

Energy Poverty in Sub-Saharan Africa: Evidence for Nigeria

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ABSTRACT

Energy poverty is the common problem for every country in sub-Saharan Africa and is mostly driven by the lack of electricity. In Nigeria, the failure of the government to fix power outage has been connected to Nigeria's slow economic growth by affecting human social capital. This research would examine the residential, educational and environmental implication of the lack of power in Nigeria, to determine the relationship between electricity consumption, school enrolment, and energy poverty measurement in Nigeria. Also, to investigate the causes of non-reliable power systems. The study used time series annually from 1990 to 2020. The study shows that energy poverty is very much present in Nigeria and is shaped by the lack of electricity which has damaging effects on Nigeria's residential, educational and manufacturing sectors through electricity consumption. The study used unit root test (ADF and PP), lag length criteria, ARDL model and bounds test, ECM (error correction model). Findings showed that at difference, all the variables are significant and so stationary, and PP test is also used to support it. Following lag length criteria, lag 2 was the best option. F-statistic is greater than I (0) and I (1), T-Statistic is too. ECM showed that the correction of the previous error will be done at a speed of 104%. Therefore, to solve the problem, TCN can update and expand transformers capacity and the new voted law that would empower state governments to generate and transfer electricity on their own should be implemented. The fact that the access to clean cooking should be increased is a gender problem as well and can save many lives. The grid needs to be renovated.

Keywords: Energy poverty, Electricity, Clean cooking, Education, Climate change, Nigeria.

ÖZ

Enerji yoksulluğu, Sahra altı Afrika'daki her ülke için ortak bir sorundur ve çoğunlukla elektrik eksikliğinden kaynaklanmaktadır. Nijerya'da, hükümetin elektrik kesintisini düzeltmedeki başarısızlığı, Nijerya'nın beşerî sosyal sermayeyi etkileyerek yavaş ekonomik büyümesiyle ilişkilendirildi. Bu araştırma, Nijerya'daki elektrik tüketimi, okula kayıt ve enerji yoksulluğu ölçümü arasındaki ilişkiyi belirlemek için Nijerya'daki güç eksikliğinin konut, eğitim ve çevresel etkilerini inceleyecektir. Ayrıca, güvenilir olmayan güç sistemlerinin nedenlerini araştırmak. Çalışmada 1990-2020 zaman serileri kullanılmıştır. Çalışma, enerji yoksulluğunun Nijerya'da çok fazla mevcut olduğunu ve elektrik tüketimi yoluyla Nijerya'nın konut, eğitim ve imalat sektörleri üzerinde zararlı etkileri olan elektrik eksikliği ile şekillendiğini göstermektedir. Çalışmada birim kök testi (ADF ve PP), gecikme uzunluğu kriterleri, ARDL modeli ve sınırlar testi, ECM (hata düzeltme modeli) kullanılmıştır. Bulgular, farklılık gösterdiğinde, tüm değişkenlerin anlamlı ve çok durağan olduğunu ve PP testinin de bunu desteklemek için kullanıldığını göstermiştir. Gecikme uzunluğu kriterlerini takiben, gecikme 2 en iyi seçenektir. F-istatistiği I (0) ve I (1)'den daha büyüktür, T-İstatistik de öyledir. ECM, önceki hatanın düzeltilmesinin 104% hızında yapılacağını gösterdi. Bu nedenle, sorunu çözmek için TCN, transformatörlerin kapasitesini güncelleyebilir ve genişletebilir ve eyalet hükümetlerini kendi başlarına elektrik üretme ve aktarma konusunda güçlendirecek yeni oylanmış yasa uygulanmalıdır.

Keykelimleri: Enerji yoksulluğu, Elektrik, Temiz yemek pişirme, Eğitim, İklim değişikliği, Nijerya.

DEDICATION

I dedicated to Almighty God

And

The Family of Yedzu Nouvengue

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All thanks to Almighty God, who provided me with wisdom, strength, and good health over the course of my studies.

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Chapter 1

INTRODUCTION

1.1 Background of the Study

In Africa, more than half of the population lives in the dark because of lack of energy (electricity), the so-called energy poverty. This problem is particularly prevalent in sub-Saharan Africa, where some regions still lack electrical infrastructure. In Nigeria, the electrification rate in rural areas is really low and, in the cities, it could be better, but it is not (Mutiso, 2019). Electricity scarcity is the main challenge facing education, residential, and manufacturing sectors in Nigeria by consequent the economic and commercial status of the country are falling behind expectations. The principal sources of electric production are hydro and thermal sources, but yet the output is very much far less than the population demand. The shortfalls of electricity production causes residential and commercial (businesses, corporate bodies) sectors to opt for off-grid power generation, which requires mainly the use of gasoline/ diesel/ kerosene generators that are environment-unfriendly and constitute an increase in the carbon foot-print index of the country. According to Ugochukwu (2021) the usage of off-grid power generators also called back up generators is growing and went up from around 60% in 2002 to 80% in 2014. This gives an average of over 84 per cent of urban residences that depend on off-grid power generators for electricity supply. The rest live in the dark or uses fossil fuels. In addition, the shortage of electricity creates a dependency on fossil fuels such as (wood, residues from biomass, charcoal) in rural households and kerosene, gas, and wood fuel in urban households (World Health

Organization, 2021). Considering that the Nigerian population is growing fast, household energy security becomes an important topic to discuss since the reliance on biomass fuels for cooking largely contributes to household air pollution, forest deforestation, and climate change (Bello, 2010). According to WHO (2019) using firewood for cooking is a major cause of health issues in third world nations due to indoor pollution, estimating that about 1.5 million people die each year hastily, showing an average of 4000 deaths/day. Moreover, the issue of household air pollution is not the only critical factor to be afraid of, climate change is also a big deal in Nigeria (Haider, Huma, 2019). Nigeria is home to more than 220 million people that rely on agricultural products for subsistence and climate change accompanied with global warming make Nigeria vulnerable (Idowu & al, 2011). In addition, climate change creates food shortage, reduces livestock's production as well as the supply of electricity from hydro power, causes the destruction of shelters and road network as the rainfall regimes will be affected therefore floods will occur. Also, the increase in the temperature and humidity will favorize the risk of diseases such as pest in farmlands and malaria. Many schools in Nigeria are also affected by electricity scarcity. The average enrollment rate to schools in Nigeria is lower than the average of the overall Africa continent and the non-electrification of schools increases the drop-out as well as human capital waste essentially for female (World Bank, 2014). From a report assessing the direct relation between electricity and schooling, it comes that current state of schools' electrification is really critical and approximatively 4 out of all 5 primary and secondary schools in Africa assessed lacked electricity access (UNESCO, UN, World Bank, 2014), and according to them the electrification of these schools can provide many benefits such as the improvement of school enrollment rate,

school results, and hours of study, the availability of ICT while teaching, and the retention of the staff.

1.2 Research Problem Statement

Electricity is a key component in the development of many countries in sub-Saharan Africa. In most African countries, including Nigeria, the process of electrification begins with the construction of power grids that provide the necessary amount of electricity to run factories, agricultural activities, and commercial enterprises. Because Nigeria is an energy poor country, a good and reliable electricity supply can spur economic growth, create more jobs, and increase income that can be reinvested to purchase more equipment (cookstoves). One of the targets of the seven sustainable development goals (SDG 7) is to grant full access to clean cooking technology to over 1.1 billion people in sub-Saharan Africa by 2030 (IEA, 2018). Such improvement will have an important impact on health and mortality statistics. Energy poverty and the nature are linked mostly through land use, as specified above, solid biomass is the main source of energy for destitute people and its overexploitation augments desertification and deforestation. So, solving electricity outage can save sub-Saharan countries from climate change drawbacks (Energy poverty, Gonzales, 2015). Electricity permits low-income people to access communication, light, and a diversity of educational opportunity. Some major effect of school electrification has led to the reduction of illiteracy as well as the improvement of teaching services (A.S.A.C Diniz, 2006). A study conducted for 120 countries, shows that a strong correlation was observed between education index and electricity consumption per capita, explaining that the greater is the electricity consumption the higher the education index is, and vice versa. The education sector with no electricity tends to perform poorly and that has negative impacts on staff behaviour and teaching techniques (Tanagawa & Nakata,

2008). Nevertheless, the reality facing Nigerians is quite unpleasant. The lack of sophisticated power facilities that can provide reliable electricity is a major factor delaying economic development and hindering social well-being in many states in Nigeria.

1.3 Research Objectives

The main objectives of this study are to assess the link between electricity consumption and some other development factors such as energy use, education, and access to clean technology for cooking. And also, the link between energy use and the growth in manufacturing sector. The study will also help to understand that energy is a key for development if associated to HDI (Human Development Index). Showing the nature of the importance that energy poverty has on education, cooking, and the environment will allow to find the factors and entities that directly interact with the problem and elaborate measures to solve them.

1.4 Research Questions

- a) What is the impact of the lack of electricity in Nigeria?
- b) What is the relationship between electricity consumption and energy poverty?
- c) How is the effect of energy poverty factors on electricity consumption in Nigeria?

1.5 Significance of the Study

Energy poverty in sub-Saharan Africa has given rise to great concern than ever and has been the subject of many studies, hence the reason for this research paper. This paper is specific in multiple points and varies from previous research because it emphasizes on Nigeria's state of electrification and all the economic, social and education impediments that comes with it. Most of research tend to focus on households' choices of cooking fuels regarding their income, the impact of energy poverty on economic growth as well as on health.

The motivation of this study is to assess the effects of households' behaviors, education and the environment on electricity consumption in Nigeria.

1.5 Structure of the Thesis

The thesis is separated into six parts. The background, the research subject, the research question, and the purpose of research, are all included in the first chapter. The second chapter focuses on the general view of electricity use in Nigeria. The goal of this chapter is to establish the real impact of electricity outages on the Nigerian population and their activities by assessing households access to clean cooking technologies, the education sustainability and impediments, as well as the related factors contributing to the disruption of the environment.

The third chapter is about the literature review of relevant topics linked to energy poverty. It talks about analyses and methods used by previous researchers to study different aspects of energy poverty and what they found. The fourth chapter of the study gives an insight into explanations for the analysis, methodologies, and definitions of variables employed in the research.

