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The Impact of Electricity Power Consumption on Economic Growth in Namibia

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***Abstract*: The study investigates the impact of electricity power consumption in kilowatt-hour (kWh) on the economic growth of Namibia from the period of 1991 to 2019 in a bivariate framework using the Autoregressive Distributed Lag model and the Toda-Yamamoto Granger non-Causality. The aim is to analyse if electricity power consumption has a positive impact on economic growth in both the short and long-run and if there is a causal relationship running from electricity power consumption to economic growth in Namibia. The ARDL F-Bound test showed the existence of cointegration between electricity power consumption and economic growth, when real GDP was the dependent variable. The use of the Toda-Yamamoto approach confirmed that there is a unidirectional causal relationship running from economic growth to electricity power consumption in the long run. The results show that, at present, the economic growth in Namibia does not dependently rely on the level of electricity power consumption of the previous years. Consequently, as Namibia's diverse economic activities, such as mining, oil exploration, agriculture, green hydrogen and fishing, continue to expand, the amount of electricity power consumption will increase. The Namibian government, through the Electricity Control Board (ECB), has already taken the step to unbundle the electricity sector with the view to bringing in competition, employment, and foreign direct investment in the market by the private sector through different renewable energy technologies such as solar, wind, and biomass. From these findings, it is recommended that policy makers in Namibia should rely on the development of conversation measures in order not to delay economic growth policies. Although electricity does contribute to economic growth in different ways, it should be noted that the conservation policies of different energy (electricity) technologies in the economy will have no or little effect on economic growth.**

***Keywords*: ARDL F-bound test, causal relationship, economic growth, Eletricity Control Board, electricity power consumption, electricity supply industry, Toda-Yamamoto approach, Unit root tests.**

1. INTRODUCTION

1.1 Background of the study

The world of today relies heavily on the consumption of energy resources as they are part of the enablers for economic growth in any developed and developing economy, considering that most activities in the economy require energy in different forms,it is found that an increase in energy usage leads to an increase in economic growth (Onyango, 2021). Electricity is one of the major sources of energy which plays an important role in the daily lives of people, both as a scale of economic and social development, as a basic humanitarian need and technological advancement. Thus, electricity has positive impacts on employment, technology transfers, marketing, export product value addition, and their related links to the growth of the economy (Esen & Bayrak, 2017).

According to Sekantsi & Okot (2016), electricity power provision can be under immense pressure in the coming years if it is highly demanded and this could lead to problems in some countries depending on their reliance on it. In the past 20 years, it has been observed that many developing countries are faced with power failures or power shortage problems.

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This is attributed to either the inability to have sufficient power generation sources which can cater for the load/energy demand of such a country or the unavailability of electricity due to outages caused by breakdowns of old infrastructure or unplanned maintenance. Electricity, as one of the major sources of energy, could be seen as the breath of life in today's society. The absence of a safe, reliable, sustainable, and reasonably supply of electricity that is affordable to meet the energy demanded can impede a country's economic and social development (Ampah, 2012). There are many uses of electricity in economic activities. Some of the primary roles, such as in the industrial sector, include electricity consumption for extracting resources under the earth, such as mining, agriculture, forestry, and fishing, whereby the energy is used to operate heavy machinery that can make processes faster and more efficient. In terms of the secondary sector of the economy, which includes work related to manufacturing and production, electricity is used by factories, warehouses, vehicles, and other required equipment. In the tertiary sector of the economy, such as the commercial and residential sectors, electricity is used to provide services such as banking, retail, education, health care, restaurants, and administration (Khattak et al., 2010).

With reference to Namibia as illustrated in Figure 1, the observed average electricity power consumption per capita is 1,378kWh of which the maximum was 1,716kWh in 2018. The annual electricity consumption growth rate between 2001 to 2012 was 3.57%. A negative annual electricity consumption growth rate of 0.179% and 0.453% is noticed between 1991 to 2000 and 2013 to 2019 respectively. In 2019 a sharp annual growth rate decrease of 4.7% in electricity consumption per capita is observed due to the reduction in rainfall which affected the broader economy through lower water and electricity generation, resulting in certain adverse effects on the industrial and secondary sectors. The severe drought of 2019 that was experienced meant that, the agricultural output was constrained, leading to a sharp decline in harvests; the mining sector could not operate at full production due to scarcity of water and so is the other sectors which rely heavily on both water and electricity (World Bank, 2022). Comparing the electricity consumption to economic growth of Namibia, a similar trend is observed in Figure 1. It is noticed that since 1991 to 2015 the average real gross domestic product (GDP) annual growth of 4.4% was experienced. From 1991 to 2010, economic growth was adequately supported due to exports, government spending and investments in mineral extraction by mines such as Rossing Uranium, Okorusu, Skorpion Zinc, Namdeb and others (Ingo, 2015). In 2016 the economy started to go down and ended up falling into a recession in 2017 of which the country is struggling to recover from. In addition, in 2020 real GDP had contracted by 8.5% due to the unprecedented impact of the Coronavirus pandemic (CoVID-19) on the Namibian economy (World Bank, 2022). Moreover, what is observed from Figure 1 is that, electricity power consumption (kWh) per capita and real GDP per capita (2015 constant, USD) moves in tandem, indicating a positive correlation. The two variables have a correlation coefficient of 0.9496, which indicates that electricity power consumption per capita and real GDP per capita in Namibia has a strong linear relationship. Thus, policy makers and related stakeholders must have an understanding of the relationship between electricity power consumption and economic growth.. In the past 40 years, the study on the relationship between energy consumption and economic growth has gained importance of which in the last three decades, the study has been narrowed to specifically understand the relationship between electricity power consumption and economic growth of which a part has been the emphasis on electricity policies (Ampah, 2012).

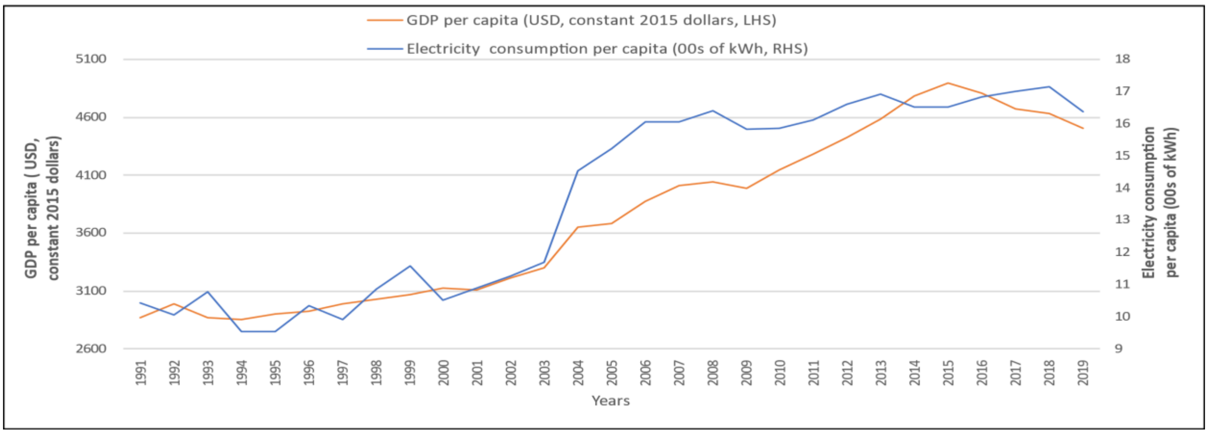

Fig. 1: Electricity consumption per capita (kWh) and real GDP per capita (USD, constant 2015) in Namibia

Note: The graph is author's own work, data sourced from the World Bank Economic Indicators, the International Energy Agency and NamPower (International Energy Agency, 2019; World Bank, 2014).

1.2 Research problem statement

Energy can comprise of different sources such as coal, crude oil, natural gas, uranium, hydro, biomass, solar photovoltaic, wind, electricity and so forth. In the modern economies, it is crucial to have reliable energy supply which is key input in the consumption, production and distribution of goods and services (Olanrele, 2018). Namibia however is a net importer of electricity, importing more than 60% of the electricity it consumes from the Southern African Power Pool (SAPP), including the power purchase agreement contracts that it has with neighbouring utilities in the Southern Africa Development Community (SADC) countries. In 2017, about 82% of the total electricity energy consumption was imported from South Africa (Santos et al., 2022). Prior to 2019, the government of the Republic of Namibia and the state utility, Namibia Power Corporation (NamPower) have not done enough in terms of investing into base load power stations which would cater for load energy demand of the country. In 2019 the Electricity Control Board (ECB) of Namibia, through the Namibian parliament introduced the Modified Single Buyer (MSB) model which now allows different parties, such as Independent Power Producers to generate electricity and sell it to contestable customers and the view was increase electricity generation, create competition, foreign direct investment, employment and contribution to economic growth.

