INFLUENCE OF ENERGY CONSUMPTION ON ECONOMIC GROWTH IN KENYA

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A THESIS SUBMITTED TO THE SCHOOL OF BUSINESS AND ECONOMICS, DEPARTMENT OF ECONOMICS IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN ECONOMICS OF MOI UNIVERSITY

OCTOBER, 2022

DECLARATION

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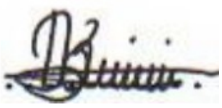
Sign:  Date: 13th October 2022

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DEDICATION

I wish to dedicate this thesis to my parents, Mr. and Mrs. Sammy Rutto, my husband, Kevin Morogo, my beloved daughter Nyla Chelagat Morogo, family, friends and lecturers for their invaluable support on my academic development, encouragement and love throughout my study. May God bless you.

ACKNOWLEDGEMENT

To God Almighty and Father of us all who fashioned my plans in this world before I existed and His favours to accomplish this task. This thesis cannot be the product of a solitary mind. There are many to whom I am indebted, but the following deserve a special mention as an expression of my deepest gratitude; To my Supervisors Dr. Richard Siele and Dr. Edwin Kimitei whose precious support and advice led to the task of writing this study to completion and being professionally around anytime I needed them appreciate the sacrifice they made despite their tight schedule.

Most importantly my Family, dear husband, Kevin and our lovely daughter, Nyla who taught me that everything I ever needed was tucked deep within me. I am grateful for their unconditional love, commitment to my success and unwavering support all through. They gave me every reason to work extra-harder.

To all those works are run as illustrations in this thesis, only eternity will tell the extent they will spark knowledge in others.

My appreciation goes to my fellow economics master students' class of 2019 and friends for their moral and spiritual support during every step of the development of this thesis.

ABSTRACT

Every sovereign nation's goal is to raise the standard of living for its citizen's by promoting economic growth. Economic growth is all about increasing productivity which is determined by many macroeconomic variables where energy consumption is a key variable. Kenya uses energy in most of its sectors in order to enhance production. According to Kenya's Vision 2030, Kenya aimed to achieve an average GDP of 10% per annum beginning the year 2012. However, achieving this economic growth rate has been unfeasible. Kenya's economic growth rate has been unimpressive and often fluctuating. The purpose of this study was to analyze influence of energy consumption on economic growth in Kenya. Specific objectives of the study were to analyze influence of electricity, petroleum and gas consumption on economic growth in Kenya. The study period was 2008-2020. Neo Classical growth, Depletion theories and Growth hypothesis were employed. Explanatory research design was employed. Secondary data sourced from the World Bank database. General Method of Moment model was adopted. Over identifying test and normality tests were conducted before making inferences. Both descriptive and inferential statistics were used in data analysis. Results were presented in form of graphs and tables. The results of the study showed that coefficient of petroleum consumption was 7.6514 , $p=0.007<0.05$, which was positive and significant at 5% level. This implied that for every 1% increase in petroleum consumption led to 7.6514% increase in GDP growth rate. Coefficient of gas consumption was -2.1673 , $p=0.024<0.05$, which was negative and significant at 5% level. This implied that 1% increase in gas consumption would result in a reduction of GDP growth rate by 2.1673%. Coefficient of electricity consumption had a coefficient of was $-0.1155,$ $p=0.907>0.05$ p=0.907 which was insignificant at 5% level. The study observed that petroleum and gas consumptions influenced economic growth in Kenya. The study therefore recommends that petroleum supply should be increased in the country considering that petroleum consumption influenced positively economic growth rate in Kenya. The government should sustain and enhance petroleum consumption through subsidies and availing in order to increase production leading to increase in economic growth rate. Further the government should consider the supply of gas and the nature of subsidy available so that gas consumption be reversed in order to have positive effect on economic growth rate. Findings of this study could be utilized by government in budget making process in the parliament or ministerial preliminary budgets and in the allocation of funds to various sectors that require substantial energy input. Additionally, findings could assist the government in order to expand current sources and exploit the other sources of energy such as solar energy, wind energy, thermal energy so as to increase the production and consumption of energy which increases economic growth. Policy makers could use these findings to establish energy policies that are realistic, time bound and those that enhance sustainable economic growth in Kenya. Government of Kenya could consider the mode of provision of electricity consumption so as to have a significant effect on economic growth in Kenya. Finally, academicians could use the results in future references and scholarly studies in creating new angle of thinking and doing things.

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ACRONYMS AND ABBREVIATIONS

ARDL	-Autoregressive Distributed Lag
CGG	-Autoregressive Distributed Lag
COMESA	**-**Common Market for Eastern and Southern Africa
EAC	-East Africa Community
GDP	-Gross domestic product
GMM	-Generalized method of moment
HIPC	-Highly Indebted poor countries
IEA	-International Energy Agency
IV	-Instrumental variable
KNBS	-Kenya National Bureau of Statistics
LDCs	**-** Less Developed Countries
MDG	-Millennium development goals
NACOSTI	**-**National Commission for Science, Technology and Innovation
NEMA	-National Environment Management Authority
VECM	-Vector Error Correction Model
OECD	- Economic Co-operation and Development
ECM	- Error Correction Model
RGDP	- Real Gross domestic product

OPERATIONAL DEFINITION OF TERMS

Economic Growth – refers to a positive change in the level of production of goods and services by a country over a certain period of time. According to Potters (2021) noted that this is an increase in the production of economic goods and services compared from one period to another.

Electricity Consumption is the form of energy consumption that uses electric energy. Electric energy consumption is the actual energy demand made on existing electricity supply (Zhenya, 2015).

Energy Consumption – refers to use of primary energy before transformation to the end use fuel, which is equal to indigenous production plus imports and stock changes minus exports and fuels (OECD, 2016).

Energy Dependence-it shows the extent to which an economy relies upon imports in order to meet its energy needs.

Environmental Externalities-refers to the economic concepts of uncompensated environmental effects of production and consumption that affect consumer utility and enterprise cost outside the market mechanism.

Gas Consumption is the quantity of gas consumed in a given period divided by labor force. Shahbaz et al., (2014) described gas as a crucial non-renewable energy source, which can be used to augment the economic activities of the world's countries.

Petroleum Consumption is the quantity of petroleum consumed in a given period (tonnes) divided by labor force. (Energy-and-Petroleum-Statistics-Report-2019)

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter provides the background to the study, statement of the problem, objectives of the study, research hypothesis, significance of the study, limitations of the study and scope.

1.2 Background of the Study

Economic growth is the backbone of each and every country. Every sovereign nation's goal is to raise the standard of living for its citizen's by promoting economic growth (Ismaila and Imoughele, 2015). It is a common view that economic growth is all about increasing productivity. The author gave a brief of the United States of America (USA) in the analysis of the effect of energy consumption in economy. The USA Gross Domestic Product (GDP) growth per capita between 1986 and 2011 averaged 2.5%; energy per capita fell by 0.17% a year over the same period. The findings of empirical studies show that there is a strong correlation between electricity use and economic development (Harford, 2013).

According to Liddle (2012) noted that there was an increase in a unit of economic growth brought in by labor and capital efficiency as a result of the issue of energy quality or the use of good-quality energy. Esen and Bayrak (2017) noted in their findings that there was a positive and statistically significant relationship between energy consumption and economic growth over the long term such that energy consumption contributed more to economic growth as the import dependence of the country decreases. Moreover, the effect of energy consumption on economic growth decreased as the income level of the country increases. This indicated that the efficient use of energy was as important as energy consumption, which was regarded as an important indicator of economic development.

According to Nondo *et al.,* (2010), Common Market for Eastern and Southern Africa (COMESA) had a combined population of 390 million people and a combined GDP of US$361 billion in the year 2007. Within the region, there are marked structural differences in the national economies and levels of social development. Based on the World Bank classification of economies by income, 12 of COMESA member countries are listed as lower income while 7 are listed as lower middle income countries. Of the 19 COMESA countries, Libya has the strongest economy with a GDP per capita of US $ 10,840 as per 2007 dollars, while Burundi has the lowest GDP per capita of US $127. Despite having significant reserves of coal, gas, geothermal, water, biomass, and other renewable energy resources, like the rest of Africa, energy consumption for COMESA countries is lower than the world average. With the exception of Egypt, Libya, Mauritius, and Seychelles, the percentage of population with access to electricity in COMESA countries ranges from 2% to 41% (COMESA, 2008). In terms of per capita energy consumption, Seychelles has the highest per capita energy consumption, followed by Libya; whereas Burundi has the lowest per capita energy consumption. In general, majority of the population in COMESA countries use low quality and inefficient sources of energy. Furthermore, energy intensity in COMESA countries is twice the world average. Combined, coal, oil, and gas account for the largest share of electricity generation. In view of the fact that more than 60 percent of COMESA countries are listed both as Least Developed Countries (LDCs) and Highly Indebted Poor Countries (HIPC) (1), energy provision will play a central role in poverty alleviation and sustainable development efforts, including achievement of the United Nations' Millennium Development Goals (MDG), which are to eliminate poverty by 2015. Hence, as COMESA countries' population and economies continues to grow demand for energy will concurrently increase, and if no measures are taken to boost energy supply, this may cause a further decline in per capita energy consumption.

1.3 Energy Consumption and Economic Growth

Energy available for consumption, its price, its environmental effects and other externalities and the overall effects of all these on the economy can never be overemphasized as far as economic growth is concerned. This is because all the fore mentioned factors have a strong bearing on energy consumption levels in Kenya which in turn affects the overall economy through influencing the level of productivity which directly will have a bearing on national output and consumption. As Kenya aspires to be a middle-income economy as visualized in Vision 2030, it faces an enormous task of meeting energy needs due to the high expectations in growth to power the economy. The country therefore needs to come up with strategies and investment plans to secure sustainable supply of energy to meet the growing demand. The energy sector is considered to be a key enabler in the achievement of Vision 2030.The major energy consumption sectors in Kenya are commercial sector, transport sector, manufacturing sector and residential sectors. Access to modern forms of energy, even though it's not by itself a panacea to economic development is believed to be pre-requisite for alleviation of poverty, increasing employment and in general, promoting better living standards. While there is no MDG on energy, the access to modern and reliable energy services is an essential input in achieving most of the MDGs, including poverty alleviation, productivity, health, education, communication services and quality governance (Economic Consulting Associates, 2014).

Globally, energy consumption has risen. The energy market dynamic are greatly affected by the economics. World rapidly increased energy demand and dependency of countries on energy will be one of the biggest problems in the world. Due to this, inventions of alternatives and renewable energy sources has become important for countries. The International Energy Agency (IEA) estimated that in 2013 total world energy consumption was 5.67×10^{20} equal to an average power consumption of 18.0 terawatts. In 2011, expenditures on energy totaled over 6 trillion USD, or about 10% of the world gross domestic product. (IEA-Key World Energy Statistics, 2014).World total primary energy (TPES) or “primary energy” differed from the world final energy consumption because much of the energy that is acquired by human is lost as other forms of energy during the process of its refinement into usable forms of energy and its transport from its initial place of supply to consumers (Stern and Cleveland, 2004).

Morimoto and Hope (2004) using Pearson correlation coefficient observed that economic growth and energy consumption in Sri Lanka are highly correlated. This result is oppose to that of Stern (1993) who examined the relationship between the USA energy consumption and GDP with a multivariate cointegration model but could not find any relationship the two variables. Energy plays an important role in the lives of humans and in the activities of the economy, both as a scale of economic and social development and as a basic humanitarian need. Economic growth is directly related to energy consumption. “Energy is the indispensable force driving all economic activities" (Alma; 2006). The relationship between energy consumption and the growth of gross domestic product has been a discipline for greater research and development (Yoo and Ku, 2009). The same effect is felt all over, including some of the LDCs like Kenya and Zimbabwe.