The study's instructive and statistical findings are discussed in the fifth chapter. This chapter will focus on statistical and econometric analysis results. The findings would lead one to accept or reject the hypothesis, as well as determine whether or not there is a link and the significance of that relationship. The conclusion is presented in the sixth chapter, along with recommendations for decision-makers.

Chapter 2

A GENERAL VIEW OF ELECTRICITY USE IN NIGERIA

2.1 Electricity and Clean Cooking Facilities in Nigeria

In Nigeria, indoor air pollution is the third leading cause of death, and women and children are the most affected. Households in rural have the worst living conditions because when a women cook dinner for their family, they produce a lot of smoke that contains what is called black carbon. The emission of black carbon in Nigerian households is mostly related to the use of wood fuels in cooking on open fires. The smoke released is very dense and causes the air to be barely breathable for people in the vicinity, leading to respiratory illnesses like lung cancer. It is important to note that most people who rely on wood for cooking are necessarily poor and live in inconvenient conditions. Households spend a large portion of their income to afford wood. Yet this money could be used in other ways, such as buying food, sending their children to school, etc. it must be admitted that, using wood for cooking is a big problem for Nigeria, and the environmental impact is clear to see. Wood supplies do not last forever and cutting down trees has a huge negative impact on the climate. Nigeria's forests are losing up their area each year, creating a significant amount of greenhouse gases that cause global warming. This scenario is due to the absence of one parameter: large, reliable and affordable electricity that can power households and the way women cook. The Nigerian government can raise revenue, partner with outside bodies, or even NGOs to provide clean cookstoves throughout Nigeria, but if

people do not have access to stable and affordable electricity, they will eventually revert to their traditional way of cooking. Using clean cookstoves reduces black carbon emissions and reduces the amount of wood needed to cook. Some may say that given the fact that we still do not have access to affordable energy, we should focus on fuel-efficient cookstoves first, but the thing is that the Nigerian population is growing very fast, which increases the carbon footprint and threatens the livelihood of the poorest. In addition, fuel-efficient cookstoves do not make smoke disappear, they only reduce it. Children's health is sensitive and smoke, however small, is still smoke. Therefore, I strongly believe that in a developing region that wants to accelerate its growth on a large scale while protecting the environment and the health of the people, we must have good energy that is readily available, and we should rely on electricity.

2.1.1 Household Air Pollution and Fuels for Cooking

Air pollution in Households is mostly caused by cooking emission and is responsible for over 1.1 million deaths in Africa according to WHO (2019). Only 17% of people in sub-Saharan Africa have access to clean cooking technologies. In Nigeria more than 98000 women and children under the age of 5 decease annually from the use of firewood, residues from biomass, kerosene, and smoke produced by diesel generators. A woman preparing breakfast, lunch and dinner using traditional ways of cooking is equivalent to her smoking between 3 and 20 packets of cigarettes a day, World health organisation (2013). Moreover, only 13% of the population has access to clean cooking technologies in Nigeria (world bank, 2019). The type of fuels used for cooking really depends on the fact that whether people live in urban areas or rural areas and also their respective income.

The main energy types used for cooking in Nigeria are given below.

2.1.1.1 Biomass

Biomass was used by 69.5 percent of the population as of 2019 data from WHO. It is the energy derived from living things like wood and natural waste. The biomass resources in Nigeria are classified as grasses/bushes, wood, leftovers, and garbage (from forests, crops and industrial activities) (Gumau, 2007). Biomass fuels play an important role in households, especially when it comes to cooking. Many households rely on it since it is relatively easy to obtain. According to the World bank organization biomass is the predominant cooking fuel used in rural areas in Nigeria due to its affordability and the fact that most of the people who live in remote areas are poor.

2.1.1.2 Liquified Petroleum Gas

In his study, Aston-Jones supported facts saying that Nigeria's cool-stored is more abundant in gas than crude oil. When released in the air without appropriate treatment, those gases become a danger for the ozone layer on which all life depends (Anija-Obi, 2001). Its distribution is essentially rigorous in urban areas. LPG offers distinct health, environmental and productivity advantages over paraffin or firewood. Limitation of gas options in Nigeria includes both the cost of fuel and the one of purchasing appliances. While convenient, there is a great sense of unsafety with security concerns, and theft of gas cylinders is an obstacle to using natural gas as a fuel especially in crowded state like Lagos. Noted that just 10.9 percent of Nigerians used LPG as of 2019 data from WHO.

2.1.1.3 Electricity

A sophisticated installation is required to obtain electricity since it comes from the conversion of other energy sources. Electricity is wanted for industrial, commercial and residential purposes and in order to be generate and distributed colossal infrastructure should be put in place. In 1929, NESCO started to supply electricity in

Nigeria as the main electricity supply company by building a hydroelectric power plant at Kura. Then in 1951, Electricity corporation of Nigeria was built and launched the construction of the 132 kV transmission line connecting Ijora to Ibadan power station in 1961. That same year, NDA (Nigeria Dam Authority) was created with the mission to enhance the country's hydro power potential. However, in 1972 both NDA and ECN were fused to become NEPA (the National Electric Power Authority). NEPA had for mission to improve and sustain the electric grid to facilitate the supply of electricity throughout Nigeria. However, even all states are connected to the grid nowadays, just 0.7 percent of the population used electricity for cooking (WHO, 2019).

2.1.1.4 Firewood

Estimates show that about 3 billion people worldwide consume about 1.55 billion cubic meters of firewood as their principal source of energy. We count around 2 billion people that lean on fuelwood for cooking and heating purposes. Firewood emits dangerous pollutants such as carbon monoxide, nitrogen and oxide of sulfur. In developing countries, women and children are the most affected by these emissions due to the significant amount of time they spent in the smoke. Noted that this is because most houses do not have ventilation systems.

2.1.1.5 Coal

Used by 3.7 percent of the population in 2019, coal is more efficient than firewood. However, coal smoke contains a significant volume of toxicity proper to itself. It contains solid ash particles, sulfur and some metal components such nickel and lean.

2.1.1.6 Kerosene

Kerosene was used by 11.6 percent of the population in 2019. It is one of petroleum derivative, really volatile and significantly utilised in Nigerian households as the primordial source of power for cooking, lighting buildings, incinerating rubbish, and fuel for vehicles (Amakiri & Owen, 2009). Due to urbanization, people that are living in urban areas use kerosene the most because they have high income. The country suffers from daily blackout so, the people have been forced to provide power for themselves. This does not create a good business environment even the owners of modern photocopy businesses tell the generators cost a death to their pockets. In Lagos, the biggest city and business center of Nigeria, the power is not always available and just comes for 5 hours a week. Nigeria relies on generators to produce electricity both at home and at work and while running these generators, dangerous fumes are released and the noise they produce is simply deafening. Business owners complain about the high price of fuel (kerosene) saying that, it is costly to maintain generators and the fact that the lack electricity is negatively affecting their operations and the storage of raw materials like leather and more. In 2013, Market analyst at TTAC Nigeria TUNJI A. said Nigeria is one of Africa's leading energy producers but it has failed to fix the electricity supply and the government is to blame, adding the fact that 60 million Nigerians are using generators, which make total of over 100 million generators running every day (BBC news Lagos, 2013). At home, due to the rising price of kerosene in some states, the average price per liter caused many people even in urban areas to turn back burning wood and any type of biomass for cooking and more (National Bureau of Statistic, August 2021). According to NBS and World Bank the highest average prices per liter of kerosene were recorded in Osun (N531.77),

Ebonyi (N607.14), Cross River (N593.75) very much above the average price per liter in the world which is \$1.01 (globalpetrolprice.com, April 2022).

2.1.2 The Impact of Air Pollution on Health in Nigeria

(Smith & al., 2000). Burning fuels in archaic appliances (residential cooking stoves) without significant emissions of hazardous waste is an impossible task, because it is way difficult to obtain a full mixture of the fuel and air during a combustion process. As a result, a significant portion of black carbon is emitted in the atmosphere. According to (Zhang & al., 2000) in China, when residents use coal and biomass for cooking, over 10% and up to 38% of the fuel carbon is converted into incomplete combustion products. which is typically the case of simple stoves in sub-Saharan African countries and others low-income countries (Smith & al., 2000). When the supply of air or oxygen is insufficient, the process of combustion is partial or incomplete resulting in the production of water which is normal but also carbon monoxide along with carbon instead of carbon dioxide. Carbon monoxide is a toxic gas causing serious respiratory illness and even lung cancer, while carbon is emitted as soot.

2.1.2.1 Heath and Illness: Case of Lung Cancer

Residential energy use in Nigeria, along with the commercial sector, has a positive impact on health. Using energy efficiently have a positive impact on households living standard through numerous features such as lightning, cooking, water treatment, and home appliances. Indirectly, energy use provides hospitals with the best tools to improve health outcomes and permits them to use effective devices to treat people suffering from respiratory diseases. When we look at developed countries, we notice that higher energy consumption enables top tier health care, better storage facilities for vaccines and medicines, adequate medical equipment and more. Therefore, regardless

the location (rural or urban) life expectancy is higher and the mortality rate insignificant.

Lung cancer:

Several epidemiological studies conducted in China have found a relation between coal use and lung cancer. These studies underpinned the fact that unusually many non-smoking women were diagnosed with lung cancer after using coal for outdoor cooking (Chapman et al., 1989; Liu et al., 1991; Mumford et al., 1987). Using Odds Ratio in 2004, Smith conducted an analysis for lung cancer allied with indoor air pollution. From those analyses, it came out that odd ratio for women in Nigeria was 1.17% followed by a confidence interval (CI=95%) between 1.02-1.35, and was the largest ratio very much above the one of men. According to data published by WHO in 2018, the number of deaths from lung cancer in Nigeria was 949 or 0.05% of total deaths. Nigeria was ranked 179th in the world according to its mortality rate index. Respiratory illness is also another consequence of air pollution.

2.1.3 Climate Change Triggers and Effect on the Nigerian Ecosystem

This part is directly linked to the use of wood fuel and any kind of biomass for cooking, lighting, cooling, etc. because most of Nigerians do not have access to electricity to power their activities they turn to other sources and somehow with abusive methods which unfortunately provoke the disruption of the environment.