As such there has been different literatures and debates which have focused on the causal relationship between electricity power consumption and economic growth. These debates revolve around whether there exists a unidirectional or bidirectional causality, or no causality relationship between electricity power consumption and economic growth (Bashier, 2016). It is imperative for policy makers to understand the causal relationship between electricity power consumption and economic growth so they can be able to design energy polices effectively. Sunde, (2018) investigated the dynamic relationship in Namibia between Carbon dioxide (CO_2) emissions, economic growth, and energy consumption for the period from first quarter (Q1) of 1991 to fourth quarter (G4) of 2016. The author investigated the long run and causal relationships among the three variables by employing the autoregressive distributed lag (ARDL)-bound testing technique and the Granger causality analysis. The results showed that, there exists a long run relationship between CO_2 emissions, economic growth, and energy consumption and it was further observed that all the variables Granger cause each other.

Unlike in many developed and other developing countries where numerous studies have been done to investigate the causal relationship between electricity consumption and economic growth as it will be demonstrated in the literature, according to the authors' knowledge, no such study has been done yet in the case of Namibia, and especially looking at it as a single country. Therefore, given the growing importance of electricity power consumption in any economy and when looking at Figure 1, whereby a positive correlation between electricity consumption and economic growth is observed; it is important for policy makers of Namibia to understand the relationship between the two variables, so they can formulate effective energy policies that do not negatively impact economic growth and or vice versa. It is on this basis that the research objectives and research questions are set out to examine the impact of electricity power consumption on economic growth in Namibia for the period from 1991 to 2019 by using electricity power consumption per capita (kWh) and economic growth as proxied by real GDP per capita (2015 constant, USD).

1.3 Research objectives

The main objectives of this research is to find evidence on the impact of electricity power consumption on the economic growth of Namibia and hence employed the autoregressive distributed lag (ARDL)-bounds testing technique as developed by Pesaran et al., (2001) and the Granger causality test as modified by Toda and Yamamoto, (1995). This study seeks to:

- Investigate the impact of electricity power consumption on economic growth in the shorth run and long run,
- Examine the existence of causal relationship between electricity power consumption to economic growth and,
- Suggest possible policy recommendations based on the outcomes of the empirical analysis.

1.4 Research Hypothesis

Given the above research objectives the following two null hypotheses were tested:

- H01: There is no long run relationship between electricity consumption and economic growth.
- H02: There is no causal relationship between electricity consumption and economic growth in Namibia.

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1.5 Research Questions

The following two questions were formulated to assist in the research objectives:

- Does electricity power consumption positively impact economic growth in Namibia, in the long run?
- Is there a causal relationship that exists between electricity power consumption and economic growth in Namibia?

2. LITERATURE REVIEW

2.1 Overview of the Electricity Supply Industry in Namibia

In Namibia before its independence in 1990, a private company called South West Africa Water and Electricity Corporation (SWAWEK) formed on 19 December 1964, and incorporated under the Companies Act, No. 23 of 1973 and fully affiliated company of the Industrial Development Corporation (IDC) of the Republic of South Africa was given the mandate to generate, transmit and distribute (outside municipal areas) electricity throughout the whole country (Jacobs, 2005). In 1996, SWAWEK became what is known today as Namibia Power Corporation (Pty) LTD or commonly known as NamPower, a government owned state utility company (NamPower, n.d.). NamPower, therefore, owned and operated all the generation stations, high voltage transmission substations and lines, distribution substations and lines. The electricity supply industry was composed of one monopoly national utility.

2.1.1 Electricity Control Board

In the year 2000, the Electricity Control Board (ECB) was established in terms of the Electricity Act (Act 2 of 2000) repealed by (Act 4 of 2007) as the statutory regulatory authority for the electricity sector (Jacobs, 2005). The ECB's core responsibility of exercising control over the electricity supply industry (ESI) entails the regulation of generation, transmission, distribution, supply, use, import and export of electricity in Namibia. In particular Part II, sections (4)(a) and (4)(b) of the electricity Act - 2007, empowers the Regulator, subject to certain conditions, to establish an electricity market, issue licenses to persons operating in the market and to publish Market Rules and regulations to govern the market (Sheetekela, 2018). With the establishment of the ECB, whose main policy goal is to guide the electricity (energy) industry away from a model dominated by a vertically integrated monopoly towards a model fostering competition in generation, distribution and supply of electricity. By November 2000, the Cabinet of the Government of the Republic of Namibia (GRN) approved a model for restructuring of the Namibian Electricity Supply Industry (ESI). A key feature of the approved model was the establishment of a Single Buyer (SB) function, embedded within NamPower. This implementation of a SB was seen as the most appropriate mechanism to manage and administer electricity-trading arrangements and to contract new investments in electricity generation (Ministry of Mines and Energy & Electricity Control Board, 2019).

2.1.2 Vertically Integrated Electricity Utility/ Monopoly

According to (Sheetekela, 2018) a single buyer model is defined as a system with a centralised agency having the role of coordinating supply (generation) and demand. This sometimes does not include the transmission and the distribution component of the electrical structure or could be referred as a system where there is competition happening in the generation segment with various independent power producers (IPPs) in competing to sell electricity to a single entity, usually a state or national power utility. In the Namibian scenario, prior to 2019 Namibia was operating under a vertically integrated utility with NamPower being responsible for power generation, power import/export agreements with neighbouring country utilities as well as purchasing power from Independent Power Producers (IPPs). The introduction of IPPs, made the full implementation of this for the single buyer model to come into effect.

2.1.3 Current Electricity Market Structure

Reforms were made starting from 2017 to 2019, and by end of 2019 the Single Buyer (SB) model was replaced with the Modified Single Buyer model (MSB). The MSB model is a new market platform for the electricity industry in Namibia. It builds incrementally on the existing SB model as it represents a modification of the existing market structure. The MSB model draws on global best practice, but it has been designed for Namibia, with the support of all the stakeholders in the Namibian electricity industry. The MSB model also gives effect to policy positions articulated in the Harambee Prosperity Plan, Energy Policy, IPP Policy and National Development Plans.

The main change from SB model is that the MSB model allows electricity consumers and Independent Power Producers (IPPs) to transact with each other directly for the supply of electricity. Certain customers are able to buy a portion of their energy requirements directly from a private generator or elligible seller. The MSB model also allows for private generators to build new generation capacity in Namibia which is specifically for export purposes, considering that Namibia has world-class renewable energy (RE) resources and there are several companies that would like to take advantage of this opportunity (Ministry of Mines and Energy & Electricity Control Board, 2019). Figure 2 shows phase 2 which is the last phase of the MSB model expected to be fully implemented in 2026. Phase 1a and phase 1b have been operational from 2019 and 2021 respectively. It is to be noted that the only difference between phase 1b and phase 2 is the capacity of energy requirements in which the eligible sellers can sell to contestable customers, which is a move from 30% capping of a customer's annual energy demand to 100% of its annual energy demand and also that under phase 2, energy importers are included as part of eligible sellers.