According to Ojinnaka (2008) energy consumption runs hand in hand with the gross domestic product. His study revealed that energy consumption per capita is an important indicator of economic growth. Energy is one of the most important resources used in all production processes and this has increased foreign earnings of countries that export energy products. The energy industries have also provided jobs to a good number of people who were unemployed. There have been improvements in infrastructure and socioeconomic activities of communities in the process of energy resource exploitation. Based on the above arguments, consistence supply of energy, thus becomes central to economic and infrastructural transformation of the nation's economy. The relationships between energy consumption and economic growth have been investigated over time but there is still need for continuous research and development. Many studies are based on whether the economic growth leads to energy consumption or vice-versa. In today's world, energy is not only considered to be a production input but is also regarded as a strategic commodity that constitutes the basis for international relations and shapes the world economy and politics. The conditions under which energy is procured and the problems experienced during the procurement process directly affect competition at both the national and international levels; these conditions also shape the production structures of the countries and constitute one of the main indicators of basic economic variables. For all of these reasons, energy is one of the most important issues in today's world.

Energy infrastructure is to improve on power availability to meet industrial and domestic demand which would therefore increase the national power, provide the energy required to accelerate growth and mobilize private sector capital for generation of electricity from renewable energy. Energy is an important component in the inputs of productions process. Energy is produced in form petroleum, electricity and biofuels. Energy consumption tends to increase with development as countries shift from labor-intensive agriculture to capital and energy intensive industries. Energy intensity therefore initially increases with rising incomes and then decreases, a pattern comparable to the Environmental Kuznets Curve.

Fang and Yu (2020) observed that economic growth was influenced by energy with particular interests in the role of human capital. The results showed that energy caused economic growth in energy-exporting, high-income, and American countries, which supported the growth hypothesis. Besides, energy could be viewed as a complement of human capital. Therefore, the growth-driving effect of energy could be indirectly achieved by human capital development.

Kenya is among the sub-Saharan African countries that are ranked lowest in per capita energy consumption levels in the world (United Nations Economic Commission of Africa, 2004). In the year 2001, Kenya was ranked number 169 out of 198 in per capita energy consumption worldwide. Energy is a necessity for survival and critical factor affecting economic development in Kenya (NEMA, 2005). Petroleum fuels are the major source used by commercial and industrial establishments. Electricity is the third source of energy in Kenya after wood and petroleum products, but is second to petroleum fuel as a source of commercial energy. About 80 Per cent of Kenya's population relies heavily on traditional energy sources such as biomass, agricultural residues, and other primitive energy sources, which exacerbate environmental degradation and air pollution related health impacts. The United Nations Economic Commission for Africa (UNECA, 2004) has cited the inadequate provision of modern energy services as a limiting factor in Economic growth and poverty alleviation. Energy is regarded as a major enabler in the development of the Kenyan economy. For the country to experience economic growth and better quality life for its citizens, access to adequate and reliable energy supply is imperative. The ultimate goal of the energy sector is to provide the affordable, sustainable and reliable supply of energy that will stimulate high and sustained economic growth leading to higher incomes, increased employment and reduced poverty levels.

1.4 Statement of the Problem

Economic growth is a major concern in today's world, especially in developing countries. Economic growth is a necessary condition for economic development which explains why it dominates various government policy thrust documents. High sustainable economic growth improves the quality of living standards but Kenya's economic growth rate has been unimpressive and often fluctuating since independence.

According to World Bank (2015), Kenya's economy in 1964 was at par with that of current economic giants of Asia such as South Korea, Hong Kong Taiwan and other newly industrializing countries. Specifically, in 1965, Kenya's two countries started deviating in 1960s and diverged much widely in the 1990s when Kenya's economy was wrecked owing to macroeconomic instability. Decades later, the East Asian countries GDP per capita is thrice that of Kenya and Kenya's economy continues to be marked by widespread poverty, unemployment and inequalities. Kenya is one the most developed countries in East Africa. Agriculture is the largest sector of the economy and accounts for about 22 percent. Manufacturing is the second largest sector and represents around 11 percent of the GDP. Kenya needs to multiply its current real GDP growth rate if it's to be able to maintain high standards of living for all its population. The various government regimes have pursued measures and came up with several policy documents to stabilize the economy and propel it towards economic growth. Despite these efforts, real GDP growth in the country continues to be marked with cyclical fluctuations of highs and lows and this calls for investigation to find out why these fluctuations continue to be witnessed.

According to Kenya's Vision 2030 (Government of Kenya, 2007), Kenya aimed to achieve an average GDP of 10% per annum beginning the year 2012. However, to date, the year 2020, the average GDP growth rate had not been achieved as depicted in table.

Table 1. 1: Annual Economic Growth Rate (%) in Kenya (2008-2020)

Year	GDP (Annual %)
2008	0.23
2009	3.31
2010	8.06
2011	5.12
2012	4.57
2013	3.80
2014	5.02
2015	4.97
2016	4.21

2017	3.82
2018	5.63
2019	4.98
2020	-0.32

Source: World Bank (2021)

According to Government of Kenya (2007), energy is one of the foundations of the Economic Pillar of the Vision 2030 that targeted a 10 percent per annum by the year 2012 and thereafter sustained growth by year 2030. Energy is one of the infrastructural enablers of the three "pillars" of Vision 2030. The level and intensity of commercial energy use in a country is a key indicator of the degree of economic growth and development. Kenya is therefore expected to use more energy in the commercial sector on the road to 2030. In the implementation of the Vision 2030 strategies there is need for policy makers and other beneficiaries to clearly understand what proportion of economic growth is attributable to sources-movers of energy consumption. The aim of this study therefore seeks to fill this gap by comprehensively looking at the influence of energy on economic growth. The study will delve more specifically on the influence of electricity consumption, petroleum consumption and gas consumption on economic growth in Kenya. It is therefore critical that various sources-movers of energy be delved with a view of establishing the influence on economic growth in Kenya.

1.5 Objectives

1.5.1 General Objective

The general objective of this study was to analyze the influence of energy consumption on economic growth in Kenya (2008-2020).

1.5.2 Specific Objectives

The study sought to achieve the following specific objectives:

1. To determine the influence of electricity consumption on economic growth in Kenya.
2. To examine the effect of petroleum consumption on economic growth in Kenya.
3. To establish the impact of gas consumption on economic growth in Kenya.

1.6 Research Hypotheses

To achieve the above objectives, the study postulated the following Hypotheses:

H_{01}: There is no significant influence of electricity consumption on economic growth in Kenya.

H_{02}: There is no significant effect of petroleum consumption on economic growth in Kenya.

H_{03}: There is no significant impact gas consumption on economic growth in Kenya.

1.7 Significance of the Study

Energy economies are very important in present economies ranging from developed to developing countries economic sector. Energy is used in households, industries, commercial institutions and the transport sector.

1.7.1 Government

The government could use the findings for budget making process in the parliament or ministerial preliminary budgets and in the allocation of funds to various sectors that require substantial energy input. The ministry of energy may use the information to identify the gaps that needs to be filled in the energy sector and also forecast the future of the sector in general.

1.7.2 Policy Makers

Further, this study helps the policy makers to establish energy policies that are realistic, time bound and those that enhance sustainable economic growth in Kenya.

1.7.3 Scholars

The study aims to help the academia expand knowledge scope of the scholars through new information and inventions. This study helps scholars to appreciate the contribution of energy consumption towards steering economic growth. Further it forms a foundation for further studies by creating a new angle of thinking and doing things.

1.8 Scope of the Study

The geographical area of this study is Kenya. The study was conducted to establish the influence of energy consumption on economic growth in Kenya. This study considered the time period from the year 2008- 2020 since it was the year 2008 when the Kenya's Vision 2030 started to be implemented. The major sources of energy used were petroleum, electricity and gas.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter presents the concepts of variables, literature review, literature and gaps and conceptual framework. The literature review consists of theoretical and empirical literature review. The literature and gaps to be filled highlights other areas that are yet to be studied.

2.2 Concepts

In this section the concepts of economic growth, electricity consumption, petroleum consumption and gas consumption was discussed.

2.2.1 Economic Growth Concept

Economic growth is a sustained increase, over a significant period, in the quantity of material goods and services produced in an economy. The economy may encompass a nation or some other geographical, political, or social unit, such as a region, a city, or a population group; it may include a group of nations or even the whole world. Economic growth is measured by using data on GDP, which is a measure of the total income earned by the people of a country through their participation in the production process.

Kenya's economic growth averaged 5.7%, making it one of the fastest growing economies in Sub-Saharan Africa. The performance of the economy has been boosted by a stable macroeconomic environment, positive investor confidence and a resilient services sector. (World Bank; 2019)

2.2.2 Electricity Consumption Concept

The most important measure in the energy balance of Kenya is the total consumption of 7.86 billion kWh of electric energy per year. Per capita this is an average of 146 kWh. Kenya could provide itself completely with self-produced energy. The total production of all electric energy producing facilities is 10 bn kWh, which is 123% of the countries own usage. The demand for electricity has shown an upward trend in the last 5 years. It was at 7,655 GWh in the 2014/15 financial year and increased to 8,769 GWh in the 2018/19 financial year. This represents an average annual percentage increase of 3.7%, with the highest growth being recorded in 2014/15 (5.7%). Overall, there has been a positive growth among all consumer categories. This is largely attributed to the increased efforts in attaining universal access to electricity by 2022.Despite this, Kenya is trading energy with foreign countries. Along with pure consumptions the production, imports and exports play an important role. Other energy sources such as natural gas or crude oil are also used. Electricity access in Kenya is low despite the government's ambitious target to increase electricity connectivity from the current 15% to at least 65% by the year 2022 (Energy and Petroleum Statistics Report, 2020).

2.2.3 Petroleum Consumption Concept

The petroleum infrastructure in Kenya not only ensures security of supply and access in the country but also supports the East African Community (EAC) and countries in the Great Lakes region such as the Democratic Republic of Congo in the Eastern Region, and South Sudan and Ethiopia in the Northern Region.

Petroleum is one of the prime movers of the country's social and economic development. Petroleum products are predominantly used in transport sector, commercial sector and industrial sector. Despite petroleum oil exploration, the total quantity of petroleum products imported into the country has increased from 3,976.3 thousand tonnes in 2008 to 6,114.4 thousand tonnes in 2018. The transport sector is the largest consumer of petroleum products followed by manufacturing, agriculture and power generation respectively. Over the years, the transport sector generally consumed more than 65% of the total net domestic sales of petroleum products as compared to the manufacturing sector, which consumed less than 20% of the total net domestic sales of petroleum products (Energy-and-Petroleum-Statistics-Report-2019)

2.2.4 Gas Consumption Concept

For many years the world has depended on oil as the main source of energy. Nevertheless, in recent years the gas has become more attractive in replacing oil as a core source of energy. Energy is important in the process of economic growth and it cannot be underestimated (Hassan *et al.*, 2017). The need for using natural gas has been rising especially since the year 2000 in the world. Natural gas is mentioned to be a replacement of the oil as the source of energy in the future near. More to that natural gas has become a very attractive source of energy as it has more advantages compared to coal and oil, as it is environmental friendly because of less carbon dioxide produced compare with the popular oil and coal. It also has fewer pollutants (Shahbaz *et al.,* 2014). All these advantages make many countries to be attracted to use natural gas as a source of energy (Apergis and Payne, 2010).

The studies of Apergis and Payne (2012), Shahbaz *et al.*, (2014) described natural gas (NG) as a crucial non-renewable energy source, which can be used to augment the economic activities of the world's countries, whether they are emerging, developing or developed. Considering declines of oil reserves in most of the oil producing nations, the opportunity of using NG as an alternative is gaining interest in many of the world's economies.