2.1.3.1 Nigeria's Forest

Nigeria forest covers an area of 10 Mha, with over 189 metric tons of biomass per hectare. Teak trees count for 60% of the total forest coverage while plantation areas constitute 25% of the forest coverage. Nigeria has about 445 forest reserves and 8% of land is dedicated to wildlife (Akindele, 2005). The forests provide benefits such as

food, medicine, fuel and natural products. Environment benefits such as carbon sequestration, watershed protection, wildlife habitat's protection, as well as water and air purification (natural resources Canada 2017). There are 8 national parks in Nigeria with diverse flora and fauna resources that are mostly peculiar to Nigeria. To sum up Forests have a tremendous contribution to gross domestic product as well as the livelihood of many (Owolabi, 2019).

2.1.3.2 Deforestation

Deforestation can be defined as the purposeful clearing of any type of forested area (nationalgeographic.org). Due to shortage of electricity and high pricing of gas and kerosene, people have been forced to use wood and biomass to run their households' activities and businesses (BBC news Lagos, 2013) and this decreases the forest. In 2017, area tree cover loss has grown up to 171 Kha equivalent to 12.1 metric tons of CO₂ emission. However, from 2001 to 2020, Nigeria lost 1.04 Mha of tree cover representing 10% of its overall surface (Globalforestwatch.com). According to the website, the 5 regions presenting the most tree cover loss are Sokoto 100%, katsina 100%, both located in the extreme northwest of Nigeria. While the other regions Kebbi, Yobe, and Gombe located in northeast Nigeria lost more than 90 per cent of forest.

2.1.3.3 Impact of Climate Change on the Environment and Agriculture

According to (Trenberth 2009) the abusive activities that drive global warming are mainly committed by human and this is one reason we experience earth's energy imbalance.

Low crop yields

The mechanism Nigeria's agriculture sector uses the repartition of crops is extremely affected by climate change through unpredictable weather conditions, resulting in inadequate output to fulfil the demands of the people. For instance, because the crops cultivated in northern Nigeria do not flourish in soils that are saturated with water as a result of severe rainfall, climate change may impede their growth. Similarly in the south part, some crops which depend on rainfall for growth, may perish during protracted droughts.

Decreased livestock productivity

Livestock need to eat grass for a favourable development, so if there is not enough food, it affects their productivity. The farm these animals feed on is destroyed by unfavourable climatic conditions. In addition, floods encourage the development of pests that attack the livestock and cause their market price to reduce.

Loss of income

One of the main drivers of the Nigerian economy is agriculture since it provides many people with income. These people are either living in rural areas or cities depending on how deep they are invested in agricultural activities. Locally and nationally, climate change damages land and causes the profit made from agricultural sales to decrease.

Public health crisis

There are a lot wetlands in Nigeria and when they overflow, it creates stagnant stretch of water that favours the spreading of illness such as malaria. Malaria is fatal to every spectrum-age (young or old). Also, climate is responsible of respiratory diseases through wildfires and erosion of solid particles.

Reduced supply of electricity from hydropower

The Nigeria's hydroelectric plant located in Kainji provides a substantial quantity of power but climate change promotes instability in the process. It affects the rainfall patterns, lowering water levels in reservoirs. As a result, the quantity of hydroelectric power decreases, affecting electricity distribution. The unfortunate situation typically touches factory operations that rely on consistent energy to function.

Damage of shelter and road networks

Flooding negatively impacts rural populations. Dwellings collapse after big floods because they lack basic building supports and proper isolation. Furthermore, because flooding destroys the road networks, rural residents are unable to commute.

To summarize, using wood for cooking and other activities exacerbates deforestation and this in turn causes ecological and economic problems. Another trouble linked to climate change is food shortage.

2.2 Electricity and Schooling in Nigeria

According to the federal government over 76 million of adults in Nigeria are illiterate, representing 38% of the population. Let us approach this problem from a perspective that matches the need for energy for growth. In rural Nigeria, the prospect of electrification is really low and children experience a different reality of life. Instead of going to school like children in most developed countries, they help their parents

with physical and laborious activities such as wood fetching and other fuels in the forest to provide light, cooking and heating, working in plantations, and animal hunting. This significantly reduces the time they have to spend accessing knowledge. This also negatively affects their school performance of the children, who cannot study during the dark hours because there is no light. All of these aforementioned living conditions cause enrolment to decline. The lack of electricity in rural areas affects children's human capital more than we may think. The criteria for electrification in rural areas is not very well met and the grid system already in place is unreliable. In most states, the reason people do not use electricity is because it is expensive. This brings us to the real issue, which is the rapid need for a large, reliable, and affordable power supply. The affordability is really important because all the people who live in remote areas are very poor and need to take good care of their children by feeding and sending them to school.

2.2.1 Educational Benefits of Electricity in Urban and Rural Areas

The lack of electricity in schools is unfortunate because it can provide many services in the classroom, right now 65% of the 74,280 primary schools in Nigeria do not have access to electricity said humanitarian coordinator Kallon (Guardian.ng 2016). Classes can be held in the early morning or late at night thanks to lighting. The introduction of ITC in the classroom, such as computers and televisions, is made easier by the availability of electricity. Electrified schools have been associated with increases in test scores and graduation rates and can help school administrators hire and keep more skilled instructors. Some study claims that electricity gives people with modest incomes access to illumination, communications, and a range of educational options (UN DESA, December 2014).

2.2.1.1 Lighting and Study Hours

The supply of light, which allows for extended study hours (or lessons) in schools, is perhaps the greatest advantage of electricity. In some states such as Borno, Ibanda, Taraba and more for example, without electrification, they had to wait till midmorning to start courses. Teachers and students agreed that educational success is higher because electricity enables on-site students to remain on campus after lessons, allowing for classes to continue into the early morning and after nightfall. However, in November 2021, medical students protested power outage for over 2 months saying that it was impossible for them to study, to charge their phones and computers also talked about the fact that they have to repeatedly spend their income to buy power banks (Ede, 2021 punchng.com). In Nepal, interviews with local teachers revealed that early morning and late evening classes are held to catch up on material that was not understood or barely taught during ordinary class times because they lacked staff (UNDESA, 2014). Moreover, the quality of electric light often plays an important role. Light-emitting diode so-called LED, last longer and a give better quality experience compared to archaic light sources like candles, paraffin lamps and wood. Tests show that after operating for 50,000 hours, paraffin light cost \$1,251, whereas the simple bulb cost \$175 and the LED just \$20. (EEDAL London, 2006). Innovations in lighting infrastructure have the potential to provide enormous advantages. For instance, the research done for certain communities in Malawi discovered that switching from paraffin lamps to solar lights lowered yearly lighting cost in houses, clinics, and schools by roughly \$50 per facility. (MVP, 2005).

To sum up, electricity eases both the batch and quality of learning and makes it possible, this explains why the furnishing of electricity has a positive impact on adolescent literacy (UNDESA, 2014).

2.2.1.2 Information Technology Communication Availability

Electricity in schools allows the use of a whole bundle of ITC technologies, which include phones, TVs, the Internet, projectors, computers and photocopiers, cameras and more. According to UNESCO, the furnishing of ITC can have a profound effect on schools. Learning becomes much easier with ITC; students can achieve great things while studying in a proficient environment suitable for the research. Computers have grown in power, and they are now linked in a worldwide network of information via the internet to facilitate study. Electricity, for example, has allowed instructors in Argentina to add receptors in corridors and classrooms for pupils to keep in touch with announcement, upcoming events and social activities. To facilitate the learning of foreign or local languages, devices appropriated to the task have been installed in every schools.

2.2.1.3 Improvement of Staff Retention

Not only is electricity attractive to students and improves their learning experience, it also increases the willingness of staff to stay for teaching experience. From a rational point of view teachers are reluctant to the idea of working in remote areas due to the lack of basic living standard like electricity. Electricity does not only provide lights, but can also improve housing and health care giving access to some facilities to make life pleasant. A study conducted in some schools in Argentina, demonstrated that almost 63% of staff and teachers surveyed said that better working conditions had improved the quality of their work.

When schools are electrified, it provides lecturers with best tools to for better quality teaching. In Africa and South America, electricity allowed lecturers to gain in computer skills. That made it suitable for them to carry online teaching, manage grades

and explore different educational techniques that can stimulate the learning spirit of students.

2.2.1.4 Better Academic Results

Overall, the benefits of electric light and ITC have a positive influence on school performance, we can observe less absenteeism and truancy, higher enrolment and participation rates, higher graduation rates resulting from better test scores. Several practical examples give explanation for these brilliant performances. After the electric lights were installed in Argentina, the truancy level impressively dropped. Moreover, after enabling solar power in Sudanese and Tanzanian schools they observed a significant amelioration in primary and secondary school completion rates from less than 50% to nearly 100% (Goodwin, October 2013). In Kenya, recently electrified schools have shown a significant jump in performance in national exams (Kirubi, 2009). In the Philippines, before the installation of six public schools with photovoltaic systems, classes had to be cancelled in wet weather by cause of lighting issue. To have their courses or whatever paper printed, people had to trip 45 minutes to reach the nearest town. But after electrification, absence dropped, presumably interest of students for school grew bigger (Valerio, June 2014). Researchers at the University of California also believe that schools that have basic amenities, especially electrified schools, do much better in raising achievement (Economics of Education Review 25, 2006).

2.2.2 Electricity Challenges to School Electrification

Mrs. Hamilton, Headmistress of Lakefield institute in Aja, Lagos, stated that the absence of power is a big impediment to ITC-based teaching techniques in Nigeria. During an interview, she went further and said without power, students cannot be kept in classes. Asking for more stable power supply to run academic

equipment and make studying enjoyable. She also explained that, large amount of money is spent on gasoline to power generators because there is no electricity. This is a significant difficulty for us, particularly if we wish to undertake modern teaching using ITC she said. Therefore, she called out the government saying it should assist them in improving their electrical supply, particularly for teaching.