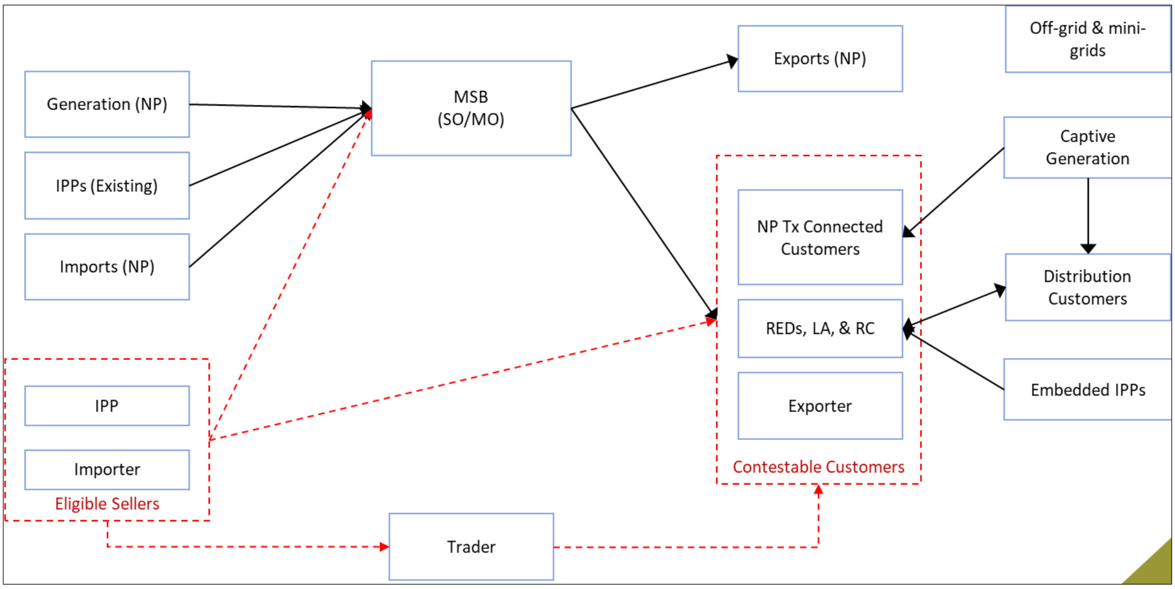

Fig. ***2*****: Phase 2 of the Modified Single Buyer (MSB) model of Namibia**

Note: NP is NamPower, LA is Local Authorities, RC is Regional Councils and Tx is Transmission. Black is existing and Red is new arrangment. Source: Eelectricity Control Board, 2019

2.2 Energy Consumption and Economic Growth Causality Criteria

According to Jumbe (2004) as cited by (Bennett, 2014) the directions of causality relationship between electricity power consumption and economic growth proxied by GDP can be categorized under four hypotheses, namely energy-led-growth hypothesis, conservation hypothesis, feedback hypothesis and neutrality hypothesis. These four hypotheses have important policy implications and hence needs to be taken under consideration. The Energy-led-Growth hypothesis states that there is a unidirectional causality relationship that runs from energy (or electricity) consumption to economic growth. This shows that economic growth is driven by electricity/energy consumption and as such electricity consumption can directly or indirectly affect economic growth (Abdelgalil, 2020).

According to Adom (2011) the conservation hypothesis (also referred to as growth-led-energy hypothesis) asserts that there is a unidirectional causality relationship that runs from economic growth (or income) to energy (or electricity) consumption. This means that a country is not being dependent on electricity or energy to stimulate economic growth, but that it is economic growth that negatively or positively impacts electricity consumption. It is highly probable that a permanent increase in economic growth would cause a permanent increase in electricity power consumption (Sekantsi & Okot, 2016). The feedback hypothesis asserts that there is a bidirectional causality relationship running between energy consumption and economic growth. Thus, increase of economic growth positively impacts energy consumption and whereas energy conservation policy will negatively affect economic growth unless the energy policies are geared towards improving energy efficiency (Jumbe, 2004; Wolde-Rufael, 2006). Neutrality hypothesis is an assertion of no feedback or

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no causality relationship between variables. Hence it becomes a scenario whereby there is no causal relationship between energy (or electricity) consumption and economic growth. Implication is that energy consumption has no impact on economic growth and therefore conservation policies will have insignificant impact on economic growth (Bunnag, 2020).

2.3 Review of Empirical Literature

Since the first study conducted by Kraft & Kraft (1978) in which the findings showed that there is a unidirectional causality running from economic growth to energy consumption in the United States, according to Dantama et al. (2012) as cited by (Dick, 2015) there have been different results among the causal relationship studies which can be attributed to a number of factors, such as using different estimation techniques, different variable choices, different study period ranging from any number of observations, and so is the level of economic development of the country or countries being studied.

In Namibia there is not much of direct and or conclusive empirical studies that can be said at this time, that was done due to limited statistical data at certain stages especially for electricity power consumption before 1990. At the time of this study only three related empirical studies have been conducted based on the author's findings. The first empirical econometric study done in 2005 investigated on the empirical analysis of energy (but not electricity energy only) demand at an aggregated level (diesel, petrol and electricity) for the period of 1980 – 2002. In this study de Vita et al. (2005) employed the ARDL-bounds testing method in order to estimate the long-run elasticities of the Namibian energy demand. The results showed that energy consumption responds positively to changes in GDP but responds negatively to changes in energy price and air temperature.

Sunde (2017) analysed the causal relationship between energy consumption (not electricity energy only) and economic growth in SADC countries with the application of the vector autoregressive (VAR) Granger causality analysis from 1971 - 2015, and it was found that there was a unidirectional causality running from real economic growth to energy consumption in Angola, Democratic Republic of Congo, Mauritius and Namibia; a bidirectional causality between energy consumption and economic growth in Botswana and Mauritius, and no causality in Mozambique, South Africa, Zambia and Zimbabwe (Sunde, 2017). Another study by Sunde (2018) investigated the dynamic relationship in Namibia between Carbon dioxide (CO_2) emissions, economic growth, and energy consumption for the period from first quarter (Q1) of 1991 to fourth quarter (Q4) of 2016. In this study, the relationship was purely for Namibia only. By applying the autoregressive distributed lag (ARDL)-bound testing technique and the Granger causality analysis, the study investigated the long run and causal relationships among the three variables. The results showed that, there exists a long run relationship between CO_2 emissions, economic growth, and energy consumption and it was further observed that all the variables Granger cause each other.

Compared to the study by Kahsai et al. (2012) , where they investigated the nexus of income level-GDP and the energy consumption from Sub-Saharan African countries, Namibia was dropped off from the study due to a lack of consistent time series data. In the study by Wolde-Rufael, (2006), when he applied ADRL and Granger causality tests as modified by Toda and Yamamoto (1995); of the 17 African countries studied for the panel data time series of 1971-2001 in order to test the long-run and causal relationship between electricity consumption per capita and real gross domestic product (GDP) per capita; Namibia was still dropped off as there was insufficient data and or missing data in order to be considered further in the empirical analysis. It can be noted that no study has yet been done in Namibia, specifically to look at the impact of electricity power consumption and economic growth, by looking at the long run and short run relationship between the variables and the causal relationship that may exist. Moreover, no bivariate nor multivariate empirical studies, found as part of existing studies for Namibia, and hence there is much to learn from earlier or recent empirical studies.

2.3.1 Empirical Literature from Single Countries

Etokakpan et al. (2020) investigated the electricity-led-growth hypothesis and its impact on environmental quality and economic growth for Turkey using annual time series data from 1970 to 2014. The causal relationship between the variables in the study was examined by using the Maki and Bayer-Hancke combined cointegration tests under multiple structural breaks and utilised the ARDL bounds test procedure for robust check. The direction of the causal relationships was examined by using the vector error correction model (VECM) Granger causality test. Their results confirmed the existence of cointegration relationship between electricity consumption, capital, labour, economic growth, and ecological

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footprint. Their analysis also proved that electricity power consumption indeed causes growth hypothesis in Turkey and this meant that if the Turkish government embarks on conservation policies this would slow down the economic growth of Turkey.

Atchike et al. (2020) investigated the relationship between electricity power consumption, foreign direct investment (FDI) and economic growth in Benin for the period of 1980-2014. They applied the autoregressive distributed lag (ARDL) bounds test with dummy variables and the Toda-Yamamoto test approach. They reported unidirectional causality relationships which runs from electricity consumption to both economic development and foreign direct investment and as well as a long run relationship with a speed of adjustment of 60.72%. Their findings suggested that the Beninese government should implement new strategies to improve access to electricity to attract foreign direct investment. Table 1 shows a summary of some empirical studies done on some of the single countries.