2.3 Theoretical Literature Review

The question of whether energy consumption affects the rate of economic growth has shaped an important question among economists. Empirical studies in this area however have conflicting results and therefore economist's views on this issue have not been unanimous. Several theories have been put forward to explain the relationship between energy consumption and economic growth. This study put into accounts the following theories and hypotheses:

2.3.1 Neoclassical Theory

Growth Models with natural resources and no technological Change. (Solow and Swan 1956). All natural resources exist in finite quantities though some such as sunlight or deuterium are available in very large quantities. Energy as an environmental resource exists both as renewable and non-renewable. Finiteness and exhaustibility of energy resources make the notion of indefinite economic growth problematic. Even sustainable development – non declining consumption - may not be feasible. When there is more than one input – both capital and energy resources - there are many alternative paths that economic growth can take. The path taken is determined by the assumed institutional arrangements. The neoclassical literature on growth and resources centers on what conditions permit continuing growth, or at least non-declining consumption or utility. Technical and institutional conditions determine whether sustainability is possible. Technical conditions include the mix of renewable and non-renewable energy resources, the initial endowments of capital and energy and the ease of substitution among inputs. The institutional setting includes market structure, the system of property right and the system of values regarding the welfare of future generations.

Solow (1974) showed that sustainability is achievable in a model with a finite and non- renewable energy. In fact, growth and consumption can occur indefinitely. However, the same model economy under competition results in exhaustion of the resource and consumption and social welfare eventually fall to zero (Stiglitz, 1974). Dasgupta and Heal (1979) show that with any constant discount rate the efficient growth path also leads to eventual depletion of the natural resource and the collapse of the economy. Sustainable economic growth occurs when society invests in sufficient capital over time to replace the depleted energy resources. Hartwick (1977) showed that if sustainability is technically feasible, a constant level of consumption can be achieved by reinvesting the resource rents in other forms of capital, which in turn can substitute for resources. Dixit *et al.*, (1980) extended the rule to multiple capital stocks while Hartwick (1995) extended the rule to open economies.

A common interpretation of this body of work is that substitution and technical change can effectively de-couple economic growth from energy and other resources. As explained above, neoclassical economists are primarily interested in what institutional arrangements, and not what technical arrangements, will lead to economic growth, so that they typically assume a priori that sustainable economic growth is technically feasible and then

2.3.2 Growth Hypothesis

Growth hypothesis treats energy as a factor of production and thus carries the policy implications that a drastic reduction in energy consumption would adversely affect economic growth. The growth hypothesis, thus, is based on the idea that energy consumption is a key determinant of economic growth. In support of the growth hypothesis, Menyah and Wolde-Rufael (2010) examine the relationship for South Africa over the period 1965–2006 and report unidirectional causality leading from energy consumption to economic growth. Shahbaz *et al*., (2013) using the data for the study period 1971–2011and the autoregressive distributed lag (ARDL) estimator, find energy consumption to have positive impact on economic growth in China .Also, Wandji (2013) investigated the case for Cameroon over the period 1971–2009 and reports that 1% energy consumption was associated with a 1.1%increase in economic growth .In a regional study by Apergis and Payne (2009) for six Central American countries over the period 1980–2004 using panel co-integration and the error correction model, the authors reveal both short-run and long-run causality running from energy consumption to economic growth. Energy consumption is a prior condition for economic growth given that energy is a direct input in the production process and an indirect input that complements labor and capital inputs (Toman and Jamelkova, 2003). In this case a unidirectional Granger causality running from energy consumption to GDP means that the country's economy is energy dependent, and that policies promoting energy consumption should be adopted to stimulate economic growth because inadequate provision of energy may limit economic growth.

2.3.3 Depletion Theory

This theory as put forward by Roper (1976) governs the reduction of non-renewable resources which includes non-renewable energy resources. According to this theory, depletion is a function of technology and sociology. In the early stage of development, energy resource is relatively readily available but the technology for its extraction and societies need for it is underdeveloped. This means that the consumption of energy is low at the stage. However as the extraction of the resource enters the mainstream of the society its presence generates more need for it and thereby advanced extraction technology. At this stage the rate of energy consumption has increased due to its extended use in the economy. This shows that the production rate at the earliest stages where demand for energy resource is low and the technology applied is underdeveloped; the production rate is an increasing function of the amount already extracted. At the mainstream of the society where extraction use advanced technology, production rate will be a decreasing function of the amount already extracted at that time. At the latest stage when the energy is completely depleted, the production rate will increase at a decreasing rate of extraction at that time. This makes governments to undertake a program known as the optimal depletion program to conserve energy.

Depletion theory governs the reduction of energy reserve. The reduction of the reserve shows that the energy resource is being used in the economy. Energy is used in households, industries and commercial institutions to fuel economic growth. Thus a reduction in the amount of energy reserve implies an increase in economic growth as energy is consumed in the economy.

2.4 Empirical Literature Review

The relationship between energy consumption and economic growth has been widely discussed by many researchers around the world. Unfortunately, the empirical findings are inconsistent across countries including the methodology used.

2.4.1 Energy Consumption and Economic Growth

Masih and Masih (2007) studied the causality between energy consumption and GDP in Asian countries using vector error correction model (VECM) and vector autoregressive (VAR)\ analysis. They used annual data over the period 1955 to 1999. They found no causality between energy consumption and GDP in Malaysia, Singapore and Philippine. They also found that there was bidirectional causality between energy consumption and GDP in Pakistan, unidirectional causality from energy consumption to GDP in India and unidirectional causality from GDP to energy consumption in Indonesia.

Sica (2007) for Italy investigated the possibility of "energy demand-led growth" and "growth driven energy demand" hypothesis using the error correction model. The result of the study did not reveal any causality linkage, though, the standard Granger test found evidence of unidirectional causality running from energy to gross domestic product.

Chieng-Chang and Chung-Ping (2008) studied the effects of energy consumption on economic growth in Asian countries using panel unit root, heterogeneous panel co integration and panel-based error correction models to re-investigate co-movement and the causal relationship between energy consumption and real GDP within a multivariate framework that includes capital stock and labour input for 16 Asian countries during the 1971–2002 period. It employed the production side model (aggregate production function). They found that there was a positive long-run co integrated relationship between real GDP and energy consumption when the heterogeneous country effect is taken into account. They found that although economic growth and energy consumption lacked short-run causality, there was long-run unidirectional causality running from energy consumption to economic growth.

Ongono (2009) carried a study on Energy consumption and economic performance in Cameroon. The results of this study show that there is no Granger causality between electricity consumption and economic performance (GDP) at the national level and primary sector. The result also revealed that in the secondary sector, production Granger causes electricity consumption. Furthermore, in the tertiary sector, the causality runs from electricity consumption to production. He recommended that any policy aimed at strengthening growth and reduce poverty must pay special attention on energy production.

Gbadebo and Okonkwo, (2009) studied on the relationship between energy consumption and the Nigerian economy from the period of 1970 to 2005. The energy sources used to test for this relationship were crude oil, electricity and coal. By applying the co-integration technique, the results derived infer that there exists a positive relationship between current period energy consumption and economic growth. With the exception of coal which was positive, a negative relationship was noted for lagged values of energy consumption and economic growth.

Halicioglu (2009) examined the relationship between GDP and energy consumption in Turkey over the period of 1960-2005 by applying the ARDL model and Granger causality test. The results show the absence of a causal relationship that is consistent with the neutrality hypothesis. Soytas and Sari (2009) employed the Toda and Yamamoto procedure, the authors conclude that there is no causal relationship between GDP and energy consumption in the case of New Zealand, Turkey and United State. To explain the neutrality hypothesis, Apergis and Payne (2009) emphasized the energy-growth links are only significant in developed and developing countries. Because, in underdeveloped countries most of the factors for development, such as capital, infrastructure, education and high technology are limited. Economic activities are based on nature so that the demand for energy consumption is low.

In a multivariate panel data framework for 11 Commonwealth Independent states from 1991 to 2005, Apergis and Payne (2009) found energy usage, capital and labour to positively affect real GDP with the inclusion of Russia only affecting real GDP responsiveness. This was an acknowledgment of Russia's strong macro-economic environment and development stage as well as its natural resource endowment. Their model results indicated a short-run unidirectional causality and long-run bi-directional causality from energy consumption to gross domestic product for both panels with and without the inclusion of Russia.

Chandran (2010) used ARDL analysis to test for causality on the same variables and found the same result. This means that reducing energy consumption does not adversely affect GDP in the short-run but would in the long-run.

Ansgar *et al.*, (2010) set out to determine the long-run relationship between energy consumption and real GDP, including energy prices, for 25 OECD countries from 1981 to 2007. They used principal component analysis to show how development both at an international level and national level account for the long-run relationship energy consumption and economic growth.

Odhiambo (2010) in his article Energy Policy, by using ARDL- bounds testing procedure; we find that the causality relationship between energy consumption and economic growth varies significantly across the countries under study. The results show that for Kenya there is a unidirectional causal flow from energy consumption to economic growth. This study however focuses only on causality between energy consumption and economic growth it does not show the energy consumption trends and the influence of energy consumption on economic growth in Kenya.

Orhewere and Machame (2011) carried out a study aiming at determining the relationship between energy consumption and economic growth over a period of 1970 to 2005. The method of analysis was unit root test, co-intergration statistics, and vector error correction based Granger causality test. The study found a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Unidirectional causality form Gas consumption to GDP in the short-run and bidirectional causality between the variable in the long-run. Although no causality was found in either direction between oil consumption and GDP in the short-run, a unidirectional causality from oil consumption to GDP is found in the long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

Adegbemi *et al.,* (2013) investigated the causal relationship between energy consumption and Nigeria's economic growth for the period of 1975 to 2010. Secondary time-series data were analyzed using co-integration and ordinary least square techniques. The result shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. The empirical results reveal that petroleum, electricity and the aggregate energy consumption have significant and positive relationship with economic growth in Nigeria. However, gas consumption although positive, does not significantly affect on economic growth. The impact of coal was negative but significant; therefore this is just the time to increase the use this resource to the nation's benefit.

Obange (2014) determined that energy is a fundamental input for economic growth worldwide. In spite of the existence, direction and magnitude of the relationship between energy consumption and overall economic growth remains debatable in empirical literature. According to sector, the nexus is yet to be established in many countries. In Kenya, energy is assumed to drive the overall economy and its strategic sectors; agriculture, manufacturing and Services. Nevertheless, there is neither evidence in policy nor in empirical literature as to whether energy consumption propels Kenya's overall economy and its strategic sectors or vice versa. The purpose of the study was to investigate the relationship between energy consumption and economic growth in Kenya using a disaggregated approach. The specific objectives were to examine the relationship between overall economic growth and energy consumption in Kenya and the nexus between the disaggregated energy (electricity & petroleum) consumption and agricultural, manufacturing and the services sector growth respectively. Based on Solow's nested growth theory and through a survey design, the study analyzed 1971-2010 World Bank data in a vector error correction model. Augmented Dickey Fuller and Phillips-Perron tests for unit roots and Johansens tests for cointegration found the series to be integrated and cointegrated, meaning longrun causation exists. Empirical results by objectives show that: one, a bidirectional causality in energy-growth nexus exists, implying that there is interdependency. Therefore, for Kenya to apprehend positive economic growth, more energy is required. Secondly, in agriculture there is bidirectional causality in long-run. Conversely, short-run only petroleum drives agriculture. Petroleum consequently is more critical for agricultural growth in Kenya. Thirdly, in manufacturing, both electricity and petroleum are significant in long-run while in short-run only electricity is significant. The manufacturing sector is therefore more dependent on electricity.

Finally, in the services sector, electricity is significant in both short and long periods. However, the services sector is also more dependent on electricity than petroleum in Kenya. We recommend that energy supply policies should aim electricity for manufacturing and services sectors and petroleum for the agricultural sector in Kenya.

Aminu, and Aminu, (2015) in the study to re-examine the causal relationship between energy consumption and economic growth using Nigeria's data from 1980 to 2011 in a multivariate framework by including labour and capital in the causality analysis. Applying Granger causality test, impulse response and variance decomposition analysis; the results of the causality test reported absence of causality and that of variance decomposition found that capital and labor are more important in affecting output growth compared to energy consumption.