2.2.2.1 Classism and Urban Preconception

This one revolves around a favouritism mechanism in electrification initiatives. Electrification manoeuvres target metropolitan clients first and foremost, because urban regions are more densely populated and also are centres of political, economic, and cultural authority. When it comes to electrified rural regions, there is a tendency for class preconception; nicer homes and wealthy schools are electrified first, omitting the poor.

Several areas provide evidence of urban favouritism in both education and electricity projects. For most schools, funding is based on student contributions and the cost of institutional operations. Therefore, rural schools are disadvantaged due to low level of enrolment rate and incapacity to provide diverse activities (UN development program, 2007).

2.2.2.2 Technical Vandalism and Theft

Resources vary in the availability of renewable energy, meaning every school chooses its power supply according to the natural resource available in its location. It can be wind, hydro or solar. According to the National Renewable Energy Laboratory, since (RE) resources vary from region, choosing the right renewable energy system depends on the region and location. In Sub-Saharan Africa, for example, mixture of hydro and wind to produce electricity for schools is confined to a few settlements where the flow

of resource is optimal. Wind and small hydropower have enormous and economically appealing potential in India, but they are underused due to the lack of suitable grid capacity and road access. More than 80% of school personnel polled felt solar performed worse than the grid. This is due to insufficient illumination and frequent fluorescent tube burnout, which lasts approximately 9 months on average. Every school required technical support at least twice, because their technological concerns were never completely handled. An assessment of Thailand's renewable energy sources discovered that a "lack of skilled labor and spare parts" is a "significant impediment," particularly for wind, solar, and biomass.

2.2.2.3 Households Lack Access to Energy

electrification projects give access to schools but seldom to households, leaving students and instructors homes without electricity. This has two clear consequences: they are not able to reap the educational benefits of household electricity and do nothing to address the human health concerns associated with reliance on solid fuels for cooking. Several studies have found a correlation between home access to electricity and good educational attainment.

Furthermore, education can be negatively affected by the lack of electricity at home. Many medical surveys have found a clear correlation between household air pollution and respiratory illnesses in children. These respiratory infections are the major reason of school absence. For instance, in Uganda a third of absenteeism is due to them and typically last for a week or more.

2.3 Electricity and Agriculture Sector

Agriculture is a mainstay of economic growth in Nigeria and provides basic livelihoods for the people (food). But it still has some major development problems.

Remote areas are the best locations for agricultural activities. Farmers living there still complain about the lack of availability of electricity and water. The lack of these factors increases the labour intensity of the production and makes farmers work harder than it should be. Farming is about taking care of livestock and crops, and electricity is truly vital for that. In any farm, especially in poultry farming, it is important to have a good heating system to avoid deaths. It might be suggested to light some wood and other fuels and let them burn for hours, that's true, but what about the emission of soot, what about the production of greenhouse gases, what about the health of the farmers themselves? With reliable electricity, the heating problem can be solved efficiently by using heating bulbs. Water supply can also be improved by building electric pumps that can help irrigate fields and feed livestock. Energy poverty and the environment are primarily linked through land-use change. As mentioned earlier, traditional biomass is an important source of energy for the poorest, and its overuse leads to increased deforestation, desertification and land degradation. However, from a global perspective, forest loss reduces carbon dioxide absorption capacity and contributes to climate change.

2.3.1 Manufacturing Sector in Nigeria

Industrial expansion is the driving force behind economic growth in Nigeria. Still, in order to do so, the manufacturing sector demands energy, this is why it is closely related to the energy sector. Energy is an essential element to the manufacturing process. Poor energy supply presents negative outcomes for industrial productivity. Relatable facts show that the unreliability of power supply in Nigeria is a challenging factor that impedes growth. Many studies based on various time periods, factors, nations, and models highlight the significance of energy in the manufacturing process.

In 2004, (Beji & Belhadj) said that industrialization provides various long-term benefits for technology transfer, employment, economic diversification and welfare enhancement. Countries may achieve rapid economic growth and development through successful industrialization. This is due to the fact that industry is recognized for providing revenue, employment, and wealth (Abdu et Annam, 2018).

2.4 Causes of the Lack of Electricity in Nigeria

Electricity access is considered one of the major constraints of private sector development. In 2013, the government privatized the generation and distribution segments of the electricity supply chain. There are currently 6 generation companies (GENCO) with 23 grids connected generation plants spread across the country and 11 distribution companies serving different parts of the countries. However, the Transmission Company of Nigeria (TCN) is under the complete control of the federal government. There is still a big mismatch in the generation, transmission and distribution. While Nigeria currently has an overall generation capacity of 12,532 MW, only around 4,500 MW is generated on most days. That is due to several constraints including the lack of gas supply, the lack of infrastructural capability of TCN to evacuate all the available capacity and convey to DISCOs. There is a blame game going on, GENCOs fault the TCN for evacuating below what is generated and the TCN insisting they evacuate more if the DISCOs improve their networks and distribute more power to the consumers. Moreover, even if the GENCOs generate electricity at their full capacity, power will be stranded on transmission and not reach consumers due to the obsolete infrastructure of TCN. These infrastructures are mainly inefficient because we avoid complex systemic issues and opt for quick fixes. Countries around the world have addressed electricity challenges with decentralized systems by leveraging local energy sources and addressing energy deficits in individual

communities. Energy experts say that the transmission grid in its present form is fragile and obsolete critical infrastructure is too large to be managed as a single entity and there have been several recommendations that it should be decentralized, but the government is reluctant to decentralize the grid. According to many stakeholders, unbundling the TCN would attract private investment that could solve the problem of dilapidated infrastructure. Many others believe that the answer could lie the sun. Nigeria has great potential to develop solar energy due to its high amount of sunlight. Estimates by the world bank suggests that investing in solar power plants could increase the availability of electricity to almost 18 million people who currently have none. In the beginning, this may mean building tiny solar panels that can cover only minimal households needs like power charging phones, power television or run a fan and cooking too, then scale up for businesses by building small scale mini-grid systems. The federal government of Nigeria has spent over 2 billion Naira as subsidy or intervention in recent years but we have not really seen any improvement. Both the government and private sector do not settle their bills when due and this affects not only DISCOs but also GENCOs. According to several popular newspaper in Nigeria this is due to misappropriation of funds by ministries, departments, and agencies.

Chapter 3

LITERATURE REVIEW

Ogwumike et al. (2016) performed a headcount ratio and logistic regression to analyze the impact of determinant of energy poverty in Nigeria based on a multidimension energy poverty index that they build using Nigeria Living Standard Survey data set of 2004. Results showed that that energy poverty is general in the country and afflicts over 75% of the population.

Akinlo (2008) researched the period of 1980-2003 for 11 sub-Saharan countries by conducting autoregressive distributed lag model (ARDL) and a vector error correction model to examine the causal relationship between energy consumption and economic growth. He found that a causal relationship exists between energy consumption and economic growth. further, he also found that energy consumption has a positive significant impact on economic growth.

Akpan et al. (2012) ran VECM and Granger causality test to study the link between electricity consumption, carbon emission and economic growth in Nigeria following (1970-2019). Results revealed that economic growth is linked with an increase in CO₂ emissions in the long run, while an increase in electricity consumption augments CO₂ emissions. Furthermore, EKC did not hold and they suggested that CO₂ emissions reduction policies could be pursued without affecting economic growth in Nigeria.

Chindo (2015) studied for the time period of 1974-2010 the relationship between energy consumption, carbon emission and GDP to assess energy poverty in Nigeria. He used an ARDL model and found that Energy use, CO₂ emissions, and GDP have a long-term link. CO₂ emissions have been demonstrated to have a considerable beneficial impact on GDP in both the long and short run, implying that increasing CO₂ emissions aids GDP growth. However, energy use has a major negative influence on GDP in the short run.

Oluwole et al. (2013) did blood sample preparation, pulmonary function test, and indoor air sampling for 59 households in three rural Nigerians communities and their findings demonstrated that household air pollution (HAP) from biomass fuel is linked to pulmonary dysfunction, decreased antioxidant defenses, and airway inflammation. Oyekale (2008) undertook a demographic health survey (DHS) for 34070 respondents in Nigeria, its goal was to assess the access of households to electricity and modern cooking facilities in rural and urban areas. he found that the usage of electricity and contemporary cooking energy sources increased significantly among urban inhabitants and educated household heads, but fell among northern Nigerians.

Oseni (2012) collected data on electricity production and distribution for Nigeria to investigate ways to improve energy access and electricity consumption of households. He found that despite the country's abundant energy resources, access to modern forms of energy is extremely limited. Many Nigerian families (about 40%) do not have reliable electricity and rely heavily on traditional energy sources like firewood, kerosene. So far, he suggested that renewable energy can be an alternative.

Buba et al. (2017) used 2013 demographic health survey dataset for Nigeria to examined the socio-economic factors that affect households 'living choices toward energy consumption. Evidence from the study showed that demographic characteristics, economic status, and public awareness are strong determinants of households' energy choices. in other terms real income, education level and whether they live in rural or urban areas.

Mobolaji et al. (2020) developed a Multidimensional energy poverty index (MEPI) and used Tobit regression model to estimate energy poverty in Nigeria. Findings revealed that MEPI was 0.38, indicating that the majority of households are energy poor, and that energy poverty is more prevalent in rural areas than in urban areas. A favourable link exists between literacy and availability to clean energy sources, according to regression results.

Jack et al. (2018) examined energy poverty in Nigeria and the issues it causes to the environment. He found out deforestation, biodiversity loss, and climate change consequences are all exacerbated by widespread energy poverty and fuelwood dependence in the country, putting the country's environmental sustainability at risk.

Nwozor (2019) evaluated the capacity utilization of refineries and electricity production/consumption in Nigeria to assess the link between energy poverty and environment sustainability. Results showed that Nigeria's forest is being degraded as a result of energy poverty; not only are trees being cut down for use as fuel wood and other purposes, forest products are being lost. All of this has significant consequences for the environment, economic activity, and individuals, including health issues caused by inefficient solid fuel burning.

Shui et al. (2004) used ADF, PP, Johansen cointegration and ECM for the time of 1971-2002 to examine the causal relation between electricity consumption and RGDP in China. Results showed that RGDP and electricity consumption are cointegrated. Also, there is Granger causality running from electricity consumption to RGDP unidirectionally.