Table 1: Summary of Electricity Consumption and Economic Growth nexus Literature in Single Countries

	Author(s)	Time Period	Study Area	Method Used	Causality Direction
1	Dey and Tareque (2019)	1971 to 2014	Bangladesh	(ARDL)- bound test approach	Electricity to Economic Growth Bidirectional (ELE↔GDP)
2	Can and Korkmaz (2019)	1990-2016	Bulgaria	(ARDL) bound test and the Toda–Yamamoto	Renewable or Electricity energy causes RGDP Electricity and RGDP causes Renewable energy
3	Zhong et al. (2019)	1971 to 2009	China	(ARDL) bounds testing approach	Electricity power consumption causes RGDP
4	Thaker et al. (2019)	1971 to 2010	Malaysia	Augmented Dickey-Fuller (ADF) Phillips-Perron (PP) Johansen-Julius (JJ) test	Electricity power consumption causes RGDP Electricity to Economic Growth
5	Akinwale et al. (2019)	1984 to 2015	South Africa	(ARDL) model	Electricity, trade openness to Economic Growth
6	Elfaki et al. (2018)	1984-2014	Sudan	ARDL model cointegration	Energy consumption to Economic Growth (negatively)
7	Chikoko et al. (2018)	1980 to 2016	Zimbabwe	Granger and Error correction model	Bidirectional (ELE↔GDP)
8	Pata & Terzi (2017)	1960 to 2014	Turkey	Unrestricted vector autoregressive (UVAR and ARDL bound test	Electricity to Economic Growth
9	Ameyaw et al., 2017	1970 to 2014	Ghana	Vector error correction model	Economic Growth to Electricity
10	Chingoiro & Mbulawa (2017)	1980 to 2014	Botswana	Vector error correction model (VECM)	Electricity to Economic Growth
11	Siddique & Majeed (2016)	1980 to 2015	Pakistan	ARDL bounds and ADF test	Cointegration between Elec, RGDP and Trade openness Electricity to Economic Growth
12	Sekantsi & Thamae (2016)	1972 to 2011	Lesotho	ARDL	Economic Growth to Electricity
13	Sekantsi & Okot (2016)	1981 to 2013	Uganda	ARDL, Granger, ADF and PP	Bidirectional (ELE↔GDP)
14	Bashier (2016)	1976 to 2013	Jordan	ARDL and VECM	Bidirectional (ELE↔GDP)
15	Dlamini et al. (2015)	1972-2009.	South Africa	Bootstrap Granger Causality	Electricity to Economic Growth
16	Saidi & Hammami (2014)	1974-2011	Tunisia	Granger causality and Johansen tests	Bidirectional (Energy↔RGDP)
17	Bennett (2014)	1980 to 2010	Swaziland	ARDL bounds testing procedure	Economic Growth to Electricity

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2.3.2 Empirical Literature from Multiple Countries

Bunnag (2020) examined the existence and direction of the causality relationship between electricity power consumption per capita and economic growth per capita in Indonesia and Thailand using annual time series data from 1971 to 2014. The analysis employed the Johansen Cointegration method and the Granger causality test techniques. For Indonesia the results showed that there is a long run correlation among electricity power consumption and economic growth and a growth-led hypothesis was observed due to the existence of a unidirectional causality direction running from electricity power consumption to economic growth. For Thailand, the results indicated no long run correlation among consumption of electric power and economic growth and neutrality hypothesis was observed as there was no causality relationship direction between electricity power consumption and economic growth.

Inuwa et al. (2019) applied both the static and dynamic panel models in the form of Fixed-Effect, Random- Effect, Difference Generalized Methods of Moments (GMM) and System GMM to examine the effect of electricity consumption on economic growth of the Economic Community of West African States (ECOWAS) Member Countries over the period from 2007–2016. Their study results revealed that electricity consumption has a positive impact and was statistically significant on economic growth for both static and dynamic panel models. In both models, capital was found to have positively impacted and statistically significant on economic growth in both models. In the case of labour, a positive and statistically significant impact on economic growth was observed for the system GMM model only. It was recommended that ECOWAS countries should explore other alternative sources of electricity generation in order to ensure sufficient and reliable supply of electricity. Table 2 shows the summary results between electricity consumption and economic growth done in some of the multiple countries.

Table 2: Summary of Electricity Consumption and Economic Growth nexus Literature in Multiple Countries

	Author(s)	Time Period	Study Area	Method Used	Causality Direction
1	Ahmad (2016)		Six ASEAN developing countries	Westerlund cointegration test and the panel ARDL estimation technique	A bidirectional causal relationship in the group of all ASEAN countries was found
2	Abdoli et al. (2015)	1980–2011	Organisation of Petroleum Exporting Countries (OPEC)	panel cointegration and panel-based error correction approach models	A long run relationship between real GDP, electricity power consumption and trade activities
					Feedback hypothesis
3	Belmokaddem et al. (2014)	1980 to 2010	65 countries	Cointegration and Granger causality tests in panel data	Bidirectional causality relationship for some of the panel
4	Fatai (2014)	1980-2011	18 Sub-Saharan Africa countries	Cointegration test and Toda-Yamamoto causality analysis	Unidirectional from energy consumption to economic growth in East and the Southern Africa Sub-region
					No causality between energy consumption and economic growth in Central and the West Africa Sub-region
5	Bayar & Özel (2014)	1970 to 2011	Hungary and Indonesia	Pedroni, Kao and Johansen co-integration tests and Granger causality tests	Bidirectional causality relationship between economic growth and electricity consumption for all the emerging countries
6	Bildirici (2013)	1970 to 2010.	Cameroon, Cote D'Ivoire, Congo, Ethiopia, Gabon, Ghana, Guatemala, Kenya, Senegal, Togo and Zambia	Autoregressive Distributed Lag (ARDL) bounds testing and VECM	A growth hypothesis for Cameron, Congo Rep., Ethiopia, Kenya and Mozambique as per the short run causality results
					For Gabon, Guatemala and Senegal but negative sign for Zambia

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					Unidirectional causality relationship runs from economic growth to energy consumption
					Gabon, Ghana and Guatemala, that there exists a bidirectional causality relationship

3. RESEARCH METHODOLOGY

3.1 Data Sources and Analysis

The study used annual time series data of total electricity consumption (kWh) per capita and real GDP per capita from 1991 to 2019. Electricity consumption is the total electricity which is consumed by the final users including industry and domestic residents. Electricity consumption is normally well below electricity generated and electricity that is distributed, since there are losses that are included. The statistical and econometric software package called EViews 12.0 was used to estimate the regression model in addressing the study objectives. The electricity consumption (kWh) data per capita and GDP per capita data (2015 constant, USD) was sourced from the World Bank Development Economic Indicators, the International Energy Agency and NamPower (International Energy Agency, 2019; World Bank, 2014). In this analysis the Cobb–Douglas production function type is used and define the real GDP per capita equation as follows:

$$RGDP = f(Elec) \rightarrow \quad RGDP = Elec^{\beta} \qquad (1)$$

Where *RGDP* is real GDP per capita (2015 constant, USD), *Elec* is electricity power consumption per capita in kWh and β is share or elasticity coefficient of electricity consumption. Equation (1) is converted using logarithmic transformation to obtain a linear econometric model specification, as shown in (2) below:

$$\ln(RGDP) = \beta_0 + \beta_1 \ln(Elec) + \mu_t \qquad (2)$$

Where β_0 is a constant, β_1 is the direct elasticity with respect to the electricity power consumption and μ_t is the error term.

3.2. Model Specification

The study adopted the Autoregressive Distributed Lag (ARDL) model that was introduced by (Pesaran et al., 2001; Pesaran & Shin, 1997) in order to investigate the impact of electricity power consumption on economic growth in Namibia. The generalized ARDL model is indicated as follows:

$$\Delta ln\ RGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\ ln\ RGDP_{t-i} + \sum_{i=1}^{q_1} \beta_{2i}\ \Delta\ ln\ Elec_{t-i} + \varepsilon_t \qquad (3)$$

Where Δ is the first deference operator, $RGDP_t$ is a dependent variable and variable $Elec_t$ represents the explanatory variables which should be purely I(0) or I(1) or a combination of the two; β_0 is the constant; β_1 and β_2 are coefficients; *i=1, …,k; p*, q_1 are optimal lag orders and ε_t is a vector of error term (Shigwedha & Kaulihowa, 2020).