Tang et al. (2015) analyzed the energy-growth links in Vietnam using the neoclassical Solow growth framework from 1971-2011. The results revealed that energy consumption has a positive impact on GDP in the long run. There is a uni-directional causality running from energy consumption to GDP. Long et al. (2018) employed the ARDL model, Toda and Yamamoto procedure over the period of 1990-2015 in Vietnam. They found evidence to conclude that electricity consumption has a positive impact on GDP per capita in both the short-run and long run. The causality test is the same as the conclusion of Tang et al. (2015) supported the growth hypothesis. However, two studies are based on an assumption that the impact of energy consumption on economic growth is the same through periods. There are two reasons to believe that the assumption is not really reasonable. First, the contributions of such factors as capital, labor, and energy into economic growth will differ in the period of economic growth and recession. Second, the advancement of high technology helps the machinery consume less energy. The differences in the conclusion of previous studies and whether there exists "structural break" demonstrate the need for new studies about this relation.

In an investigation of the drivers of energy consumption, Keho (2016) found energy consumption to be co-integrated with real GDP per capita with the energy input variable used (per capita/total energy) affecting the sign and magnitude of the estimates. In the long-run, GDP and energy consumption per capita were positively related for all select countries with the exception of Benin while that position changed to a negative relationship for the case of Kenya when total energy consumption was used. Per capita GDP was an insignificant explanatory variable to per capita energy consumption but a significant explanatory variable to total energy consumption.

In another panel study of 75 net energy importing countries between 1990-2015 by Esen and Bayrak (2017), with Kenya incorporated under both the lower-middle income economies bracket and also among countries whose level of energy dependence was below 50%, a strong positive L-R relationship existed, with the short run energy consumption coefficients though negative, significant, with the income levels further affecting this relationship. The writers also reinforced the argument that subject to the development stage, improved energy efficiency weakened the effect on economic growth arising from increased energy consumption.

Twerefou *et al.* (2018) highlighted that the availability of reliable energy supply to meet the demand of the growing population in West Africa is vital for achieving not only economic growth but also achieving the sustainable development aspirations of the sub region. Though, conflicting conclusions have been championed on the energy-growth nexus with little information on the nexus in the sub-region. The study employed the panel cointegration techniques and data on total energy consumption, electricity consumption and petroleum consumption to establish the causal relationship between energy consumption and economic growth for the 17 countries in the West African sub region. The results indicated that in the short run, there is no causal relationship running from total energy, electricity and petroleum consumption to growth. Although, there is a unidirectional relationship running from growth to electricity consumption, conservation policies in electricity may not have effect on economic growth. In the long run, electricity and petroleum consumption were found to have a positive and significant impact on growth proposing that policy choices should focus on enhancing the generation of these types of energy.

Olarinde (2018) suggested that energy is critical to the survival and expansion of any economy. Energy consumption has been skewed towards household usage, and below thresholds for sector-driven growth in Nigeria. In time and methodology, those studies highlighted the significance of energy use for economic growth, using the Bound test and the Auto Regression Distributed Lag (ARDL) to inaugurate the long- and short-run relationships between disaggregated energy consumption and economic growth in Nigeria from 1990 to 2016. The variables considered are real GDP, energy consumption decomposed into electricity and petroleum consumption, labour and capital. The findings showed that petroleum consumption and labour have a significant positive relationship with GDP in the short and long run. Moreover, the causality results indicated that feedback causation between economic growth and energy consumption as well as labour exists, whereas one-way causation runs from labour to economic growth. The study recommends diversification of the power-generation portfolio in the country, since this will improve energy consumption. Full deregulating policies in the energy sector would encourage industrialization and shift energy demand towards increasingly productive uses. In conclusion, a strong institutional framework is required to ensure energy policies attain their objectives and targets.

Bhuiyan *et al.* (2022) examined efficient use of energy is the pre-condition for economic development. Excessive use of fossil fuel harms the environment. As renewable energy emits no or low greenhouse gases, more countries are trying to upsurge the use of energies from renewable sources. Concurrently, no matter developed or developing, nations have to maintain economic growth. Our research review showed that renewable energy does not hinder economic growth for both developing and developed countries, whereas, there is slight significance of consuming renewable energy (threshold level) on economic growth for developed countries.

2.4.2 Electricity Consumption and Economic Growth

Sueng (2005) investigated the short- and long-run causality relationship between electricity consumption and economic growth in Korea by using the co-integration and error-correction models. This employed annual data covering the period 1970–2002. The overall results show that there exists bi-directional causality between electricity consumption and economic growth. This implied that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption.

Yemane (2006) suggested while the availability of electricity by itself is not a panacea for the economic and social problems facing Africa, the supply of electricity is nevertheless believed to be a necessary requirement for Africa's economic and social development. The study tested the long-run and causal relationship between electricity consumption per capita and real gross domestic product (RGDP) per capita for 17 African countries for the period 1971–2001 using cointegration test proposed by Pesaran et al. (2001) and modified version of the Granger causality test due to Toda and Yamamoto (1995). The empirical results showed that there was a long-run relationship between electricity consumption per capita and real GDP per capita for only 9 countries and Granger causality for only 12 countries. For 6 countries there was a positive uni-directional causality running from real GDP per capita to electricity consumption per capita; an opposite causality for 3 countries and bi-directional causality for the remaining 3 countries. The result should, however, be interpreted with care as electricity consumption accounts for less than 4% of total energy consumption in Africa and only grid-supplied electricity is taken into account.

RF Hirsh (2007) examined that the growth rate of electricity consumption has important implications for business and public policy. The article described differed trends in the relationship between growth in economic activity and electricity use and offers hypotheses to explain them. These new trends require utility system stakeholders to have thoughts on old assumptions and prepare for a new reality of lower growth rates in electricity consumption. The observation that a unit of GDP could rise with less energy input disputed the notion that economic growth depends on increasing energy consumption.

Mozumder and Marathe (2007) used Granger causality to analyze causality direction between GDP and electricity consumption for Australia. He found that GDP affected electricity consumption but no causality was found from electricity consumption to GDP.

Ighodaro and Ovenseri-Ogbomo (2008) for Nigeria used data for 1970 to 2003 on a co integration and bivariate Granger causality technique. They found unidirectional causality between energy consumption (electricity demand) and economic growth with causality running from energy consumption to economic growth. They concluded that a well-designed energy conservation policy can be an effective tool in managing the energy sector in Nigeria. Contrary to the result, Omotor (2008) also for Nigeria found a bidirectional relationship between coal production and economic growth as well as between economic growth and electricity use while Olusegun (2008) used a bound testing cointegration approach and found no causality between electricity consumption and economic growth. In a related, though, different study, Celik and Ozerkek (2009) examined the relationship between consumer confidence, personal consumption and other relevant economic and financial variables for nine European Union countries. Using panel data analysis, they found the existence of a long run relationship and concluded that consumers are able to detect early signals about future rates of economic growth as they contribute through the consumption channel. Although literature is replete with studies on energy as a whole, there are studies that examine energy by separating it into its sub-components such as electricity and petroleum.

The study by Mushtaq (2008) found a unidirectional causality for GDP and oil consumption, electricity and GDP and a neutral impact for gas and GDP. Therefore, energy growth and GDP are highly correlated in a way that increase in GDP is invariably accompanied by increases in energy consumption, and some facts shows that energy consumption raises more rapidly in countries with most rapid economic growth, a study by Dunkerley (1982) evidently supports this.

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Tang (2009) used ECM and Granger causality analysis to test for causality between electricity consumption, income, population and FDI. He used data for 1970 to 2005 period. He found bidirectional causality between electricity consumption, income and FDI in the short run.

Ciarreta, *et al.*, (2010) used panel data for European countries for the period 1970 to 2007 to analyze the causality between electricity consumption, real GDP and energy price. The causal relationship running from electricity consumption to GDP is revealed from their results. In addition, they find a bidirectional relationship between energy price and GDP.

Apergis *et al.*, (2011) also used panel data for the period 1990 to 2006 for 88 countries. They found a bidirectional relationship between electricity consumption and growth in the short run and long run. Chen et al., (2007) used electricity consumption data to test for a causal relationship with GDP in Asian countries. They used data for the period 1971 to 2001 to conclude that there was a unidirectional causality from GDP to electricity consumption in the short run in Malaysia. Furthermore, they found different results from Masih and Masih (2007) and Chandran (2010). They also found unidirectional causality from electricity consumption to GDP in Indonesia. The result in Philippine contradicted Masih and Masih (2007). However, they found a unidirectional causality from GDP to electricity consumption. Causality between electricity consumption and other variables in Malaysia was also found to contradict Lean et al. (2010) who found bidirectional causality between aggregate output and electricity consumption. Lang (2010) found bidirectional causality among total electricity consumption, industrial electricity consumption and real GDP in Taiwan for the period 1971-2006.

Orhewere and Machame (2011) carried out a study aiming at determining the relationship between energy consumption and economic growth over a period of 1970 to 2005. The method of analysis was unit root test, co-integration statistics, and vector error correction based Granger causality test. The study found a unidirectional causality from electricity consumption to GDP both in the short-run and long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

Adegbemi *et al.,* (2013) investigated the causal relationship between energy consumption and Nigeria's economic growth for the period of 1975 to 2010. Secondary time-series data were analyzed using co-integration and ordinary least square techniques. The result shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. The empirical results reveal that electricity and the aggregate energy consumption have significant and positive relationship with economic growth in Nigeria.

Akhmat and Zaman (2013) suggested a unilateral link for electricity and gas consumption in India in the long run. Wolde-Rufael (2010) shows the same linkage for nuclear energy in the long run. Other studies on India show evidence of the conservative hypothesis, or a unidirectional link flowing from economic growth to energy consumption, for different sources of energy: electricity consumption (Ghosh, 2002) in the short run; Abbas and Choudhury (2013) in the short run and the long run; nuclear energy in the long run (Akhmat and Zaman, 2013); and coal consumption in India in the short run (Govindaraju and Tang, 2013). Similarly, Shahbaz *et al.*, (2016) examined the relationship between globalization and energy consumption in India and have found acceleration of globalization results in a decline in energy consumption, but economic growth increases energy demand in the long run.

Adeyemi and Ayomide (2013) examined the relationship between electricity consumption and economic growth in Nigeria using the Johansen Co-integration technique based on the Cobb-Douglas growth model covering the period 1980-2008. The study adopted also conducted the Vector Error Correction Modelling and the Pairwise Granger Causality test. The study found the existence of a unique co-integrating relationship among the variables in the model with the indicator of electricity consumption impacting significantly on growth. Also, the study shows an evidence of bi-directional causal relationship between electricity consumption and economic growth.

Enu and Havi (2014) carried a study aiming at examining the extent to which electricity consumption influences economic growth in Ghana. The study employed Augmented Dickey Fuller test, Co-integration test, Vector Error Correction Model and Granger Causality test. The study revealed that, in the long term, a hundred percent increase in electricity power consumption will cause real gross domestic product per capita to increase by approximately fifty two percent. However, in the short run, electricity consumption negatively affects real gross domestic product per capita. The study again revealed that unidirectional causality run from electricity consumption to economic growth meaning that any policy actions taken to affect the smooth consumption of electricity in Ghana will definitely affect her gross domestic product per capita.

Kasperowicz (2014) investigated the relationship between electricity consumption and economic growth in Poland for the period 2000 to 2012. The behavior of electricity consumption in relation to the economy is very important for improving stable economic growth and development. The results indicated that there is the causal relationship between electricity consumption and economic growth in Poland and the relationship is bi-directional. He discovered the bi-directional causality between capital and economic growth. The evaluated growth model showed that electricity consumption is a pro-growth variable, so the results indicate that economic growth of Poland is electricity-dependent. Therefore stated that electricity is a limiting factor to economic growth of Poland.

Sekantsi *et al.* (2016) examined electricity consumption and economic growth nexus in Uganda from 1981 to 2013. Autoregressive distributed lag-bounds testing and

Granger causality tests were employed for analysis. The results confirmed the existence of long-run relationship between electricity consumption and economic growth and vice versa. Further, the Granger causality test results confirmed conservation hypothesis in the short run and feedback hypothesis in the long run. Therefore, the study recommended Ugandan authorities not only to develop energy policies geared toward promoting efficient energy use but also to expand electricity infrastructure to address increased electricity demand to support economic growth.