Soytas et al. (2007) ran unit root test, cointegration test and ECM for the time period of 1968-2002 to examine the link between electricity consumption and MVA using labor, fixed investment in Turkey. It came out that the three vectors labor, fixed investment, manufacturing sector value added and power consumption were linked so cointegrated. The vector error correction (VEC) findings point to a one-way causal relationship between power consumption and manufacturing sector value added. In other term a high electricity consumption conducts to the growth of MVA.

Jessel et al (2019) undertook a literature review of 406 articles and developed a heuristic model to study the effect of energy poverty on people's health and climate change. The model showed that energy insecurity and insufficient household energy have detrimental impacts on people's health whether directly through illnesses or indirectly through food insecurity. Bukari et al. (2021) ran a heteroscedastic double-hurdle model using Ghana Living Standard Survey (GLSS) from 2016-2017 to evaluate the impact of energy poverty on household health expenditure. Their findings showed that household health costs rise as a result of energy poverty. As a suggestion, they proposed that health insurance and remittances can greatly lessen the detrimental impact of energy poverty on household health expenses.

Lean et al. (2010) researched the period of 1975-2010 for Bangladesh by conducting an ARDL model to evaluate the relationship between electricity consumption and CO₂ emissions. Results showed that electricity usage rises as industrial technologies and activity improve. Furthermore, there is a one-way relationship between electricity usage and CO₂ emissions. However, in Nigeria, even though the growth of industrial activities requires more electricity, CO₂ emissions with reliable and affordable electricity will be lesser than without electricity.

Oum (2019) used Lao economic consumption survey dataset (LECS) for 2008-2009 and 2013-2014 to assess energy poverty and its implication in peoples 'lives (education, health, and well-being). He used Probit and the ordinary least square models and found that energy poverty has a negative impact on schooling and health. A household is also considered poor if it is not connected to the power grid or if its energy use exceeds 10% of total income or expenditure.

Gonzales (2015) researched for the period of 1970-2010 for sub-Saharan Africa. He studied the relationship between HDI, life expectancy, GDP, electricity consumption and more to give an overview of energy poverty in Nigeria. As a result, he found that energy access is really low in sub-Saharan Africa, and that has detrimental effects on health, economic growth and the environment.

Rajabrata et al. (2021) took 50 developing countries for the period of 1990-2017 and built an energy development index (EDI) to examine the effects of energy poverty on health and education. He used panel fixed model and endogenous threshold regression model and found that in the health sector, poverty and income level have a strong threshold effect; however, it has not been the same conclusion for education sector.

Intriguing discovery, considering that the literature tends to regard the health and education sectors from the same angle of reflexion.

Sovacool et al (2014) did a statistical survey in some developing countries linking school enrolment, electricity consumption, access to electricity and household income. Their report showed that the lack of electricity delays the progress in the education sector and also prevent households to undertake basic domestic activities like lighting, cooking, studying for students. As a result, school drops increase on years bases.

Table 3.1: Literature Review in Chronological Order

Authors	Period	Country	Variables	Methodology	Findings
Shiu et al. (2004)	1971 2002	China	Electricity consumption GDP	ADF and PP Johansen cointegration ECM	results indicate that real GDP and electricity consumption for China are cointegrated and there is unidirectional Granger causality running from electricity consumption to real GDP.
Soytas & Sari (2007)	1968 2002	Turkey	Electricity consumption MVA Total employment Total fixed investment	Unit root test Cointegration test ECM	Found that labor, fixed investment, electricity consumption, and value added are related via three cointegrating vectors. The VEC results indicate unidirectional causality running from electricity consumption to value added
Akinlo (2008)	1980 2003	Cameroon, Congo, Gold Coast, Ghana, Gambia, Kenya, Senegal, Sudan, Nigeria, Togo, Zimbabwe,	Energy consumption GDP Consumer price index Government expenditure	ARDL model, the VECM Granger	There is a causal relationship between energy consumption and economic growth, although it was not similar path for all the countries examined.
Oyekale (2008)	2008	Nigeria	Demographic health survey (DHS) 34070 respondents	SUBP regression, descriptive statistics	The results of the SUBP regression show that access to electricity and modern cooking energy sources significantly increased ($p < 0.01$) among urban dwellers, educated household heads but declined with resident in northern Nigeria.
Lean & Smyth (2010)	1975 2010	Bangladesh	Electricity consumption, Co2 emissions	ARDL	Improvement in industrial technology and activity increases electricity consumption. And there is a unidirectional link between electricity consumption and co2 emission.

Akpan & Akpan, (2012)	1970-2019	Nigeria	Carbon emission, Index of electricity consumption, RGDP	VECM Granger causality No EKC was obtained	findings show that in the long run, economic growth is associated with increase carbon emissions, while an increase in electricity consumption leads to an increase in carbon emissions. Granger causality results confirm a unidirectional causality running from economic growth to carbon emissions, indicating that carbon emissions reduction policies could be pursued without reducing economic growth in Nigeria
Oseni (2012)		Nigeria	Electricity production, Electricity distribution, etc...	Collection of data and analytic interpretation	It was found that the access to modern form of energy in the country is very low despite the country's abundant energy endowment. Greater proportions (over 40%) of Nigerian households do not have access to electricity and still depend largely on traditional forms of energy (e.g., firewood, kerosene, etc.)
Oluwole et al. (2013)	2013	Nigeria	Blood sample preparation, pulmonary function test, indoor air sampling during cooking	Fifty-nine mother child pairs from 59 households that used firewood exclusively for cooking in three rural communities.	Exposure to HAP from biomass fuel is associated with pulmonary dysfunction, reduced antioxidant defense and inflammation of the airways. Further studies are needed to better define causal relationships and the mechanisms involved.
Sovacool et al. (2014)		Developing countries	School enrolment, Electricity consumption, access to electricity, household income,	Statistical Survey	the report shows that primary and secondary schools can provide students with the light, heat, comfort, and modern tools of teaching they deserve if planners, investors, and policymakers make a determined, coordinated effort at promoting electricity for education.
Chindo et al. (2015)	1974-2010	Nigeria	Carbon emission Energy consumption GDP	ARDL	results revealed that there is a long run relationship energy consumption, CO ₂ emissions and GDP. Both in the long run and short run, CO ₂ emissions has

					been found to have a significant positive impact on GDP. On the other hand, energy consumption shows significant negative impact on GDP in the short run.
González (2015)	1970-2010	Sub Saharan Africa	HDI, Life expectancy, GDP, Electricity consumption, Energy consumption, passengers per car, CO ₂ emission	Graphical analysis	Energy access is really low in sub-Saharan Africa, and that has detrimental effects on health, economic growth and the environment.
Ogwumike et al. (2016)	2004	Nigeria	household size; educational level, gender and age of household head; general poverty; region of residence; proportion of working members in the household	The headcount ratio and the logistic regression technique	The estimates show that energy poverty is pervasive in the country; it afflicts over 75 per cent of the population
Buba et al. (2017)	2013	Nigeria	2013 demographic health survey dataset	In this study they empirically examined socio-economic factors that influence households' likelihood of energy consumption in Nigeria.	Evidence from the study revealed that demographic characteristics, economic status, public awareness and social variables are strong determinants of households' energy choice in the country and conformed to the propositions of "Energy Ladder Hypothesis"

Jack et al. (2018)			Nigeria		Assessing household electricity access, Household dependency on firewood	pervasive energy poverty and fuelwood dependence in the country precipitates deforestation, biodiversity loss, and climate change impacts thereby undermining environmental sustainability in the country.
Nwozor et al. (2019)	2012	2017	Nigeria		Evaluating Capacity utilization of refineries and electricity production,	Energy poverty has a degrading impact on Nigeria's forest not only are trees lost through logging for use as fuel wood as well as for other purposes but also non timber forest products.
Oum (2019)	2008/2009 2012/2013		Lao People's democratic Republic	Lao economic consumption survey (LECS) data Electricity access Clean cooking access Household income and more.	Probit model OLS	This paper finds that energy poverty negatively impacts households' average school years and health status. Also, a household is qualified as poor if it is not connected to an electricity grid or its consumption on energy exceeds 10% of total income or expenditure.
Jessel et al. (2019)	1990	2019	world		Heuristic model and literature review of 406 articles and papers.	Energy insecurity and the inadequate household's energy have detrimental on children and adults' health directly (through illnesses) and indirectly (through food insecurity).
Mobolaji et al. (2020)			Nigeria	MEPI, Age of household heads, Gender, Household size, Household income, Credit access,	Multidimensional energy poverty index MEPI and Tobit regression model	Results show that national average MEPI was 0.38; suggesting that the majority of households are energy poor and energy poverty was found to be greater in rural area than urban. Regression result shows a positive correlation between literacy level and access to clean energy sources.

Bukari et al. (2021)	2016 2017	Ghana	Ghana Living Standard Survey (GLSS) household demographics, health, income, education	Heteroscedastic double hurdle model	energy poverty increases household health expenditures. Our results also suggest that the negative effect of energy poverty on household health expenditures is significantly reduced through health insurance and remittances.
Rajabrata et al. (2021)	1990 2017	50 developing countries	EDI, and more	panel fixed effect model, endogenous threshold regression model	Results show that poverty and income levels have a significant threshold effect in the health sector; however, a similar effect is absent in the education sector.

Chapter 4

METHODOLOGY AND DATA

4.1 Introduction

This chapter covers the analytical methods and data used to illustrate how the lack of reliable electricity impedes the sectors of wealth creation in Nigeria. In this study we use time series econometrics. We collected data from the Nigerian Bureau of statistics, the Human Development data center, and World Bank for the period 1990-2020. The dependent variable is electricity consumption and the independent variables are access to electricity (urban and rural), access to clean cooking, HDI, manufacturing sector value added and school enrolment.

4.2 Explanation of the Variables

Electricity consumption: Refers to the amount of electrical energy utilized or consumed by individuals over a given time period. Nigeria's average per capita power usage is approximately 150 kWh, making it one of the lowest in the world. Grid-connected clients saw an average of 28 outages per day in 2011, according to estimates.