3.3 Unit Root Tests

The first stage of running any econometric analysis is to conduct the unit root test of stationarity because the use of non-stationary data could affect the results by leading to spurious regressions such as white noise. The Augmented Dickey-Fuller (ADF) test and the Phillips-Perrons (PP) test are commonly used for unit root tests to determine the order of integration. Thus, the unit root tests was conducted by ADF and PP tests. Both ADF and PP tests was chosen to ensure reliable results of the test for stationarity due to the inherent individual weaknesses of the two techniques (Zhong et al., 2019). In each case, the lag-length was chosen using the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). According to Shigwedha & Kaulihowa (2020) the ADF test corrects for a high order serial correlation by adding lag differences while the PP test corrects any serial correlation and heteroscedasticity in the errors by directly modifying the t-statistics. The general ADF test regression equation is as follows;

$$X_t = \alpha_t + \beta_t t + \rho X_{t-1} + \sum \delta \Delta X_{t-1} + \mu_{1t} \qquad (4)$$

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Where, X_t denotes the level of the time series variable under consideration, t represents the time trend and μ_{1t} denote the normally distributed random error term with zero mean and constant variance. The PP test on encompasses fitting the regression and its equation is as follows:

$$Y_t = Z_1 + \lambda y_{t-1} + Z_2(t - T/2) + \sum_{i=0}^{n} \delta_i \Delta Y_{t-1} + \mu_{2t} \quad (5)$$

Where, Y_t is the time series variable, T represent the estimated sample size and μ_{2t} denotes the covariance stationary disturbance error term. Unit root test hypothesis is;

H_0: ρ = 0 (The variable has unit root / non-stationary)

H_1: $\rho \neq 0$ (The variable has no unit root / stationary), the null hypothesis is rejected if the t-statistics is less than the critical values with a significant aspect in pursuit of the stationary alternative hypothesis (Shigwedha & Kaulihowa (2020).

3.4 Autoregressive Distributed Lag (ARDL) Model

Cointegration is the necessary criteria for stationarity among non-stationary variables and the cointegration test is conducted to establish whether there exists a short-run and long-run relationship between variables. The ARDL bound test technique has a number of advantages over the commonly used Johansen cointegration techniques. According Pesaran & Shin (1997) the ARDL approach is more robust and is the more statistically significant approach in determining the cointegration relation in small samples ranging from 500 to 1000 observations, whilst the Johansen co-integration techniques require large data samples for validity. Another advantage is that, unlike other cointegration techniques which requires all of the explanatory variables to be integrated of the same order, the ARDL F-bound technique can be applied even if the variables are of order (1) or (0) or a mixture of both or mutually cointegrated, but this does not apply if they are of order (2) or higher (Pesaran et al., 2001). The F- boubd test is used as an initial step to test the existence of any long-run relationship among the variables and thereafter, the next step is to estimate and determine the long-run relationship coefficients values. After the long-run co-efficient are evaluated, the analyst then makes an estimation of the short-run elasticity of the variables with the Error Correction Model (ECM) representation of the ARDL model and by applying the ECM version of ARDL, the speed of adjustment to equilibrium is determined (Zhong et al., 2019).

Narayan (2004) on the other hand in the study for Fiji developed a set of asymptotic critical F-values for a small sample size ranging from 30 to 80 observations. By comparing 31 observations and 500 observations it was found that critical values based on the large sample size deviate significantly from those of the small sample size. Many studies has used the Pesaran et al., (1999, 2001) F-statistic critical bounds and others that of Narayan (2004). This study looked at both the two critical F-statistics bounds at a 5% level significance and the one that yielded results at 5% significance level was taken. An ARDL equation (6) known as the Unrestricted Error Correction Model (UECM) was constructed in order to perform the F- bound test to obtain the existence of short run and long-run relationship between the variables;

$$\Delta ln\ RGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta\ ln\ RGDP_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta\ ln\ Elec_{t-i} + \beta_3 ln\ RGDP_{t-1} + \beta_4 ln\ Elec_{t-1} + \varepsilon_{1t} \quad (6)$$

where Δ is the first difference operator, $ln\ Elec$ is the natural logarithm of electricity consumption per capita, $ln\ RGDP$ is natural logarithm of real domestic product per capita, p and q are the lag lengths, $\beta's$ are the parameters to be estimated, and ε_t is a white noise error term.

In the test for cointegration when real GDP is the dependent variable, the null hypothesis of: H_0: $\beta_3 = \beta_4 = 0$ for no cointegration was tested against the alternative H_1: $\beta_3 \neq \beta_4 \neq 0$ which means there is cointegration. In deciding between the two hypotheses, the calculated F-statistic value is assessed against the critical values. Based on the numbers of variables, the critical values consist of lower and upper bounds. The upper bound applies when all the variables are integrated of order one, I(1) while lower bound assume all the variables are integrated of order zero, I(0) (Dembure & Ziramba, 2016). If the calculated F-statistics value exceeds the upper bound, then the null hypothesis of no cointegration is rejected. If the calculated F-statistics value is lower than the lower bound critical value, then the null hypothesis cannot be rejected. Conclusive inference with regards to cointegration cannot be reached if the calculated F-statistics falls within the critical bounds. The F-statistics results was compared to the critical values provided in Narayan (2004) and Pesaran et al. (2001).

3.5 ARDL Bounds Test to Error Correction Model (ECM)

The long-run elasticities from the estimation of UECM in equation (6) is the coefficient of one lagged explanatory variable (electricity power consumption in kWh) divided by the coefficient of one lagged dependent variable (real GDP). The long-run inequality, elasticities from equation (6) is β_3/β_4. The short-run effects on the other hand, are captured by the coefficients of the first-differenced variables in equation (6). From the bound test results, if variables are not cointegrated, the short-run ARDL (p, q) will be specified as:

$$\Delta ln\ RGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, \Delta\ ln\ RGDP_{t-i} + \sum_{i=1}^{q} \beta_{2i}\, \Delta\ ln\ Elec_{t-i} + \varepsilon_{1t} \quad (7)$$

However, if there is cointegration, the error correction model (ECM) is specified as below.

$$\Delta ln\ RGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, \Delta\ ln\ RGDP_{t-i} + \sum_{i=1}^{q} \beta_{2i}\, \Delta\ ln\ Elec_{t-i} + \lambda_1 ECT_{t-1} + \varepsilon_{1t} \quad (8)$$

Where λ represent the speed of adjustment parameter, while error correction term (ECT) is the residual obtained from the estimated cointegration model of equation (3). The coefficient of the lagged error correction term is expected to be less than zero, to be negative and statistically significant to further confirm the existence of a co-integrating relationship among the variables. The *ECT* shows how much of the disequilibrium is being corrected. Specifically, *ECT* shows the extent to which any disequilibrium in the previous period is adjusted in $RGDP_t$. A positive coefficient of the *ECT* indicates a divergence from the equilibrium, while a negative coefficient indicates convergence to equilibrium (Shigwedha & Kaulihowa, 2020).

3.5.1 Diagnostic and Stability Tests

The diagnostic check was done to test for robustness of the residuals. The model's robustness was determined by checking for autocorrelation, heteroscedasticity, the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square for stability tests. In order not to reject the null hypothesis of no autocorrelation, it is required that the probability of the observed R-squared be greater than 5 per cent. Else, the alternative hypothesis of autocorrelation must hold. With regards to heteroscedasticity, the null hypothesis states that the residual is homoscedastic if the P-value of the F-statistic and Chi-square is greater than 5%, else accept the alternative hypothesis of heteroscedasticity if the P-value of the F and Chi-square is smaller than 5%. With respect to the stability test, if the plot of CUSUM statistics stays within the critical bounds of 5% significance level, the null hypothesis that all coefficients in the error correction model are stable cannot be rejected. However, if either of the lines falls outside the critical bound then the null hypothesis can be rejected at the 5% level of significance, and this is an indication that the model suffers from structural breaks. Lastly, with respect to normality, the null hypothesis states that, residuals are normally distributed. The Jarque-Bera normality test is used, and if the residual is normally distributed then the coefficient of the residual is insignificant (P-value > 0.05), otherwise the alternative hypothesis must be accepted.

3.6 The Toda–Yamamoto approach to Granger non-causality test

The study further investigated the short-run and long-run causal relationship between economic growth (real GDP) and electricity power consumption using the Granger causality test as modified by Toda & Yamamoto (1995). According to Dembure & Ziramba (2016) the Toda-Yamamoto (T-Y) test has been found to be superior compared to the ordinary Granger Causality as it does not require the pre-testing of variables for cointegration. Thus, if causality relationship tests are done in the presence of non-stationarity or no cointegration, the Toda-Yamamoto (T-Y) test assists in overcoming the problem of asymptotic critical values. Moreover, the T-Y approach is suitable for the standard vector autoregression (VAR) test, whereby the variables can be estimated while in their levels rather than in their first difference as in the case with the ordinary Granger Causality test. The first step tested the time series to determine the maximum order of integration (d_{max}) of the variables in the system using the Augmented Dick Fuller (ADF) and Phillips-Perron (PP) tests. The second step in the analysis determined the optimal lag length, ρ, which is always unknown and has to be obtained from the VAR estimation of the variables in their levels. The ρ degrees was determined using different lag length criterion of Akaike's Information Criterion (AIC), Schwarz Information Criterion (SC) and among others (Toda & Yamamoto, 1995). In the third step we determined the causality test by conducting the Modified Wald (MWALD) Procedure to test for the VAR (k) of which the optimal lag length is equal to $k = (p + d_{max})$. The MWALD test is said to have an asymptotic chi-squared distribution with p degrees of freedom in the limit when a VAR $(p + d_{max})$ is estimated (Dembure & Ziramba, 2016).