Raza *et al.* (2016) investigated the effect of electricity consumption on economic growth of four South Asian countries; Pakistan, India, Bangladesh and Sri Lanka by using time series annual data from 1980 to 2010. Pedroni's panel cointegration results affirmed that there exists a long-run relationship between electricity consumption and economic growth in South Asia. Results of random effects model suggested the positive and significant impact of electricity consumption on economic growth of South Asian countries. Results of panel Granger causality test confirmed that the unidirectional causal relationship flows from electricity consumption to economic growth. It is therefore recommended that the South Asian countries should consider the development initiative and low-cost mode to produce electricity to enhance economic growth in the region.

Lipin *et al.* (2016) indicated that electric power has been playing a more and more important role in national economy for developing countries. In recent years, with the rapid development of economy in Sichuan province of China, electric power demand has entered a high-speed development period. For power grid companies, studying on the development trend of electricity is the key to expand electricity market and promote sustainable development for almost all industries. Electric power construction is necessary for maintaining hasty economic growth from the perspective of society. Based on Granger causality and co-integration relationship model, there is long-term equilibrium relationship between electricity consumption and GDP in Sichuan. Analysis results showed that electric power has an observable effect on the economic development. Therefore, Sichuan should maintain better development of electric industry to serve as the firm foundation for the growth of the economy.

Molem, and Ndifor, (2016) carried a study aimed at determining effect of Energy Consumption on Economic Growth in Cameroon from the period of 1980 to 2014. The energy sources used to test for this relationship were Petroleum and electricity. The study made used of secondary time series data. Using the Generalized Method of Moments technique, the results obtained shows that Gross Domestic Product (GDP), population growth rate and petroleum prices, have a positive relationship with petroleum consumption. Also, there was an established positive relationship between Gross Domestic Product (GDP), population growth rate, electricity prices and electricity consumption. Again, the study found a positive and significant relationship between petroleum consumption, electricity consumption, Gross domestic investment (GDI) and population growth rate and economic growth. Furthermore, the empirical result revealed that the rate of inflation and economic growth are positively related.

Wen-Cheng (2017) investigated the existence and nature of the Granger causality between electricity consumption and economic growth for 17 industries in Taiwan. The results over the period 1998–2014 suggested that cointegration test showed a long-run equilibrium relationship and a bi-directional Granger causality between electricity and economic growth has been found. This indicated that a 1% increase in electricity consumption boosted the real GDP by 1.72%. The government could pursue energy conservation and carbon reduction policy in some industries without impeding the economic growth for adjusting the industrial structure.

Ehigiamusoe &Babalola (2021) showed a short-run and long-run joint causality from electricity and trade to growth, as well as joint causality from trade and growth to electricity. Moreover, the Dumitrescu–Hurlin Granger non-causality technique showed a bidirectional causality between electricity and growth and between trade and growth on the other hand a unidirectional causality from electricity to trade. It also revealed the causal relationships from exports, imports, renewable and non-renewable electricity to growth. The study denoted that electricity consumption and trade openness stimulate growth, while the latter also determines electricity consumption and trade openness.

Majewski *et al.* (2022) shed light on the nexus between electricity supply and economic growth in South Asian countries during 1990–2018. The study adopted Pedroni’s panel cointegration test as well as Dumitrescu and Hurlin’s (DH) causality test for panel data. The empirical results confirmed that there exists a long-term relationship between electricity supply and economic growth. The results for Pakistan also implied that fostering green energy generation would lead to a positive effect on economic growth through improved electricity production. The government may use several policy tools to stimulate adoption of renewable energy, such as fiscal incentives, low interest loans, or grants for rural populations to speed up the green energy transformation.

2.4.3 Petroleum Consumption and Economic Growth

The study by Mushtaq (2008) found a unidirectional causality for GDP and oil consumption, electricity and GDP and a neutral impact for gas and GDP. Therefore, energy growth and GDP are highly correlated in a way that increase in GDP is invariably accompanied by increases in energy consumption, and some facts shows that energy consumption raises more rapidly in countries with most rapid economic growth, a study by Dunkerley (1982) evidently supports this.

Sajal (2009) probed cointegration and Granger causality between economic growth and petroleum consumption, using annual data covering the period 1980–2004, for Bangladesh, Bhutan, Burma, China, Maldives, Nepal, and Pakistan in a bivariate vector auto regression framework with change in international oil price as exogenous variable. Augmented Dickey-Fuller tests revealed that all the series are non-stationary in nature. Presence of long-run equilibrium relationship has been established between economic activity and petroleum consumption in Bangladesh, Bhutan, China, and Pakistan. Unidirectional long-term causality running from economic growth to petroleum consumption has been found to be existent for Bangladesh, Bhutan, and China while long-run bi-directional causality has been found for Pakistan. For countries like Maldives and Nepal, though series are found to be non-cointegrated, there subsists bidirectional short-run causality between economic growth and petroleum consumption. For Burma, no causality is found in either direction. The study also points out the implications of the results and suggests some policy prescriptions based on empirical findings, which are country specific.

Gbadebo, & Okonkwo, (2009) investigated the relationship between energy consumption and the Nigerian economy from the period of 1970 to 2005. The energy sources used to test for this relationship were crude oil, electricity and coal. By applying the co-integration technique, the results derived infer that there exists a positive relationship between current period energy consumption and economic growth. With the exception of coal which was positive, a negative relationship was noted for lagged values of energy consumption and economic growth.

Orhewere and Machame (2011) carried out a study aiming at determining the relationship between energy consumption and economic growth over a period of 1970 to 2005. The method of analysis was unit root test, co-integration statistics, and vector error correction based Granger causality test. Although no causality was found in either direction between oil consumption and GDP in the short-run, a unidirectional causality from oil consumption to GDP is found in the long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

Abbas and Choudhury (2013) concur when looking at electricity consumption in India and agricultural GDP over the period 1972-2008. Some authors find evidence of a unidirectional relationship relating to the growth hypothesis, which suggests that energy consumption drives economic growth in the long run (Pao and Tsai, 2010) and in the short run (Yang and Zhao, 2014; Nain *et al.*, 2015).

Akhmat and Zaman (2013) suggest a unilateral link for electricity and gas consumption in India in the long run. Wolde-Rufael (2010) shows the same linkage for nuclear energy in the long run. Other studies on India show evidence of the conservative hypothesis, or a unidirectional link flowing from economic growth to energy consumption, for different sources of energy: electricity consumption (Ghosh, 2002 (in the short run); Abbas and Choudhury, 2013 (in the short run and the long run)); nuclear energy in the long run (Akhmat and Zaman, 2013); and coal consumption in India in the short run (Govindaraju and Tang, 2013). Similarly, Shahbaz and others (2016) examine the relationship between globalization and energy consumption in India and have found acceleration of globalization results in a decline in energy consumption, but economic growth increases energy demand in the long run.

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Musavir (2019) examined empirically the relationship between the petroleum consumption which is a non-renewable and fast-depleting natural resource and economic growth for India for the period 1980–2014. The results obtained thereof act as the tools for the proper resource management and the environmental planning for sustainability. The study found that economic growth and petroleum consumption are cointegrated and hence there is a long-run relationship between the petroleum consumption and economic growth; contrariwise speaking, petroleum consumption has a significant impact on the economic growth of India in the long run. Therefore, the reduction of petroleum consumption if carried out will have the serious consequences on economic growth of India in the long run. The Granger causality test confirmed that there is unidirectional causality running from petroleum consumption to economic growth in the short run but not vice versa. Hereafter, the study found that to achieve the dual goal of economic growth and environmental sustainability, the policymakers should focus on conserving the non-renewable petroleum resources. But at the same time, the investment in the renewable energy sector ought to be pursued so as to maintain the same level of energy consumption as well as achieve the sustainable development.

Seema *et al*. (2019) discovered that over the period 1985-2013, the wealthier states of India experienced a pervasiveness of the feedback hypothesis between real gross domestic product growth and petroleum consumption in the short run and the long run. Over the short period, the whole 23 Indian state panels showed support for the conservative hypothesis. Concerning the panels containing low- and middle-income Indian states, although there seemed to be significant bidirectional effects in the long run, none of the results suggest that energy consumption increases economic growth. This implied that growth in energy demand can be controlled without causing detriment on economic growth. The results, nonetheless, indicated that for the low- and middle-income states, increases in petroleum consumption could adversely affect economic activity in the short and long run. These findings relate to the aggregate data on petroleum. Scrutinizing the short-run and long-run energy-growth linkages using disaggregated data on petroleum consumption revealed that only a few types of petroleum products have stable long-run relationships with economic growth. , Actually, disaggregated petroleum data, the vector error correction model (VECM) and cointegration results supported the neutral hypothesis for high-incomes states. For the low- and middle-income groups, while the conservation effect is found to prevail in the short run and the long run, increased economic growth appears to reduce consumption of petroleum products.

Akinlo (2021) mentioned that Nigeria is a major oil-producing country but with a low electricity supply; therefore, the country depends largely on refined petroleum to power economic activities. The study used a multi-methodological approach, which included nonlinear autoregressive distributed lag model, vector error correction modelling, and Hatemi-J causality tests to examine both asymmetric effect and causal relations between petroleum consumption and economic growth in Nigeria over the period 1980–2016. The results provided evidence in support of cointegration and nonlinearity between petroleum consumption and economic growth. Asides, the results showed that causality runs only from economic growth to petroleum consumption is provided. The finding supports the conservation hypothesis, meaning that petroleum conservation measures may not necessarily harm economic growth. Alternatively, the impact of an increase in petroleum consumption on economic growth may be enhanced by the 'booster-effect' of petroleum conservation policies. In general, issues of non-linearity and asymmetry need to be taken into consideration in the examination of the nexus between petroleum consumption and economic growth.

2.4.4 Gas Consumption and Economic growth

The study by Mushtaq (2008) found a unidirectional causality for GDP and oil consumption, electricity and GDP and a neutral impact for gas and GDP. Therefore, energy growth and GDP are highly correlated in a way that increase in GDP is invariably accompanied by increases in energy consumption, and some facts shows that energy consumption raises more rapidly in countries with most rapid economic growth, a study by Dunkerley (1982) evidently supports this.

Orhewere and Machame (2011) carried out a study aiming at determining the relationship between energy consumption and economic growth over a period of 1970 to 2005. The method of analysis was unit root test, co-integration statistics, and vector error correction based Granger causality test. Unidirectional causality form Gas consumption to GDP in the short-run and bidirectional causality between the variable in the long-run. Our findings imply that a policy to reduce energy consumption aimed at reducing emission will have negative impact on the GDP in Nigeria.

Lim & Yoo (2011) investigated the short- and long-run causality issues between natural gas consumption and economic growth in Korea by applying time-series techniques. It employed quarterly data covering the period 1991–2008. Tests for unit roots, co-integration, and Granger-causality based on the multivariate vector error-correction models are presented. The results indicated that there is bidirectional causality between natural gas consumption and economic growth in Korea. This interprets that an increase in natural gas consumption directly affects economic growth and that economic growth also stimulates further natural gas consumption.

Adegbemi *et al.,* (2013) investigated the causal relationship between energy consumption and Nigeria's economic growth for the period of 1975 to 2010. Secondary time-series data were analyzed using co-integration and ordinary least square techniques. The result shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. However, gas consumption although positive, does not significantly affect on economic growth.

Destek (2016) examined the relationship between natural gas energy consumption and economic growth in 26 Organisation for Economic Co-operation and Development (OECD) countries within a multivariate production model from 1991 to 2013. The study divulged that natural gas consumption, GDP growth, gross fixed capital formation, and trade openness are cointegrated with endogenous structural breaks. In accordance with the panel fully modified ordinary least square and the panel dynamic ordinary least square, natural gas consumption in OECD countries positively affects GDP growth in the long-run. Additionally, the VECM Granger causality test unraveled unidirectional causality from natural gas consumption to GDP growth, which supported the growth hypothesis for the short-run. The study concluded that there is bidirectional causality between natural gas consumption and economic growth which affirms the feedback hypothesis in the long-run.