Access to electricity: According to the World Bank, 55.4 percent of Nigerians had access to electricity in 2020, which ranked Nigeria 171 out of 190 nations in terms of access to power. Access to electricity is viewed as one of the key impediments for the private sector. It has now reached 83.9 percent in urban regions, while it is still 25.54 percent in rural areas.

Access to clean cooking technologies: Refers to the percentage of the population who cooks primarily with clean cooking fuels and technology (World Bank). In Nigeria, access to clean cooking is extremely limited, with only 15% having access in 2020. According to Dr. Goddy Jedy Agba, Minister of State for Power, over 175 million Nigerians still lack access to clean, dependable, and inexpensive cooking energy.

Manufacturing sector value added: The total estimated net output of all resident manufacturing activity units obtains by adding outputs then subtracting consumption is known as (MVA). According to the World Bank, Nigeria's manufacturing value added was 12.67 percent in 2020.

School enrolment: It represents the average of males and females in secondary education that are registered to a school program and regularly attend classes. According to the world Bank and UNESCO, (2017). The percentage of children attending secondary schools in less than 50 percent.

HDI: according to Wealth Human Organization, is a combination of three fundamental items for a country to measure its level of attainment. The three composites are health, knowledge and standard of living.

4.3 Model Specification

In this model, electricity consumption is the dependent variable while access to electricity, access to cooking, manufacturing sector value added, school enrolment, HDI are independent variables.

$$EC=f(AE, AC, MVA, SE, HDI)$$

(EC) Electricity consumption, (dependent variable)

(AE) Access to electricity

- Urban areas
- Rural areas

(GDP) - Gross domestic product

(AC) - Access to cooking

(MVA) - Manufacturing value added

(SE) - School enrolment

(HDI) - Human development index

u – error term.

In econometric form the model is given as

$$EC = \beta_0 + \beta_1 AEU + \beta_2 AER + \beta_3 AC + \beta_4 MVA + \beta_5 SE + \beta_6 HDI + u$$

Where,

β_0 = Intercept

β_1 - β_6 = slope parameters

4.4 Unit Root Test

Having trending or nonstationary with time series data is often common. Therefore, before performing any analysis with time series, stationarity analysis must be conducted.

Stationarity refers to the case where the moments (like mean, variance, autocorrelation) of the process do not change with time. In other words, properties of the series are not depending on the time. If time series is nonstationary then most likely, the limiting distributions of the test statistics (like t, F or Chi-square statistics) could not be used. In general stationarity tests are referred to as ‘unit root’ tests and mostly they are used synonymously.

In unit root tests, the null hypothesis states that series have a unit root whereas, the alternative hypothesis is that the series is stationary. There are several unit roots tests. Among them, Augmented Dickey-Fuller and Phillips-Perron tests are the mostly used ones. Here also in this thesis these two tests are used.

The Dickey-Fuller (DF) test:

Dickey and Fuller created Dickey-Fuller in 1979. The null hypothesis is that the data series test is nonstationary, that it has a unit root. The contrary hypothesis is that series is stationary.

Augmented Dickey-Fuller (ADF) test:

Dickey- Fuller tests assumes that error terms are not serially correlated. However, with higher order autoregressive equations, serial correlation might be a challenge. To overcome the challenges of serial correlation among the error terms, lag differences are empirically calculated. The Augmented Dickey-Fuller approach has the benefit of allowing for autoregressive process of higher order. A more powerful parametric test is the *Augmented Dickey-Fuller* test.

Phillips-Perron (PP) Test:

The Philip-Perron test (abbreviated as PP) is a unit root test for determining stationarity, Philip (1987) and Perron (1988). It can be used alternatively or instead of Dickey-Fuller test. It usually fixes t-test statistic by adopting nonparametric methods to take care of serial correlation in error term without adding lagged difference terms. The null hypothesis is that there is a unit root (nonstationary), whereas the alternative hypothesis is that there is no unit root (stationary). If H_0 cannot be rejected at the levels,

the first difference should be chosen to make the series stationary. The series is considered to be stationary if H_0 is accepted (Maddala, 1998).

When ADF test and PP tests are compared we see that,

- a) Results are not significantly different
- b) PP has a benefit of no need to specify the number of lags
- c) Davidson and Mackinnon show in 2004 that ADF performs better than PP in finite samples.

4.5 Autoregressive Distributed Lag Model (ARDL) Bounds Testing

After testing for unit root of the series, cointegration tests are done. ARDL is a powerful approach for predicting a link between economic time series, or look for evidence of cointegration. Bounds test, which is an extension of ARDL modeling, employs F and t-statistics to prove the existence of long run relationship. In a univariate equilibrium correction system, it is necessary to determine the importance of the lagged values of the variables. So, we also use the Lag selection method and bounds test have find evidence of short and long-term relationships between the variables. It examines the likelihood of the variables moving together over time. The hypothesis of cointegration is rejected if the value of F-statistic is higher than the lower and higher limits respectively $I(0)$ and $I(1)$.

4.6 Error Correction Model (ECM)

When long run relationship is found to exist and the long run model is estimated, then the Error Correction Model (ECM) is estimated. ECM is a method for calculating the influence of a time series on another over the short and long term. It is important to know that an error correction alludes to the possibility that a mistake, or even a break from a long-run equilibrium, will alter the prior period's short-run dynamics. As a

consequence, ECM can predict how long it will take for a dependent variable to return to equilibrium after another variable have changed.

Chapter 5

EMPIRICAL RESULTS

5.1 Introduction

As referred in the methodology section, test results will be presented and interpreted in this chapter. Everything begins with unit root test to see if there is unit root in the series. OLS estimation method assumes there is stationarity at level, but if there is no stationarity series are then differenced. Otherwise differs, OLS is not the right choice for the estimation.

ADF and PP tests are conducted as follow to test for unit root. Results are given down below

Table 4.1: ADF Test

UNIT ROOT TEST RESULTS TABLE (ADF)								
	At Level							
		EC	AC	AER	AEU	HDI	MVA	SE
With Constant	t-Statistic	-1.105	-3.7719	-2.5375	-6.1093	-3.7228	-4.8055	-0.8398
	Prob.	0.7006	0.0082	0.1174	0	0.0088	0.0009	0.793
		n0	***	n0	***	***	***	n0
With Constant & Trend	t-Statistic	-2.2195	-6.1036	-6.3932	-5.8401	-3.846	0.0573	-2.2076
	Prob.	0.4624	0.0001	0.0001	0.0003	0.0277	0.9952	0.4686
		n0	***	***	***	**	n0	n0
Without Constant & Trend	t-Statistic	0.6059	1.632	0.7989	0.2392	1.9242	-0.698	0.8794
	Prob.	0.8417	0.9714	0.8797	0.7474	0.9848	0.4054	0.8938
		n0	n0	n0	n0	n0	n0	n0
	At First Difference							

		d(EC)	d(AC)	d(AER)	d(AEU)	d(HDI)	d(MVA)	d(SE)
With Constant	t-Statistic	-6.2949	-5.0664	-11.4524	-6.6651	-4.1675	-2.2848	-6.3283
	<i>Prob.</i>	0	0.0004	0	0	0.003	0.1835	0
		***	***	***	***	***	n0	***
With Constant & Trend	t-Statistic	-6.1791	-4.7314	-4.9705	-6.6893	-4.7733	-1.9561	-6.2096
	<i>Prob.</i>	0.0001	0.0046	0.0025	0.0001	0.0034	0.598	0.0001
		***	***	***	***	***	n0	***
Without Constant & Trend	t-Statistic	-6.2096	-4.4889	-11.2102	-6.8525	-3.6401	-2.3678	-6.0931
	<i>Prob.</i>	0	0.0001	0	0	0.0007	0.0198	0
		***	***	***	***	***	**	***

Table 4.2: PP Test

UNIT ROOT TEST RESULTS TABLE (PP)								
	At Level							
		EC	AC	AER	AEU	HDI	MVA	SE
With Constant	t-Statistic	-1.0434	12.1199	-3.765	-9.4669	-4.3549	-1.2192	-0.8398
	<i>Prob.</i>	0.7244	1	0.0079	0	0.0018	0.6528	0.793
		n0	n0	***	***	***	n0	n0
With Constant & Trend	t-Statistic	-2.207	6.8829	-6.3707	-9.7455	-9.8944	-0.313	-2.314
	<i>Prob.</i>	0.4689	1	0.0001	0	0	0.9864	0.4142
		n0	n0	***	***	***	n0	n0
Without Constant & Trend	t-Statistic	0.7905	13.2267	0.645	-0.2701	1.6819	-1.0245	0.8794
	<i>Prob.</i>	0.8784	1	0.8501	0.5803	0.9747	0.268	0.8938
		n0	n0	n0	n0	n0	n0	n0
	At First Difference							
		d(EC)	d(AC)	d(AER)	d(AEU)	d(HDI)	d(MVA)	d(SE)
With Constant	t-Statistic	-6.3029	1.2627	-16.2303	-18.791	-4.1166	-4.633	-6.3283
	<i>Prob.</i>	0	0.9978	0	0.0001	0.0034	0.0009	0
		***	n0	***	***	***	***	***
With Constant & Trend	t-Statistic	-6.1862	-0.7528	-32.6581	-22.5385	-4.7625	-5.1146	-6.2096
	<i>Prob.</i>	0.0001	0.9588	0	0	0.0035	0.0015	0.0001
		***	n0	***	***	***	***	***
Without Constant & Trend	t-Statistic	-6.2178	2.2377	-12.3914	-19.0507	-3.5732	-4.5639	-6.0476

	<i>Prob.</i>	0	0.9923	0	0	0.0009	0	0
		***	n0	***	***	***	***	***

Table 4.1 illustrates the unit test for ADF results. The results reveal that at level electricity consumption and school enrolment are nonstationary in every case of the model. Access to cooking, AEU and HDI are significant then stationary with constant and with constant and trend while AER and MVA are just significant (with constant and trend) and with constant respectively so, stationary too. There is no stationarity without constant and trend. At first difference, they are all integrated of order I (1) without constant and trend thus significant except for MVA which is not integrated and insignificant with constant and (with constant and trend).