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$$ln\ RGDP_t = \beta_1 + \sum_{i=1}^{k} \beta_{1i}\ ln\ RGDP_{t-i} + \sum_{i=1}^{k} \beta_{2i}\ ln\ Elec_{t-i} + \varepsilon_{1t} \quad (9)$$

$$ln\ Elec_t = \alpha_1 + \sum_{i=1}^{k} \alpha_{1i}\ ln\ Elec_{t-i} + \sum_{i=1}^{k} \alpha_{2i}\ ln\ RGDP_{t-i} + \varepsilon_{1t} \quad (10)$$

The above system of equations were estimated by Seemingly Unrelated Regression (SUR) method. For equation (9), $ln\ Elec$ Granger causes $ln\ RGDP$ if H_0: $\beta_2 = 0$ is rejected against H_A: at least one $\beta_2 \neq 0$ and for equation (10), $ln\ RGDP$ Granger Causes $ln\ Elec$ if H_0: $\alpha_2 = 0$ is rejected against H_A: at least one $\alpha_2 \neq 0$ (where i = 1,…,k and the parameters of i = k+1,…,d_{max} are ignored).

4. FINDINGS AND RESULTS ANALYSIS

4.1 Unit root or Stationarity tests

The unit root test or stationarity test was performed based on the ADF and PP tests to determine the order of integration of the variables in order to avoid spurious results if the variables were integrated at I(2) or higher considering that the ARDL method was used. In both the ADF and PP tests, the lag length selection was based on the Schwarz Info Criterion (SIC). The calculated values using ADF and PP tests for real GDP and electricity consumption was compared with the critical value at 1%, 5% and 10% levels of significance based on SIC lag length selection, both variables in their transformed natural logarithm. Table 3 shows the results and both variable series are integrated of order one, I(1) after first differencing.

Table 3: Unit root or Stationarity test results

VARIABLE	MODEL SPECIFICATION	ADF TEST		PP TETS		ORDER OF INTEGRATION
		Levels	1st Difference	Levels	1st Difference	
LNRGDP	Constant	-0.6933 [-2.9719] (0.8326)	-3.8429* [-3.6998] (0.0071)	-0.7227 [-2.9719] (0.8250)	-3.9778* [-3.6998] (0.0052)	I(1)
	Constant and Trend	-1.1379 [-3.5806] (0.9039)	-3.7659** [-3.5875] (0.0347)	-1.5894 [-3.5806] (0.7714)	-3.9017** [-3.5875] (0.0215)	
	None	2.9026 [-2.6501] (0.9984)	-3.3752* [-2.6534] (0.0015)	2.4367 [-1.9534] (0.9951)	-3.4558* [-2.6534] (0.0014)	
LNELEC	Constant	-0.8685 [-2.9719] (0.7831)	-5.3831* [-3.6998] (0.0002)	-0.8854 [-2.9719] (0.7778)	-5.3831* [-3.6998] (0.0002)	I(1)
	Constant and Trend	-1.7177 (-3.5806) (0.7164)	-5.2975* [-4.3393] (0.0011)	-1.9574 [-3.5806] (0.5983)	-5.2975* [-4.3393] (0.0011)	
	None	1.3371 (-1.9534) (0.9506)	-5.0369* [-2.6534] (0.0000)	1.3263 [-1.9534] (0.9496)	-5.0391* [-2.6534] (0.0000)	

Notes: Number in parentheses [ ] are the critical values at 1% or 5% level of significance. * and ** indicates significance at 1% and 5% level. The number in brackets () is the probability values. It be noted that when it is significant at 1% level, it implies significance at 5% and 10% as well and when only significant at 5% this also means significant at 10% level, but not at 1%.

4.2 Cointegration analysis

The results in Table 3 shows that the variables are integrated of order one I(1), thus the ARDL approach was used to test for cointegration. The F-bound test for cointegration was based on the joint F-statistic under the null hypothesis of no cointegration. The critical values from Narayan (2004) and Pesaran et al., (2001) are used in comparison to the calculated F-statistic. The Akaike information criteria (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQIC) was used to determine the optimal lag order of each variable and for both variables an optimal lag order of 1 was selected by the criterions.

As shown in Table 4, when real GDP is the dependent variable, the model shows there is cointegration between the variables. This is because the F-statistic value of 5.8002 is greater than the critical values of the upper bound at all significant levels, i.e. 1%, 5% and 10% based on Pesaran et al., (2001) critical bounds and also at 10% significant level based on Narayan (2004) critical F-statistics critical bounds and thus the null hypothesis is rejected. This indicates there is a long run casual relationship between the variables. When electricity power consumption is the dependent variable the results shows that there is no cointegration, thus only a short run causality relationship exists between the variables.

Table 4: F-bound test statistics for cointegration with ARDL method

F-Bound Test							
Dependent Variable	**F-Statistics**	**K**	**Significance Level**	**Bound Critical Values (Nayaran, 2005)**		**Bound Critical Values (Pesaran et al., 2001)**	
				I(0)	**I(1)**	**I(0)**	**(I(1)**
LNRGDP	5.8002	1	10% 5% 1%	4.29 5.395 8.17	5.08*** 6.35 9.285	4.04 4.94 6.84	4.78*** 5.73** 7.84
	t-statistic (3.3840)		5%	-2.86	-3.22	-2.86	-3.22**
LNELEC	2.62806	1	10% 5% 1%	4.29 5.395 8.17	5.08 6.35 9.285	4.04 4.94 6.84	4.78 5.73 7.84
	t-statistic (-2.2774)		5%	-2.86	-3.22	-2.86	-3.22

Notes: *,**,***indicate significance at 1%, 5% and 10% level respectively. The critical values are taken from Narayan (2004) for 30 observations and also from Pesaran et al., (2001), Case III: Unrestricted intercept and no trend

4.3 Long Run coefficients and the Error Correction Model

Table 4 test results shows there is a cointegration relationship between the variables, this means there is a long run equilibrium relationship. The findings of having at least a long run relationship between electricity power consumption and economic growth is in line with other empirical studies such as Chikoko et al., (2018); Bunnag, (2020); Olanrele, (2018) and among others. Table 5 shows the results for long run coefficients for the model among the variables.

Table 5: Long-run estimates based on Least Square Method

Dependent variable: LNRGDP				
Variables	**Coefficient**	**Standard error**	**T- Statistic**	**Probability**
LNRGDP(-1)	0.757358	0.071703	10.56249	0.0000*
LNELEC	0.205359	0.062099	3.306969	0.0029**
C (constant)	0.525339	0.229263	2.291429	0.0306**
R-squared: 0.984862 and Durbin-Watson stat: 1.709564				

Note: *, ** denotes significance at 1% and 5% level respectively. Source: computed by the author using EViews 12.0 software package.

Table 6: Error Correction Model Test Results

Dependent Variable: D(LNRGDP) ARDL Model (1,1)				
Variable	**Coefficient**	**Standard Error**	**T-Statistic**	**Probability.**
C	-0.000274	0.007578	-0.036214	0.9714
D(LNRGDP(-1))	0.682110	0.376057	1.813849	0.0834
D(LNELEC)	0.242079	0.089809	2.695499	0.0132
D(LNELEC(-1))	-0.011513	0.098763	-0.116570	0.9083
ECT(-1)	-0.903976	0.425577	-2.124118	0.0451
R-squared: 0.345969 **Probability (F-Stat): 0.045012** **Durbin-Watson statistics: 1.444966**				

Note: This is the author's own work

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As per the Table 6, the error correction model equation is written as;

D(LNRGDP) =-0.00027 + 0.6821*D(LNRGDP(-1) + 0.2421*D(LNELEC) – 0.0115*D(LNELEC)(-1) – 0.9039*ECT(-1).