Farhani (2019) investigate the relationship between natural gas consumption and economic growth of France. To analyze the relationship, an extended Cobb–Douglas production function is used. The auto-regressive distributive lag bounds testing approach is applied to test the existence of the long-run relationship between the series. The vector error correction model Granger causality approach is implemented to detect the direction of causal relation between the variables. The results indicated that variables are cointegrated for the long-run relationship. They also showed that natural gas consumption, exports, capital and labor are the causative factors to economic growth in France. The causality analysis pointed out that feedback hypothesis is validated between gas consumption and economic growth. The bidirectional causality is as well found between exports and economic growth, gas consumption and exports and capital and gas consumption. The feedback hypothesis between gas consumption and economic growth implied that adoption of energy conservation policies should be discouraged; somewhat, gas consumption and economic growth policies should be conjointly implemented.

Ummalla & Samal (2019) examined that for the last three decades, both China and India are considered as the largest emerging market economies in the world. Both of these economies play an essential role in the global economy in terms of economic output and CO_2 emissions. Hence, these countries are expected to play an important role in setting up environmental and sustainable development policies. Therefore, the study aimed to investigate the role of natural gas and renewable energy consumptions on CO_2 emissions and economic growth throughout 1965-2016 within a multivariate framework. The autoregressive distributed lag bounds testing approach to cointegration and vector error correction model (VECM) is adopted to explore the long-run and causal nexus among the natural gas consumption, renewable energy consumption, coal and petroleum consumption, CO_2 emissions, and economic growth, respectively. The empirical results showed existence of long-run equilibrium association among the variables. The Granger causality results indicated that the short-run bidirectional causality between renewable energy consumption and economic growth in India, while no causality is found between these two variables in China. However, natural gas consumption causes economic growth in China whereas no causality is confirmed in India in the short-run. Further, the findings recommend that there is long-run bidirectional causality among the considered variables in both countries.

Fadiran *et al* (2019) stated that the relationship between natural gas consumption and economic growth is examined. Twelve countries in Europe are considered, 10 of which make up the highest natural gas vehicle (NGV) markets in Europe. The study considered four key variables in this exercise; gross fixed capital formation, labor force, trade openness, and real GDP. This study made use of panel cointegration analysis and long-run vector error correction model analysis in scrutinizing both the short-run and the long-run relationship dynamics between natural gas consumption and economic growth. The results indicated that a long-run impact of natural gas consumption on economic growth does indeed exist. However, this does not seem to be the case in the short run. The results suggested the existence of the growth hypothesis in Austria, Bulgaria and Switzerland, while the United Kingdom (UK) and

Italy support the conservation hypothesis.

Seyi & Ada (2018) examined the role of natural gas consumption in Iran's domestic output from 1980 to 2013 in a multivariate model which integrates real gross fixed capital formation as additional variable. The drive of our study is to investigate whether natural gas consumption and gross fixed capital formation affect domestic output and its implication on the Iran economy. With the autoregressive distributed lag (ARDL) technique for cointegration, we found that natural gas consumption in the short and long-run have no significant impact on output. However, real gross fixed capital formation showed positive and statistically significant impact both in the short and long-run on economic growth. According to Toda and Yamamoto methodology to test for causality, we find a unidirectional causality running from real gross domestic product (GDP) to natural gas consumption, despite the fact that natural gas consumption to real GDP and from natural gas consumption to real gross fixed capital formation all without a feedback in the long-run. As of the empirical results, we inferred that natural gas consumption lacks a role in domestic output as it doesn't stimulate economic growth yet real gross fixed capital formation does.

Sanches (2020) motivated by the effects of the use of non-renewable energies such as natural gas, the study aimed to analyse the effect of natural gas consumption on economic growth. Panel data techniques are used covering 16 countries, these being the largest consumers of natural gas, according to mundi index, with annual frequency and a time horizon from 1995 to 2017. The Autoregressive Distributed Lag (ARDL) model has confirmed to be the most suitable for capturing the dynamic correlation in short- and long-term effects. The results showed a positive relationship between natural gas consumption and economic growth both in the short and long term application.

Hafiz et al. (2021) mentioned that natural gas is a vital energy resource that is utilized to produce the national output of Pakistan. Alternatively, natural gas is a relatively cleaner energy resource compared to oil and coal, improving the level of natural gas consumption can be expected to stimulate economic growth while slightly improving environmental quality in the process. Henceforth, it is pertinent to assess the economic growth effects associated with the consumption of such comparatively cleaner energy resources. The main objective of this study is to explore the asymmetric effects of natural gas consumption, controlling for financial development, on Pakistan's economic growth figure over the 1965–2019 period. The results from the Augmented Dickey–Fuller, Phillips–Perron, and Zivot–Andrews unit root tests confirm a mixed order of integration among the variables. Besides, the bounds test and the Gregory–Hansen co-integration analysis reveal evidence of long-run associations between economic growth, natural gas consumption, and financial development in the context of Pakistan. Moreover, the outcomes from the nonlinear autoregressive distributed lag model analysis show that in the short-run, positive changes in the natural gas consumption levels increase Pakistan's economic growth. Alternatively positive and negative changes in natural gas consumption levels increase and decrease the nation's economic growth level in the long-run, respectively. Both positive and negative changes in the financial development level are found to reduce Pakistan's economic growth level in the long run only. Moreover, the Hacker–Hatemi-J causality analysis validates that natural gas consumption causally influences the economic growth level in Pakistan. Therefore, verifying the energy consumption-led growth phenomenon. Several policy level suggestions are put forward for Pakistan to enhance its natural gas consumption level in order to increase its economic growth rate in the future.

For Kenya there is need for more energy supply augmentations in order to cope with long-run energy demand. In the short-run however, Kenya should explore more efficient and cost effective sources of energy in order to address the energy dependency problem.

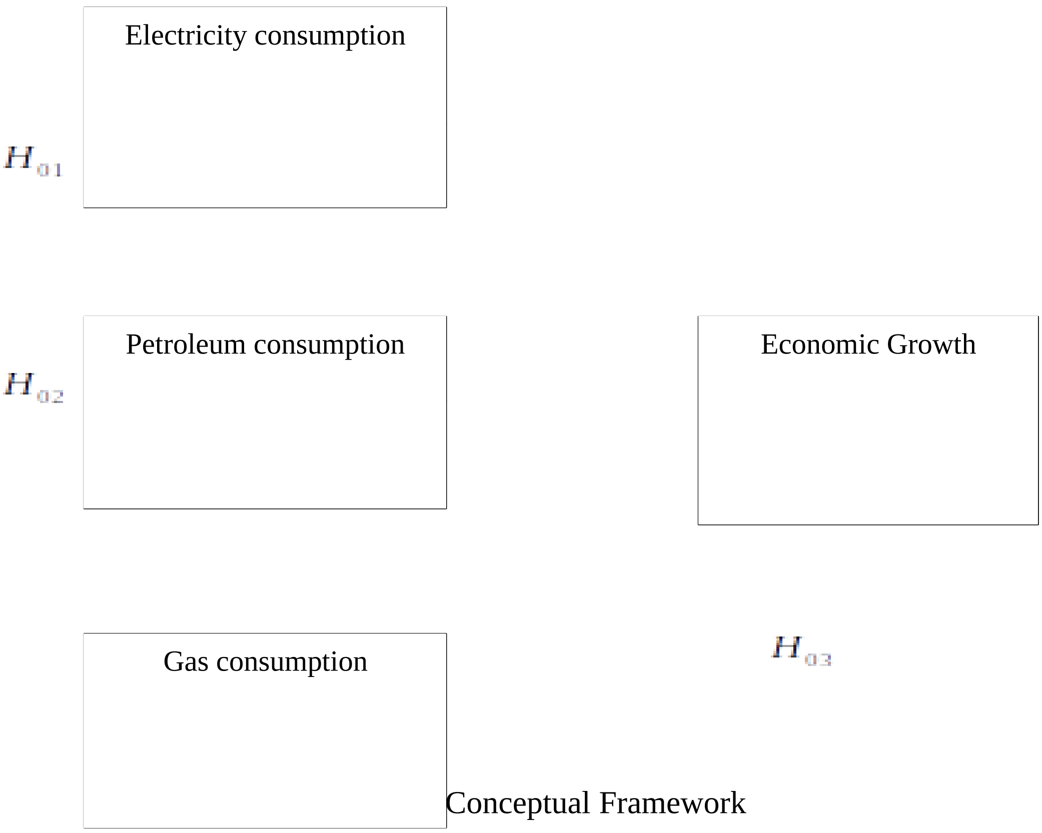
2.5 Literature and Gaps

The previous studies have several gaps that need to be filled. In the literature on energy consumption economic growth nexus by Apergis and Payne (2009), the studies have been done in the developed countries and therefore the results may not portray the situation in the developed countries. Similar studies should be done in developing countries. Most of the studies dealing with the energy consumption and growth nexus focus on production side models, which often include capital stock and labor in addition to energy consumption and economic growth. Studies that focus on consumption side should also be done.

Most of the studies also focus on causality between energy consumption and economic growth they do not show the energy consumption trends and the influence of energy consumption on economic growth. Future studies should focus on these areas in order to fill the gap that exists in the study of the influences of energy consumption on economic growth.

2.6 Conceptual Framework

A conceptual framework is a pictorial relationship between the dependent and independent variables. It presents the relationship between the dependent and independent variables of the study in a pictorial form. The independent variables of this study were electricity consumption, petroleum consumption and gas consumption while the dependent variable was economic growth. The conceptual framework is clearly presented in the figure 2.1 below (Locke et al; 2007):



Conceptual Framework

Source: Author (2022)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the methodology that was adopted in the study. The following sections were explored; Area of study, research design, model specification, target population, data sources and collection, data analysis technique, estimation of parameters and ethical consideration of the study.

3.2 Area of Study

This study focused on the energy sector in Kenya. Kenya is a country in the eastern part of Africa. Her neighbors include Ethiopia, Tanzania, Uganda, Somalia and Southern Sudan. Kenya lies at latitude 0.4252^0S and longitude 36.7517^0E.

3.3 Research Design

A research design is the ‘procedures for collecting, analyzing, interpreting and reporting data in research studies’ (Creswell and Plano, 2007). The research design sets the procedure on the required data, the methods to be applied to collect and analyze this data, and how all of this is going to answer the research question (Grey, 2014). This study adopted an explanatory research design. Explanatory study sets out to explain and account for the descriptive information. So, while descriptive studies may ask ‘what’ kinds of questions, explanatory studies seek to ask ‘why’ and ‘how’ questions (Grey, 2014). Explanatory research looks for causes and reasons and provides evidence to support or refute an explanation or prediction. It is conducted to discover and report some relationships among different aspects of the phenomenon under study. This design perpetuates the understanding and interpretation of relationships among the study variables i.e. how energy consumption affects economic growth in Kenya.

3.4 Model specification

This study used the Generalized Method of Moments in analyzing the data. The GMM method produces unbiased, consistent, and efficient estimations. Theoretically stated that the Generalized Method of Moment (GMM) cannot be used when the number of instrumental variables is greater than the number of parameters analyzed. GMM was first formalized by Hansen (1982).

In a method of moments, a population moment condition is that a vector of observed variables, v_t , and unknown parameter vector θ with true value θ_0 which satisfy a $kx\,1$ element vector of conditions:

$$E\left[f\left(v_t,\theta\right)\right]=0 \text{ for all } t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

The method of moment estimator $\hat{\theta}_T$ is used to solve the analogous sample moment conditions given as:

$$g_T\left(\hat{\theta}_T\right)=T^{-1}\sum f\left(v_t,\hat{\theta}_T\right)=0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2$$

Where T is the size of the sample.

Consequently, under the usual regularity conditions, $\hat{\theta}_T \to \theta_0$, where θ_0 is the solution for equation 3.2, in which there are k unknowns and k equations leading to unique solution. Suppose that f is a $qx\,1$ vector and $q>k$ meaning there are k unknowns and q equations implying that there is no unique solution.

