach. *The Energy Journal*, *40*(4), 10.5547/01956574.40.4.esou

Stern, D.I., 2000. Multivariate cointegration analysis of the role of energy in the US macroeconomy. *Energy Economics*, *22*(2), pp. 267-283.

Thapa-Parajuli, R., Aryal, S., Alharthi, M. and Paudel, R.C., 2021. Energy consumption, export performance and economic growth in a landlocked developing country: The case of Nepal. *AIMS Energy*, *9*(3), pp. 516-533.

Twerefou1, D.K., Iddrisu1, K.S. and Twum, E.A., 2018. Energy consumption and economic growth: Evidence from the West African sub region. *West African Journal of Applied Ecology*, *26*(SI), pp. 217-233.

World Bank, 2021. Report: Universal Access to Sustainable Energy Will Remain Elusive Without Addressing Inequalities. Washington, D.C.