The error correction term (ECT) has a negative coefficient which is statistically significant at 5% level and hence it provides support of the long run causality. The negative coefficient of -0.9039 for ECT suggests that more than 90.39% of disequilibrium in the previous year of real GDP is corrected in the current year (Ampah, 2012). From the differenced data of electricity power consumption there is an indication that there is a positive impact from eletcricity consumption to real RGDP in the short run. The results suggest that a 1% change in current electricity power consumption results in a 0.2421% change in economic growth in the same direction which is significant at a 5%. In this analysis, the Durbin-Watson statistic value is 1.4449, which is greater than the R-squared value of 0.3459, hence implies that there is no autocorrelation.

4.4 Diagnostic and Stability tests

The error correction model when real GDP is the dependent variable was tested for stability in order to establish the robustness and adequacy of the model. Diagnostic tests carried out such as Breush-Godfrey Serial Correlation test, Breusch-Pagan-Godfrey Heteroskedasticity, showed that the model does not suffer from serial correlation nor Heteroskedasticity. The Jargue-Bera probability is 0.7726 (i.e. P>0.05) and hence the null hypothesis was rejected proving that data is normally distributed. The CUSUM and CUSUMQ statistics were plotted against the critical bound of 5 percent significance level and the null hypothesis is that the coefficient vector is the same in every period, whilst the alternative is that it is not (Ampah, 2012). Figure 4 and 5 indicats the CUSUM and CUSUMQ plots respectively and since the plotted values are within the 5% critical bounds, the null hypothesis cannot be rejected since all the coefficients of the estimated ECM model are stable over the 1991 -2019 period and the model does not suffer from structural breaks. Furthermore, the results showed that the short run model is not spurious because the Durban-Watson statistics value of 1.4449 is found to be greater than the R-squared value of 0.3459.

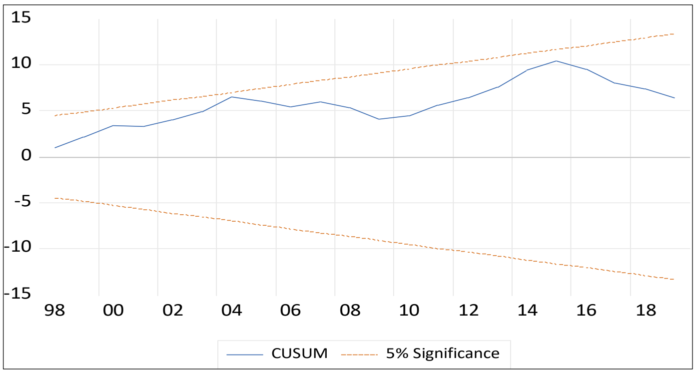

Fig. 3: Cumulative sum of recursive residuals (CUSUM) stability test

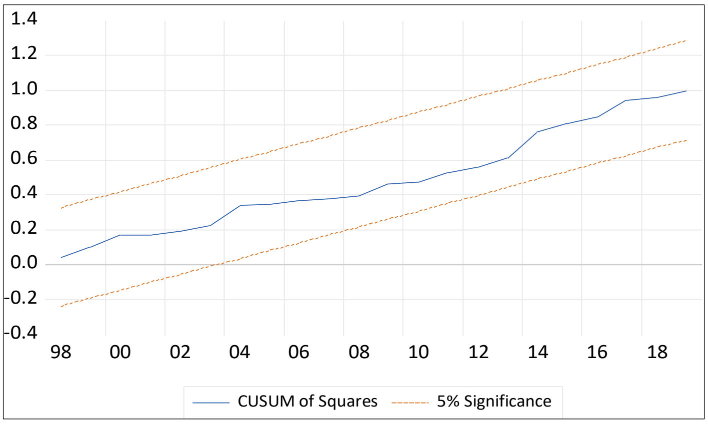

Fig. 4: Cumulative sum of recursive residuals (CUSUM) squares stability test

4.5 Toda-Yamamoto non- Granger Causality test

The Toda-Yamamoto Granger non-Causality (T-Y) approach was utilised to determine the direction of causality between economic growth proxied by real GDP and electricity power consumption. As per results in Table 7 the order of integration is one, *I*(1) for all the variables. This means the VAR Model will add one (1) extra lag. After the determination of the maximum order of integration, the next step taken was determining the optimal lag length. An optimal lag length of 1 was confirmed by Akaike's Information Criterion (AIC), Schwarz Information Criterion (SIC), Final Prediction Error (FPE) and the Hannan Quinn Information Criterion (HQIC). To confirm if the chosen optimal lag length lie within the unit root circle and VAR model stability, a serial correlation test was performed and the results of the inverse roots of the characteristic AR polynomial was checked. The outcome showed no serial correlation and VAR model was well behaved as all the values lie within the unit circle. In addition, the modulus values were less than 1 which satisfied the VAR stability condition. The model was constructed in EViews 12.0 and the simulated results are shown in Table 8, which shows the Granger non-causality outcome between real GDP and electricity power consumption (Elec). The findings indicate that there is no granger causality running from electricity power consumption, but there is a unidirectional causality relationship that runs from economic growth (real GDP) to electricity power consumption in the long run which is statistically significant at 5% level.

Table 7: The Toda-Yamamoto Granger non-Causality test results

Dependent variable: LNRGDP			
Excluded	**Chi-squared**	**df**	**Probability**
LNELEC	0.729666	1	0.3930
All	0.729666	1	0.3930
Dependent variable: LNELEC			
Excluded	**Chi-squared**	**df**	**Probability**
LNRGDP	5.771678	1	0.0163
All	5.771678	1	0.0163

Note: This is own compilation by author based on EViews 12.0 simulation results

5. CONCLUSIONS AND RECOMMENDATIONS

The study examined the presence of cointegration among the variables using the ARDL F-bound test, in which the presence of cointegration was found to exist between real GDP (economic growth) and electricity power consumption. In tracing the direction of causality between economic growth and electricity power consumption, the Toda-Yamamoto approach proved that there exists a unidirectional causality relationship running from economic growth to electricity power consumption and these findings are consistent with those of, Sekantsi & Thamae, (2016) and Sunde, (2017, 2018). The Toda-Yamamoto Granger non-Causality test revealed, at a significance level of 5%, evidence of a long-run unidirectional causal relationship between economic growth and electricity power consumption.

The results indicate that the electricity power consumption in Namibia is determined by economic growth, meaning that growth-led-energy or electricity conservation policies will have little or no effect on Namibia's economic growth. We found that there is a short run bidirectional causality effect between economic growth and electricity power consumption. These findings will assist policymakers in understanding that energy consumption has a beneficial impact on economic growth in the short run. Based on different economic activities such as mining, oil exploration, agriculture, green hydrogen and others that keep growing in Namibia, this will positively improve the level of electricity power consumption. In light of the MSB promulgation in 2019 by the Namibian government, the step has already been taken to unbundle the electricity sector in order to introduce competition, employment, and foreign direct investment and increase electricity generation in the market by the private sector through various renewable energy technologies such as solar, wind, and biomass. Consequently, it is recommended that care be taken in order to strike a balance between the country's electricity generation and economic growth. Aside from the apparent beneficial short-term impact, the study provides no evidence that electricity power consumption drives economic growth in Namibia. Thus, growth-oriented energy policies will have little to no effect on economic growth. Thus, if there is an increase in real GDP, this will lead to an increase in electricity consumption, of which the externality cost of electricity usage may set back economic growth due to possible pollution to the environment especially with the use of fossil fuels that emit carbon dioxide into the atmosphere.

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REFERENCES

[1] Abdelgalil, K. A. , A. (2020). The effect of electric power consumption on economic growth in Sudan: An emperical investigation (1990-2017). Arab Journal for Scientific Publishing, 2, 19–36. www.ajsp.net

[2] Adom, P. K. (2011). Electricity Consumption-Economic Growth Nexus: The Ghanaian Case. In International Journal of Energy Economics and Policy (Vol. 1, Issue 1). www.econjournals.com

[3] Ampah, I. K. (2012). Electricity Consumption and Economic Growth in Ghana. http://hdl.handle.net/123456789/1113

[4] Atchike, D. W., Zhao, Z. Y., & Bao, G. (2020). The relationship between electricity consumption, foreign direct investment and economic growth: Case of Benin. International Journal of Energy Economics and Policy, 10(4), 507–515. https://doi.org/10.32479/ijeep.9415

[5] Bashier, A.-A. A. (2016). Electricity Consumption and Economic Growth in Jordan: Bounds Testing Cointegration Approach. European Scientific Journal, ESJ, 12(1), 429. https://doi.org/10.19044/esj.2016.v12n1p429

[6] Bennett, M. S. (2014). Electricity consumption and economic growth in Swaziland. In International Journal of Recent Research in Interdisciplinary Sciences (IJRRIS) (Vol. 1). www.paperpublications.org

[7] Bunnag, T. (2020). Causality relationship between electricity consumption and economic growth in Indonesia and Thailand. International Journal of Energy Economics and Policy, 10(6), 266–271. https://doi.org/10.32479/ijeep.10159

[8] Chikoko, L., Ngundu, T., & Kupeta, K. (2018). Economic growth and electricity consumption in a multivariate framework: A case of Zimbabwe 1980 to 2016. ACTA Universitatis Danubius, 14(5), 20–33.