GMM picks a value for θ such that it approaches closest to satisfy equation 3.2. The closeness can be defined by the following criterion function:

$$Q_T(\theta) = \left[T^{-1}\sum f(v_t,\theta)\right]' W_T \left[T^{-1}\sum f(v_t,\theta)\right] = g_T(\theta)' W_T g_T(\theta)$$ 3.3

Where W_T is the weighting matrix, converges to a positive definite matrix W as T grows large.

The GMM estimator depends on the weight matrix $Q_{GMM}(W_T)$ which becomes the GMM estimator of θ_0 (true value) given as $\hat{\theta}$ can be obtained by finding argument of the minimum (argmin) of equation 3.3 as follows:

$$Q_{GMM}(W_T) = \hat{\theta} = \text{argmin}\, Q_T(\theta)$$ 3.4

In applying the GMM approach, there are pertinent advantages including the requirement is a moment condition in which there is no need to log-linearize any variable. Further, while non-linearities is not a problem when utilizing GMM approach, GMM is robust to heteroskedasticity and distributional assumptions.

The Generalized Method of Moments (GMM) of estimation of DSGE model was employed in analysis of influence of energy consumption on economic growth in Kenya.

A strength of GMM estimation is that the econometrician can remain completely agnostic as to the distribution of the random variables in the DGP. For identification, the econometrician simply needs at least as many moment conditions from the data as he has parameters to estimate. A moment of the data is broadly defined as any statistic that summarizes the data to some degree. A data moment could be as narrow as an individual observation from the data or as broad as the sample average. GMM estimates the parameters of a model or data generating process to make the model moments as close as possible to the corresponding data moments. Davidson and MacKinnon (2004) indicated the detailed treatment of GMM. The estimation methods of linear least squares, nonlinear least squares, generalized least squares, and instrumental variables estimation are all specific cases of the more general GMM estimation method.

In applying the GMM approach, there are pertinent advantages including the requirement is a moment condition in which there is no need to log-linearize any variable. Further, while non-linearities is not a problem when utilizing GMM approach, GMM is robust to heteroskedasticity and distributional assumptions. According to INDRA (2009), there are several advantages to using GMM. First, the method is a common estimator, which provides a useful framework for comparison and assessment. Second, it allows researchers to perform the estimation in more detail in the long-term as well as the short-term, and to overcome violations of assumptions in regression analysis. This method was used because it is potentially more powerful than the existing methods because it contains no errors in the variables. The method also provides a natural way to construct tests which take account of both sampling and estimation error. Also the Generalized Method of Moments will be used because its estimators can be computed without specifying the full data generating process. Generalized Method of Moments estimator was used in this study because they have large sample properties which are easy to characterize so as to facilitate comparison. A family of such estimators can be studied a priori in ways that make asymptotic efficiency comparisons easy. The Generalized Method of Moments (GMM) of estimation of DSGE model was employed in analysis of influence of energy consumption on economic growth in Kenya.

3.5 Target Population

This study was carried out in Kenya. Kenya has an estimated population of 40 million according to the Kenya 2009 census report. A majority of the population are either in the middle class income or low income bracket who are the main consumers of energy products. Kenya's main economic activity is agriculture followed by industrialization.

3.6 Data Source and Collection

The research used data that employed yearly data from 2008-2020.The annual data for petroleum consumption, electricity consumption, gas consumption and real GDP were retrieved from the secondary data on energy which was obtained from the World Bank database and KNBS.

3.7 Data Analysis Technique

Data analyses were done at descriptive and inferential level. At descriptive level, analysis involved computing descriptive statistics that included means, medians, maximum and minimum values, standard deviations, skewness, and kurtosis. At inferential level, there was the model formulation and estimation. Below are diagnostic tests and estimation of parameters of the study. Diagnostic checks relating to the properties of data to be used in the study modeling need to be implemented in empirical research. In econometric modeling, it is essential to diagnose the following tests for GMM model.

3.7.1 Normality Test

Normality of data was assessed using the skewness, kurtosis, histogram normality curve and a scatter graph for the data on the dependent and independent variables. If the scatter plot graph is linear and the histogram is normal, the data is suitable for correlation and regression analysis (Ernst & Albers, 2017). As a result, a Kolmogorov-Smirnov test was used to ensure that the residuals are normally distributed. Skewness is a measure of symmetry, or more precisely, the lack of symmetry. A distribution, or data set, is symmetric if it looks the same to the left and right of the centre point; it could be positive or negative. Kurtosis is a parameter that describes the shape of a random variable's probability distribution; it could be high or low kurtosis. The purpose of testing normality was to define if the distribution of the score on the variables is normal, if not the subsequent results could be unreliable. A distribution is normal if the values of both Skewness and Kurtosis are not far away from zero (Jayaram & Baker, 2008). Testing linearity and normality of the data confirmed whether the data is fit for inferential analyses, namely correlation and regression.

In addition, the Jarque-Bera test was used to determine normality in the study. Furthermore, skewness and kurtosis was used for the omnibus test, as proposed by Jarque and Bera (1987). Many authors have discussed improved Jarque-Bera tests. The Jarque-Bera statistic has two degrees of freedom and follows the chi-squares distribution. The expected value of the statistic under the null hypothesis of normality is two.

The study therefore tested the hypothesis;

H_0: Distribution is normal.

H_1: Distribution is not normal.

Decision criteria; If the P-values are less than the level of significance, reject the H_0. If a test does not reject normality, this suggests that a parametric procedure that assumes normality (e.g. a t-test) can be safely used. In addition to the formal tests for normality, data is also graphically examined.

3.7.2 Suitability of instruments

The most straightforward way to check if excluded instruments are correlated with the included endogenous regressors is to examine the fit of the first stage regression. The most commonly used statistic in this regard is the partial *R*2 of the first stage regression. Alternatively, one can use an F-test of joint significance of the instruments in the first stage regression. The problem is that the latter two measures are able to diagnose the instrument relevance only in the case of a single endogenous regressor.

One measure that can overcome this problem is so-called Shea partial *R*2 statistic. Baum, Schaffer and Stillman (2003) suggested that a large value of the standard partial *R*2 and a small value of Shea's partial *R*2 statistic can indicate that our instruments lack relevance.

Another rule of thumb used in research practice is that F-statistic below 10 can be a reason for concern. As excluded instruments with little explanatory power can lead to biased estimates, one needs to be parsimonious in the choice of instruments. Therefore, the study employed only instruments which have been proposed in the related literature and meet the above conditions.

3.7.3 Multicollinearity Test

Variance Inflation Factor (VIF) was used to test for multicollinearity. The VIF are calculated as:

$$VIF = \frac{1}{(1-R^2)} \quad \text{..3.1}$$

Tolerance $= \frac{1}{VIF}$ ……………………………………………..3.2

Where VIF= variance inflation factor, R^2= coefficient of determination.

When the independent variables have VIF values less than 10 (Nachtscheim, 2004), means that there is no multicollinearity.

3.7.4 Over-Identification Test

In practice, it is prudent to begin by testing the over-identifying restrictions, as the rejection may properly call model specification and orthogonality conditions into question. Such a test can be conducted if and only if we have surfeit of instruments – if we have more excluded instruments than included endogenous variables. This allows for the decomposition of the population moment conditions into the identifying and the over-identifying restrictions. The former represent the part of the population moment conditions which actually goes into parameter estimation and the latter are just the remainder. Therefore, the identifying restrictions need to be satisfied in order to estimate parameter vector and so it is not possible to test whether restrictions are satisfied at the true parameter vector. On the other hand, over-identifying restrictions are not imposed and so it is possible to test if this restrictions hold in the population. In the context of GMM, the over-identifying restrictions may be tested via the commonly employed J statistic of Hansen (1982). This statistic is none other than the value of the GMM objective function $Q_T(\theta) = f_T(\theta)' W_T F_T(\theta)$ evaluated at the efficient GMM estimator:

$$J_T = T\, Q_T(\hat{\theta}_T) \quad \text{………………….3.5}$$

and it converges to a X^2_{q-p} distribution under the null hypothesis (with the number of over-identifying restriction, q-p, as the degrees of freedom). A rejection of the null hypothesis implies that the instruments are not satisfying the orthogonality conditions required for their employment. This may be either because they are not truly exogenous, or because they are being incorrectly excluded from the regression. The test can also be interpreted if the conditions of orthogonality are satisfied, this implies that policy makers will adjust the levels of electricity, petroleum and gas consumption in line with the reaction function proposed with the expectations on the right hand side based on all the relevant information available to policy makers at that time. This implies parameter vector values that would mean the implied residual is orthogonal to the variables in the information set Ω_t.

3.8 Correlation Analysis

The correlation coefficient can inform whether influence of energy consumption on economic growth in Kenya are correlated or not; the more symmetric as indicated by positive correlations, the more feasible it becomes (Kandil and Trabelsi, 2010). Cross-sectional correlations between the variables enable determination on whether their combined influenced on economic growth would result in a significant relationship the variables.

The greater the absolute value of the correlation coefficient, the stronger the relationship. The extreme values of -1 and 1 indicate a perfectly linear relationship where a change in one variable is accompanied by a perfectly consistent change in the other. For these relationships, all of the data points fall on a line.

Positive coefficients indicate that when the value of one variable increases, the value of the other variable also tends to increase. Positive relationships produce an upward slope on a scatterplot. Negative coefficients represent cases when the value of one variable increases, the value of the other variable tends to decrease. Negative relationships produce a downward slope.

3.9 Estimation of Parameters

The following equation was investigated:

$$InRGDP_{ijt} = \beta_0 + \beta_1 InPetr_{it} + \beta_2 InElect_{it} + \beta_3 InGas_{it} + \mu_{it} \quad \ldots\ldots\ldots\ldots 3.6$$

Where ;

β_0 –Constant term

β_1 – Coefficient of Petroleum Consumption

β_2 –Coefficient of Electricity Consumption

β_3 – Coefficient of Gas Consumption

Management of quantitative data will involve processing of the data through coding, entering the data into the computer using the STATA 14.

3.10 Expected Output

The results of this study after analysis provides recommendations and policy implications to the various sectors which would enable policy makers to implement appropriate policies towards energy consumption in Kenya hence ensuring that economic growth is improved for the benefit of the living standards of the citizens of Kenya.

3.11 Ethical Considerations

In carrying out this study, formal approval was carried out for mutual interest between the researcher and the participants. Consequently, the following approval was obtained prior to commencement of the study: written authority letter from Moi University, School of Business and Economics through Economic Department and research permit from National Commission for Science, Technology and Innovation-Kenya (NACOSTI). Prior to NACOSTI application, authority letter from Moi University was first sought.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

This chapter presents diagnostic tests performed, descriptive statistics, model selection and analysis of inferential statistics. Further discussion of the results is done and hypothesis testing results is presented.

4.2 Descriptive Statistics

Descriptive statistics for the GMM model are reported in Table 4.1 and include mean, standard deviation and value ranges from a sample of 13 years. The characteristics of the variables which were examined were; petroleum consumption, electricity consumption and gas consumption in relation to economic growth rate.

Table 4. 1: Summary of Descriptive Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
GDP Rate	13	4.1075	2.17783	-0.316	8.085
PC‘000’Tonnes	13	4127.28	673.054	3048.7	4891.3
EC Gwh	13	5076.35	1668.61	2431.7	8041.9
GC ‘000’Tonnes	13	155.755	85.3319	74.6	326.2

Source: Author (2022)

4.2.1 Electricity Consumption

The results in table 4.1 showed that the mean value of electricity consumption is 5076.354 with a maximum of 8041.9 and a minimum of 2431.7. The standard deviation of electricity consumption is 1668.61.