Table 4.2 illustrates the unit test for PP results for the series. The results reveal that they are all not integrated at level without constant and trend except for AC, AER, and AEU that are stationary with constant as well as with constant and trend. They are significant at 1% too so, the null hypothesis is rejected. At first difference, they are all integrated of order I (1), stationary and significant at 1% while AC is not integrated, non-stationary and insignificant.

Lag Selection:

Table 4.3: Lag Length Criteria

VAR Lag Order Selection Criteria Endogenous variables: EC AC AER AEU HDI MVA SE						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-361.147	NA	1644.531	27.27011	27.60607	27.37001
1	-164.783	276.3633	0.033959	16.35431	19.04197*	17.15349
2	-88.8215	67.52145*	0.010928*	14.35715*	19.39652	15.85562*

The result revealed that optimal lag 2 is the best to choose, SC is astatic at lag 1. Therefore, for the model EC, AC, AER, AEU, HDI, MVA, and SE, Lag 2 will be used to run the analysis as indicated by the majority of the criterion.

ARDL Model:

Table 4.4 ARDL Model

Dependent Variable: EC Selected Model: ARDL (1, 2, 0, 0, 2, 0, 2) Dynamic regressors 2 lags, automatic: AC AER AEU HDI MVA SE				
Variable	Coefficient	Std. Error	t Statistic	Prob.
EC (1)	0.0456	0.183411	0.24863	0.8075
AC	130.262	45.80621	2.84376	0.0138
AC (1)	216.3353	73.19108	2.95576	0.0111
AC (2)	64.4206	35.28096	1.82593	0.0909
AER	1.35234	0.619051	2.18453	0.0478
AEU	5.218711	1.493905	3.493336	0.004
HDI	631.169	192.722	3.27502	0.006
HDI (1)	386.5356	130.6431	2.958713	0.0111
HDI (2)	181.71	78.66277	2.30999	0.0379
MVA	2.6168	1.006067	2.60102	0.022
SE	2.030138	0.775098	2.6192	0.0212
SE (1)	1.23535	0.88792	1.39129	0.1875
SE (2)	4.052582	1.287098	3.14862	0.0077
C	229.466	134.6448	1.70424	0.1121
R squared	0.965026	Mean dependent var	116.6514	
Adjusted R squared	0.930052	S.D. dependent var	29.13248	

S.E. of regression	7.704871	Akaike info criterion	7.227732	
Sum squared resid	771.7455	Schwarz criterion	7.899648	
Log likelihood	-83.5744	Hannan-Quinn criter.	7.427528	
F-statistic	27.59263	Durbin-Watson stat	1.973641	
Prob(F-statistic)	0			

After ARDL Model is estimated, the following tests are undertaken in order to verify whether the estimated model has any specification and stability problems regarding the error term. These are namely, autocorrelation test, heteroskedasticity test, normality test and stability test.

Serial correlation Test:

To test serial correlation Breusch-Godfrey Serial Correlation LM Test is used.

Table 4.5: Serial correlation LM Test

Breusch-Godfrey Serial Correlation LM Test: Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.687734	Prob. F (2,20)	0.5142
Obs*R-squared	1.86609	Prob. Chi-Square (2)	0.3934

The null hypothesis is that there is no serial correlation. Test results give the probability value of F-statistic as 0.5142, greater than 5%, and thus the null hypothesis cannot be rejected. So, no autocorrelation.

Heteroskedasticity Test:

Table 4.6: Heteroskedasticity test: Breusch Pagan Godfrey

Heteroskedasticity Test: Breusch Pagan Godfrey Null hypothesis: Homoskedasticity			
F statistic	1.022753	Prob. F (13,13)	0.4841
Obs*R squared	13.65185	Prob. Chi Square (13)	0.3988
Scaled explained SS	2.223878	Prob. Chi Square (13)	0.9996

The test results of Breusch Pagan Godfrey test revealed that the probability of F test is higher than 5%. Meaning the model is free from heteroskedasticity. So, the error terms are homoscedasticity distributed

Normality Test:

Jarque Bera test is conducted to check whether the error terms are normally distributed and results are given in the following table

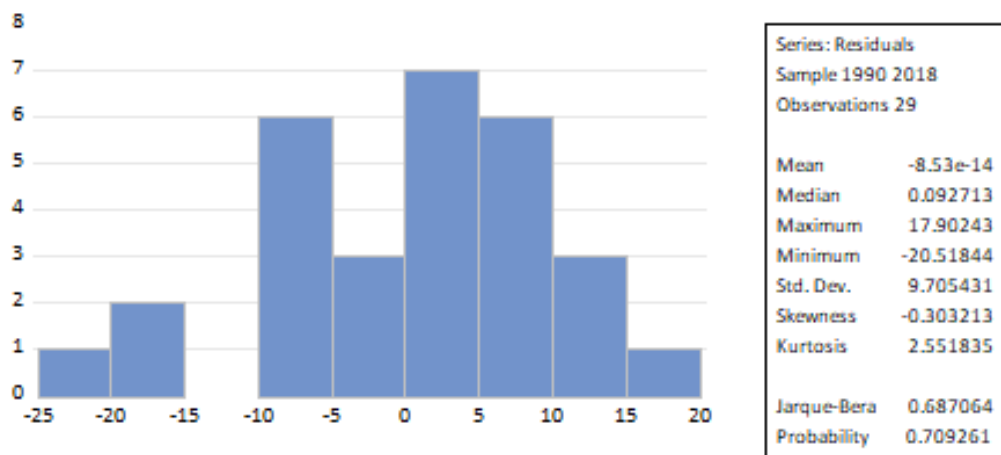


Figure 4.1: Histogram Normality Test

The result revealed that the probability of statistic is 0.7092 and Jarque Bera is 0.6870 which is higher than 5%. Thus, residuals are normally distributed.

Ramsey RESET Test for testing specification of the model to make sure that the estimated model is in the right form, Ramsey RESET test is done.

Table 4.7: Ramsey RESET Test

Ramsey RESET Test Equation: UNTITLED Omitted Variables: Squares of fitted values Specification: EC EC(-1) AEU AER AC AC(-1) AC(-2) HDI HDI(-1) HDI(-2) MVA SE SE(-1) SE(-2) C			
	Value	df	Probability
t-statistic	1.079811	12	0.3015
F-statistic	1.165992	(1, 12)	0.3015
Likelihood ratio	2.503723	1	0.1136
F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	68.34647	1	68.34647
Restricted SSR	771.7455	13	59.36504
Unrestricted SSR	703.3991	12	58.61659
LR test summary:			
	Value		
Restricted LogL	-83.5744		
Unrestricted LogL	-82.3225		

Results show that the probability of F-statistic is 0.3015 so greater than 0.05.

Therefore, according to the test results, there is no specification error in the model.

Stability Diagnostic Test:

CUSUM test is conducted to check the stability of the estimated parameters.

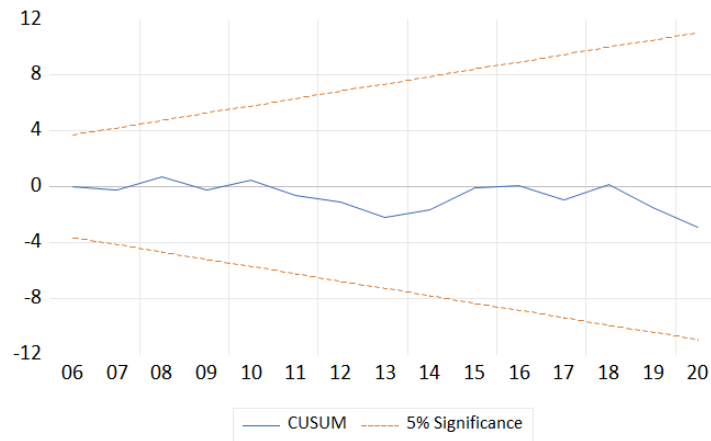


Figure 4.2: CUSUM Test

In the diagram above, we can see that the stability of model is respected. The 5% level of significance is represented by the red lines while the blue line represents the CUSUM. Since the blue line is in between the red lines, we conclude that estimated parameters are stable.

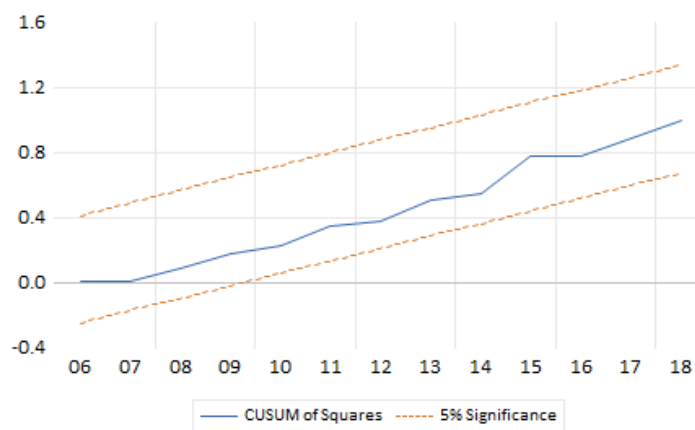


Figure 4.3: CUSUM of squares Test

The CUSUM Square graph also shows that parameters are stable.

Long-Run Form and Bounds Test:

After the specification and stability tests for the estimated ARDL model are done, next step is the estimation of the long run relationship and cointegration between variables.

Bounds Test:

Table 4.8: Bounds test

F-Bounds Test Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I (0)	I (1)
F-statistic	6.300734	10%	2.12	3.23
k	6	5%	2.45	3.61
		2.50%	2.75	3.99
		1%	3.15	4.43
Actual Sample Size	27		Finite Sample: n=35	
		10%	2.387	3.671
		5%	2.864	4.324
		1%	4.016	5.797
			Finite Sample: n=30	
		10%	2.457	3.797
		5%	2.97	4.499
		1%	4.27	6.211
t-Bounds Test Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif.	I (0)	I (1)
t-statistic	-5.70085	10%	-2.57	-4.04
		5%	-2.86	-4.38
		2.50%	-3.13	-4.66
		1%	-3.43	-4.99

The F-statistic is 6.300 and at 5% the lower bound is 2.97 with the upper bound 4.499. The null hypothesis cannot be rejected if the F- statistic value is below the upper I (1) and lower I (0) boundaries, and there is no co-integration. It is inconclusive if it is between the lower bound I (0) and the higher bound I (1). There is co-integration if the F- statistic is greater than the upper bound I (1) and lower bound I (0). As a result, the null hypothesis is rejected. So, based on our findings, we have co-integration and can reject the null hypothesis because the F-statistic is bigger than I (0) and I (1). Furthermore, the T-Statistic result for the bounds test is bigger than I (0) and I (1), indicating that the variables have a long-term relationship.