[9] Dantama, Y. U., Abdullahi, Y. Z., & Inuwa, N. (2012). Energy consumption - ecomonic growth nexus in Nigeria: An emperical assessment based on ARDL bound test approach. European Scientific Journal June Edition, 8(12).

[10] de Vita, G., Endresen, K., & Hunt, L. C. (2006). An empirical analysis of energy demand in Namibia. Energy Policy, 34, 3447–3463. www.seec.surrey.ac.uk/Research/SEEDS.htm

[11] Dembure, H., & Ziramba, E. (2016). Testing the validity of Wagner's law in the Namibian context: A Toda-Yamamoto (TY) Granger causality approach, 1991-2013.

[12] Dick, E. (2015). Electricity consumption and economic growth: A comparative study of Nigeria and Ghana. https://oer.unn.edu.ng/read/electricity-consumption-and-economic-growth-a-comparative-study-of-nigeria-and-ghana

[13] Esen, Ö., & Bayrak, M. (2017). Does more energy consumption support economic growth in net energy-importing countries? Journal of Economics, Finance and Administrative Science, 22(42), 75–98. https://doi.org/10.1108/JEFAS-01-2017-0015

[14] Etokakpan, U. M., Osundina, O. A., Bekun, F. V., & Sarkodie, S. A. (2020). Rethinking electricity consumption and economic growth nexus in Turkey: environmental pros and cons. Environmental Science and Pollution Research, 27, 39222–39240. https://doi.org/10.1007/s11356-020-09612-4/Published

[15] Ingo, S. (2015). An examination of the causal relationship betwneen economic growth, foreign direct investment and exports in Namibia.

[16] International Energy Agency. (2019). Electricity consumption per capita, Namibia 1991-2019. International Energy Agency. https://www.iea.org/data-and-statistics/data-browser?country=NAMIBIA&fuel=Electricity%20and%20heat&indicator=ElecConsPerCapita

[17] Inuwa, N., Adamu, S., Saidu, M., & Sani, M. B. (2019). Dynamic panel modelling of electricity consumption and economic growth in Economic Community of West African States (ECOWAS).

[18] Jacobs, F. L. (2005). The reforming of the electricity supply industry: Competition and regulatio: An analysis of ESI reforms in Namibia. http://hdl.handle.net/11070/2692

[19] Jumbe, C. B. L. (2004). Cointegration and causality between electricity consumption and GDP: Empirical evidence from Malawi.

[20] Kahsai, M. S., Nondo, C., Schaeffer, P. v., & Gebremedhin, T. G. (2012). Income level and the energy consumption-GDP nexus: Evidence from Sub-Saharan Africa. Energy Economics, 34(3), 739–746. https://doi.org/10.1016/j.eneco.2011.06.006

[21] Khattak, U. R. N., Tariq, M., & Khan, J. (2010). Determinants of household's demand for electricity in district Peshawar. https://mpra.ub.uni-muenchen.de/id/eprint/56007

[22] Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. . The Journal of Energy and Development, 3(2), 401–403. https://www.jstor.org/stable/24806805

[23] Ministry of Mines and Energy, & Electricity Control Board. (2019). Electricity supply industry detailed market design. https://www.ecb.org.na/images/docs/Rules_and_Regulations/MSB/MSB_Detailed_Design_Report.pdf

[24] NamPower. (n.d.). Namibia Power Corporation (Pty) LTD company profile. Retrieved March 1, 2022, from https://www.nampower.com.na/About.aspx

[25] Narayan, P. K. (2004). Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji (No. 02). 2(4), 1–40. https://www.researchgate.net/profile/Paresh-Narayan/publication/268048533_Reformulating_Critical_Values_for_the_Bounds_F-_statistics_Approach_to_Cointegration_An_Application_to_the_Tourism_Demand_Model_for_Fiji/links/55d8786e08ae9d65948f8fd4/Reformulating-Critical-Values-for-the-Bounds-F-statistics-Approach-to-Cointegration-An-Application-to-the-Tourism-Demand-Model-for-Fiji.pdf

[26] Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. Applied Economics, 37(17), 1979–1990. https://doi.org/10.1080/00036840500278103

[27] Olanrele, I. (2018). Revisiting electricity-economic growth nexus in Sub-Sahara Africa: Perspectives from Nigeria and South Africa. International Journal of Management and Sustainability, 7(3), 180–193. https://doi.org/10.18488/journal.11.2018.73.180.193

[28] Onyango, R. B. A. (2021). Energy use and economic growth in the Southern African Development Community (SADC). https://researchspace.ukzn.ac.za/handle/10413/20143

[29] Pata, U. K., & Yurtkuran, S. (2017). The relationship between electricity consumption and economic growth in the selected member countries of the International Energy Agency (IEA): An ARDL bounds test approach. Iran Economic Review, 21(2), 341–364.

[30] Pesaran, H. M., & Shin, Y. (1997). An autoregressive distributed lag modelling approach to cointegration cnalysis. In The Norwegian Academy of Science and Letters.

[31] Pesaran, H. M., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326. https://doi.org/10.1002/jae.616

[32] Santos, A. M., Barrios, D., Taniparti, N., Tudela, P. J., Muci, F. J., & Lu, J. (2022). A growth diagnostic of Namibia. https://nrs.harvard.edu/URN-3:HUL.INSTREPOS:37370788

[33] Sekantsi, L. P., & Okot, N. (2016). Electricity consumption–economic growth nexus in Uganda. Energy Sources, Part B: Economics, Planning and Policy, 11(12), 1144–1149. https://doi.org/10.1080/15567249.2015.1010022

[34] Sekantsi, L. P., & Thamae, R. I. (2016). Electricity consumption and economic growth in Lesotho. Energy Sources, Part B: Economics, Planning and Policy, 11(10), 969–973. https://doi.org/10.1080/15567249.2013.876125

[35] Sheetekela, S. P. , N. (2018). Exploratory study into leasing of Namibia's consumer rooftop for solar energy generation by distribution utilities.

[36] Shigwedha, W. N., & Kaulihowa, T. (2020). Investigating the Effects of Government Expenditure and Money Supply on Unemployment in Namibia. In Journal of Economics and Behavioral Studies (Vol. 12, Issue 4).

[37] Sunde, T. (2017). Energy consumption and economic growth modelling in SADC countries: An aplication of the VAR Granger causality.

[38] Sunde, T. (2018). Revisiting the Environmental Kuznets Curve and the Role of Energy Consumption: The Case of Namibia. https://mpra.ub.uni-muenchen.de/86507/1/MPRA_paper_86507.pdf

[39] Sunde, T. (2020). Energy consumption and economic growth modelling in SADC countries: an application of the VAR Granger causality analysis. In Int. J. Energy Technology and Policy (Vol. 16, Issue 1).

[40] Toda, H. Y., & Yamamoto, T. B. (1995). Statistical inference in vector autoregressions with possibly integrated processes. In EUEVfER Journal of Econometrics (Vol. 66).

[41] Tsaurai, K. (2013). Is there a relationship between electricity consumption and economic growth in Zimbabwe? In Corporate Ownership & Control (Vol. 10, Issue 4).

[42] Wolde-Rufael, Y. (2006). Electricity consumption and economic growth: A time series experience for 17 African countries. Energy Policy, 34(10), 1106–1114. https://doi.org/10.1016/j.enpol.2004.10.008

[43] World Bank. (2014). Electric power consumption (kWh per capita) - Namibia. World Bank. https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=NA

[44] World Bank. (2022, January 25). The World Bank in Namibia, economic outlook. World Bank. https://www.worldbank.org/en/country/namibia/overview#1

[45] Zhong, X., Jiang, H., Zhang, C., & Shi, R. (2019). Electricity consumption and economic growth nexus in China: an autoregressive distributed lag approach. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-019-04699-w