Therefore, when EC is the dependent variable there is cointegration between AC, AER, AEU, HDI, MVA and SE.

Long Run Estimation:

Table 4.9: Long Run Relationship

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-229.466	134.6448	-1.70424	0.1121
EC(-1)*	-1.0456	0.183411	-5.70085	0.0001
AC(-1)	21.65286	10.86913	1.992143	0.0678
AER**	-1.35234	0.619051	-2.18453	0.0478
AEU**	5.218711	1.493905	3.493336	0.004
HDI(-1)	-426.343	125.9995	-3.38369	0.0049
MVA**	-2.6168	1.006067	-2.60102	0.022
SE(-1)	4.847366	1.127986	4.297363	0.0009
D(AC)	-130.262	45.80621	-2.84376	0.0138
D(AC(-1))	64.42064	35.28096	1.825932	0.0909

D(HDI)	-631.169	192.722	-3.27502	0.006
D(HDI(-1))	181.7098	78.66277	2.309985	0.0379
D(SE)	2.030138	0.775098	2.6192	0.0212
D(SE(-1))	-4.05258	1.287098	-3.14862	0.0077
Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
AC	20.70853	10.32388	2.005886	0.0661
AER	-1.29336	0.612794	-2.11059	0.0547
AEU	4.99111	1.322991	3.772596	0.0023
HDI	-407.749	103.0663	-3.95618	0.0016
MVA	-2.50267	0.975535	-2.56544	0.0235
SE	4.63596	0.81024	5.72171	0.0001
EC = EC - (20.7085*AC -1.2934*AER + 4.9911*AEU -407.7490*HDI -2.5027*MVA +4.6360*SE)				

The result revealed that access to clean cooking technologies (AC), access to electricity in urban areas (AEU) and school enrolment (SE) are all positively related to electricity consumption and are significant. Human development index (HDI), electricity access in rural areas (AER) and Manufacturing sector value added (MVA) have an inverse relationship with electricity consumption. Electricity access is low in rural areas and that severely affects the overall access to electricity in Nigeria. The majority of the people live in rural communities and the cost of grid extension is exorbitant therefore some studies suggest that photovoltaic panels are the best cost-effective option for rural communities. That means whenever (AER) performs, it is not a direct consequence of the electric grid improvement since the population is using other ways to run activities. HDI reflects the level of social and economic development in a country and Nigeria is amongst the country with the lowest HDI index. Living standard, healthcare, GDP are components of HDI. Electricity should be included in

the creation of fundamental public services to provide access to electricity for low-income inhabitants to improve human development but is still not the case in Nigeria. The more people have access to electricity the better EC will be. In urban areas AEU is quite high and AC has been improving too, that shows a positive effect on EC. Moreover, SE has been shown to have a positive impact on EC, that is because it has been impressively growing too lately, illustrating that the more people are educated the higher their standard of living is. The manufacturing sector in Nigeria is menaced by inadequate power supply, malfunctional and old industrial installations and poor maintenance so many companies lean on signed contracts with foreign organs to provide them with industrial generators.

$$EC = EC - (20.7085*AC - 1.2934*AER + 4.9911*AEU - 407.7490*HDI - 2.5027*MVA + 4.6360*SE)$$

ARDL Error Correction Regression:

Finally, to see in what amount of time a deviation from the long run relationship in short run will be corrected and long run relationship will be reached again, the short run Error Correction Model is estimated. In the model error correction coefficient, $CointEq(-1)$, must be negative and significant.

Error Correction Model:

Table 4.10: Error Correction Model

ARDL Error Correction Regression Dependent Variable: D(EC) Selected Model: ARDL (1, 2, 0, 0, 2, 0, 2) Case 3: Unrestricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-229.466	28.99001	-7.91536	0

D(AC)	-130.262	22.97221	-5.67041	0.0001
D (AC(-1))	64.42064	20.12642	3.2008	0.007
D(HDI)	-631.169	96.39802	-6.54753	0
D(HDI(-1))	181.7098	61.39406	2.95973	0.0111
D(SE)	2.030138	0.501811	4.045625	0.0014
D(SE(-1))	-4.05258	0.73277	-5.5305	0.0001
CointEq(-1)*	-1.0456	0.130232	-8.02878	0
R-squared	0.783734	Mean dependent var		2.17325
Adjusted R-squared	0.704057	S.D. dependent var		11.71538
S.E. of regression	6.37324	Akaike info criterion		6.783288
Sum squared resid	771.7455	Schwarz criterion		7.167239
Log likelihood	-83.5744	Hannan-Quinn criter.		6.897457
F-statistic	9.83641	Durbin-Watson stat		1.973641
Prob(F-statistic)	0.000036			
F-Bounds Test				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.300734	10%	2.12	3.23
k	6	5%	2.45	3.61
		2.50%	2.75	3.99
		1%	3.15	4.43
t-Bounds Test				
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-8.02878	10%	-2.57	-4.04
		5%	-2.86	-4.38
		2.50%	-3.13	-4.66
		1%	-3.43	-4.99

Results show that CointEq(-1), is indeed negative -1.0456 and significant. The term is expected to be between 0 and -1 in general however here the number is slightly greater than 1 in absolute value. The correction of the previous year's error will be done in the subsequent years at a speed of adjustment of 104%. If all diagnostics specification and stability test are significant, then this would indicate that the system is convergent with an oscillatory adjustment process. As given above all the specification and stability test are significant. Also, the bounds test for the t-test is also found to be significant. In conclusion, the error correction term is statistically significant. For a correction term greater than 1 in absolute value, it can be said that speed of adjustment will fluctuate

forward and then finally settle at the equilibrium. So overall, we conclude that there is long run cointegration relationship between the variables.

Chapter 6

CONCLUSION AND RECOMMENDATION

6.1 Discussion of Findings

This research had for objective to assess the impact of some energy poverty measurements such as clean cooking access, electricity access, human development index, manufacturing sector value added and school enrolment on electricity consumption in Nigeria. Time series data for the period (1990-2020) was analyzed using Autoregressive Distributed Lag (ARDL) estimation method.

Energy poverty is thoroughly ingrained in Nigeria and the study shows that the lack of electricity has detrimental impacts on Nigeria's state of electrification (in rural and urban households), education, the environment and the manufacturing sector. Talking about the damaging impact of energy scarcity on households, we have seen that the most used cooking fuel in Nigeria was biomass necessarily because of its affordability, people income, and the fact that most of the population is located in rural areas. Cooking with biomass is associated with environmental issues such as deforestation, households air pollution and climate change. Emissions coming from burning biomass and firewood is mostly made of black carbon which has been shown to have a harming impact on people's health causing respiratory diseases that sometimes lead lung cancer. Climate change is a big deal for Nigeria and if not address properly situation like low crop yields, food shortages, public health crisis and more will still perpetuate. However, cooking with gas or electricity is pleasant to health and the environment

unfortunately, both remain a luxury for most of the Nigerian population due to their price and reliability respectively. Electricity consumption has been a determinant factor for the education sector in Nigeria through ITC availability, lighting and staff retention. As WHO has well-said the higher electricity consumption is, the better outcome we can expect from schooling performances. Nevertheless, the fact that a considerable parcel of the Nigerian population is still illiterate and schools not electrified tells a lot about the state of electrification of Nigeria. Electricity is unreliable and not at scale, leading to unceasing outages, drops out, teachers become reluctant to the idea of working in some areas etc. noted that the affordability of electricity is prevalently linked to rural areas where people have low income.

Energy poverty is directly linked to electricity consumption and the nature of that relationship is unidirectional as both items are responsive of each other performance in the society. Moreover, Electricity consumption has demonstrated some slight progress in Nigeria lately but still faces some obstacles that have massive repercussion and delay its full expansion. These obstacles are clearly stated as the growing but still low access to clean cooking technologies, electricity and school enrolment rate. However, it is important to note that the manufacturing sector in Nigeria cannot perform well without adequate power supply but yet both variants have an inverse relationship because many factories rely on foreign capital inputs to achieve high scale production. Reasons behind this choice is the high electricity price fixed by the TCN and yet outages and low power distribution still prevail. The electric grid in Nigeria needs a complete re-structuration and a high-level maintenance to improve its capacity and permit everyone to access electricity at scale. Still the government is more preoccupied by funds misappropriation and corruption at the expense of the population

and this is why even the human development index of Nigeria increases, it will never be in accordance with the level electricity consumption in the country

6.2 Recommendations

Following the findings, we recommend as follow:

- The Nigerian Transmission Company can update and expand transformer capacity to do this. The distribution businesses have lately strengthened their network and are ready to meet customer demand. Load rejections may be reduced as a result of this.
- second, Nigerian legislators recently voted in favor of a constitutional amendment measure that would empower state governments to generate and transfer electricity on their own. Investors and enterprises would be able to join in the Nigerian energy market as a result of this. States or enterprises can also send surplus supply to the national grid. Excess electricity from microgrid initiatives might be sent to the national grid.
- Third, a modern smart grid would allow data to flow between power sellers and customers. System operators will be able to match electrical supply with demand, analyze consumer behavior, and plan grid growth as a result of this.
- Fourth, the fact that the access to clean cooking should be increased is a gender problem as well. Women are more prone than males to suffer considerably from the negative effects coming with the use of hazardous charcoal and solid biomass due to social-cultural norms that predominantly confine them to kitchen tasks, prevalently in Africa. Having a Focus on women-centered sustainable energy solutions may so both speed accessibility and save lives.

- Finally, the Nigerian government should accelerate efforts to decentralize the country's power grid. Mini-grids powered by (RE) sources such as solar photovoltaic and wind turbines might be used to achieve this.

Increased local electric power supply dependability, especially in rural and peri-urban areas, would be the result.

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