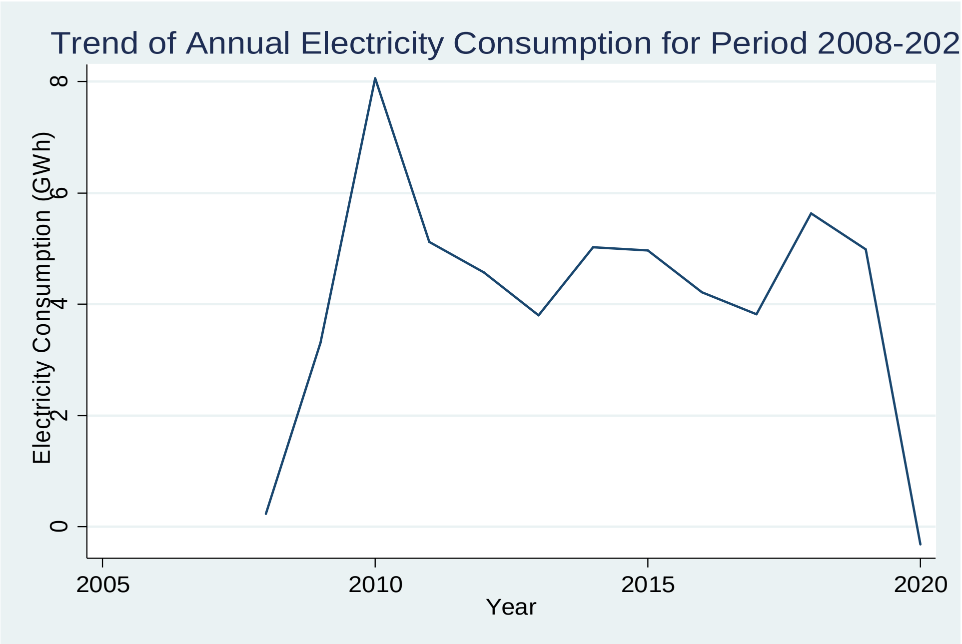


Figure 4. 1: Trend of Annual Electricity consumption for period 2008-2020

Source: Author (2022)

In figure 4.1, electricity consumption over the years have witnessed significant improvement. The percentage of electricity consumption as at 2008 was -0.84 but steadily increased to 9.02 as at 2011. Through the years 2011-2019 there has been fluctuations on electricity consumption. A substantial percentage decline was seen in the year 2020 on electricity consumption to -0.65.

4.2.2 Petroleum Consumption

The results in table 4.1 showed that the mean value of petroleum consumption is 4127.277 with a maximum of 4891.3 and a minimum of 3048.7. The standard deviation of petroleum consumption is 673.0548.

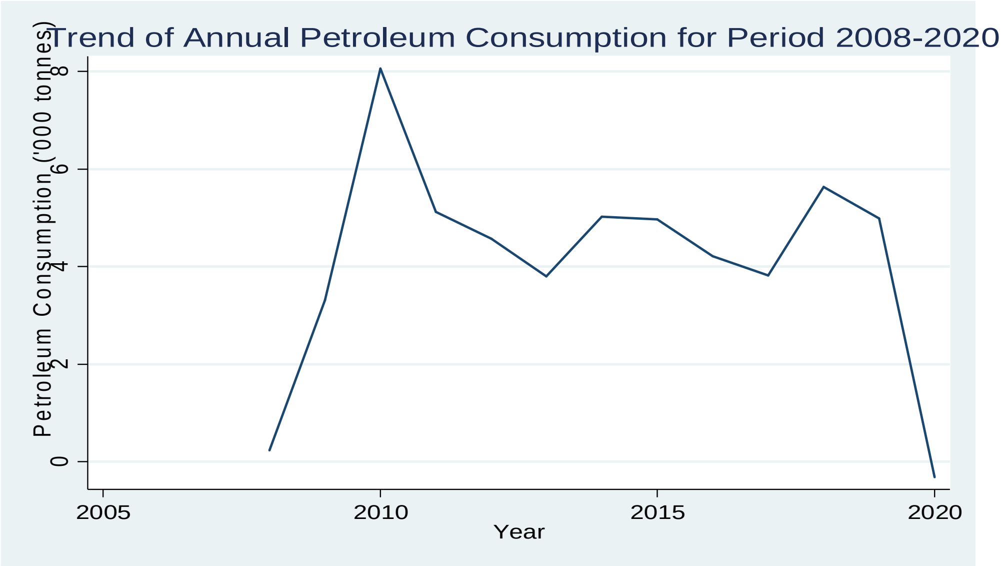


Figure 4. 2: Trend of Annual petroleum consumption for period 2008-2020

Source: Author (2022)

In figure 4.2, Petroleum consumption over the years have witnessed oscillation .The percentage of petroleum consumption as at 2008 was 0.36 but increased by 15.25 percent as at 2009. Through the years 2010-2013 there has been decrease on petroleum consumption,-5.70 percent as at 2012. A substantial percentage increase in 2015 at 20.33 percent and thereafter decline in petroleum consumption to -10.15 percent.

4.2.3 Gas Consumption

The results in table 4.1 showed that the mean value of gas consumption is 155.7538 with a maximum of 326.2 and a minimum of 74.6. The standard deviation of gas consumption is 85.33194.

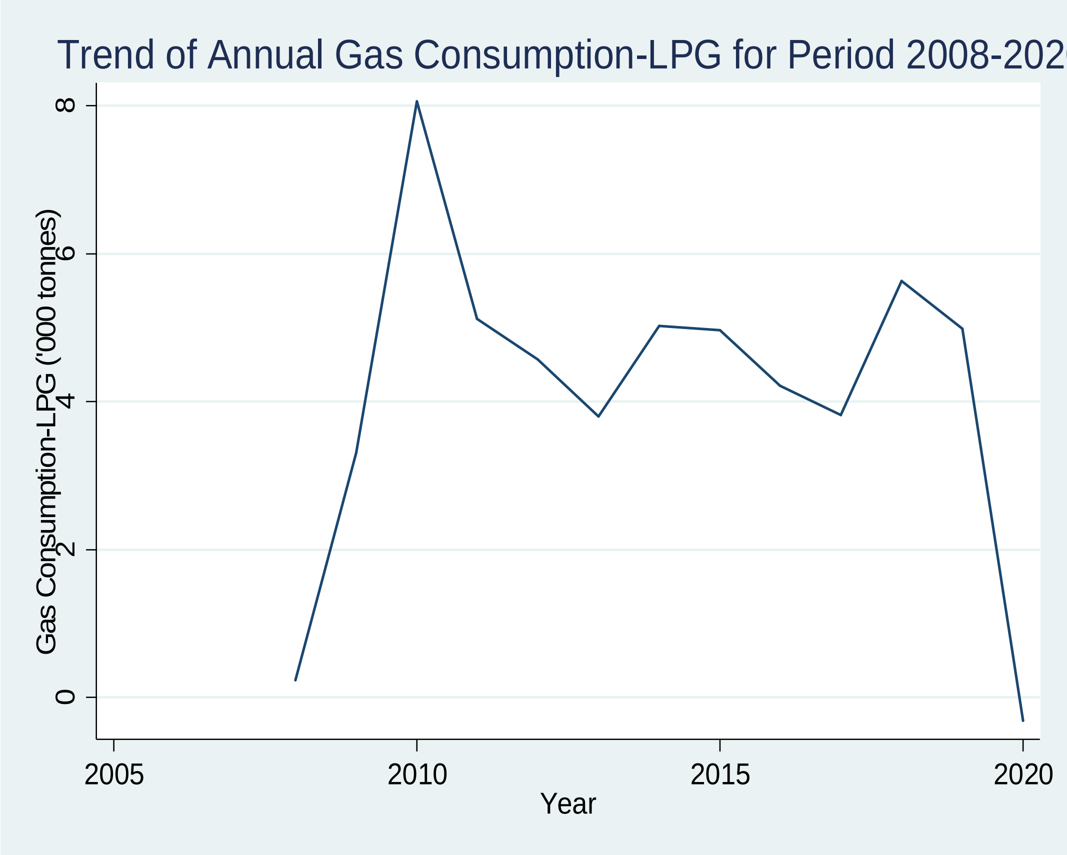


Figure 4. 3: Trend of Annual gas consumption for period 2008-2020

Source: Author (2022)

In figure 4.3, it is evident that there has been increase in gas consumption since 2008.Through the years 2010-2019 there has been fluctuations on gas consumption. A substantial drop was seen in the year 2020 on gas consumption from 2019 at 40.40 percent to 4.52 percent.

4.2.4 GDP Rate

The results in table 4.1 showed that the mean value of GDP is 4.1075 with a maximum of 8.085 and a minimum of -0.316. The standard deviation of gas consumption is 2.177831.

Figure 4. 4: Trend of Annual GDP for period 2008-2020

Source: Author (2022)

In figure 4.4, it is evident through the years 2010-2019 there has been fluctuations on GDP rate. In 2010, the GDP rate steadily rose to 8.058. Meanwhile, substantial drop of GDP rate was depicted in the year 2020 on GDP rate to -0.316.

Graphical trend of annual GDP growth rate and petroleum consumption is depicted in figure 4.5.

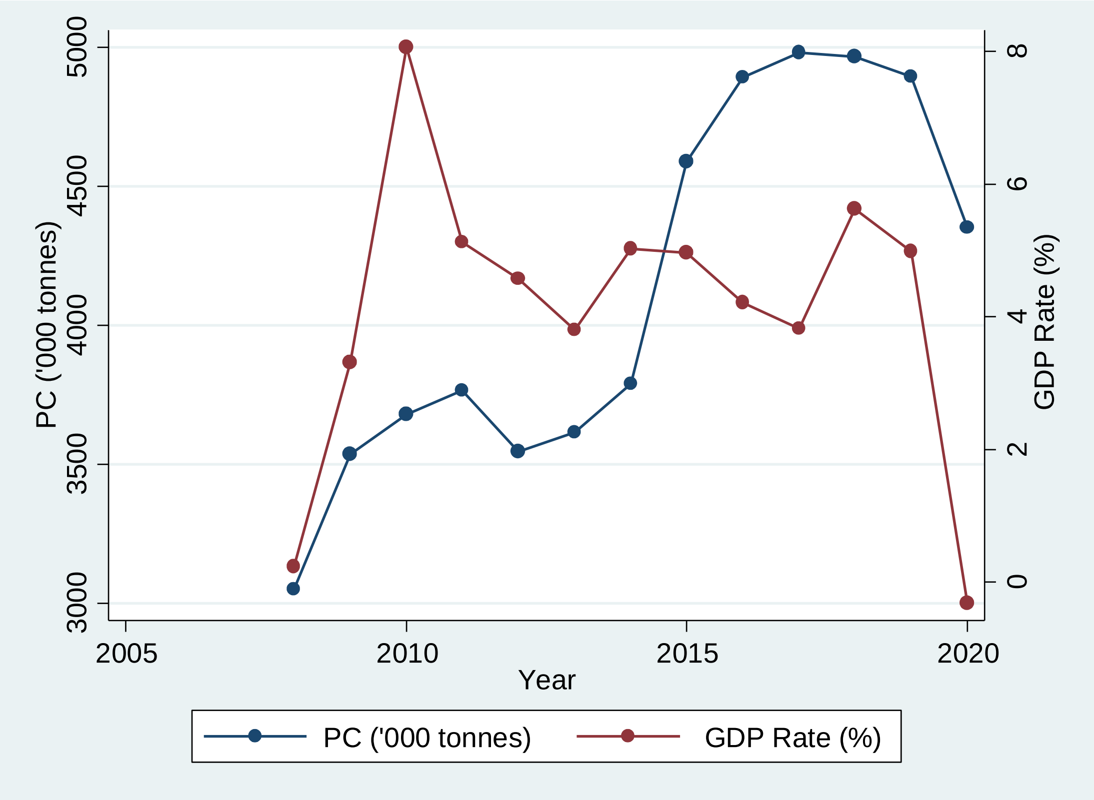


Figure 4. 5: Trend of Annual Petroleum consumption and GDP for period 2008-2020

Source: Author (2022)

In figure 4.5, increase in petroleum consumption led to an increase in GDP growth rate and vice versa. From 2008 to 2017 there has been rise in petroleum consumption and thereafter a drop as at 2020 which is equivalent to the GDP rate drop.

Graphical trend of annual GDP growth rate and electricity consumption is depicted in figure 4.6

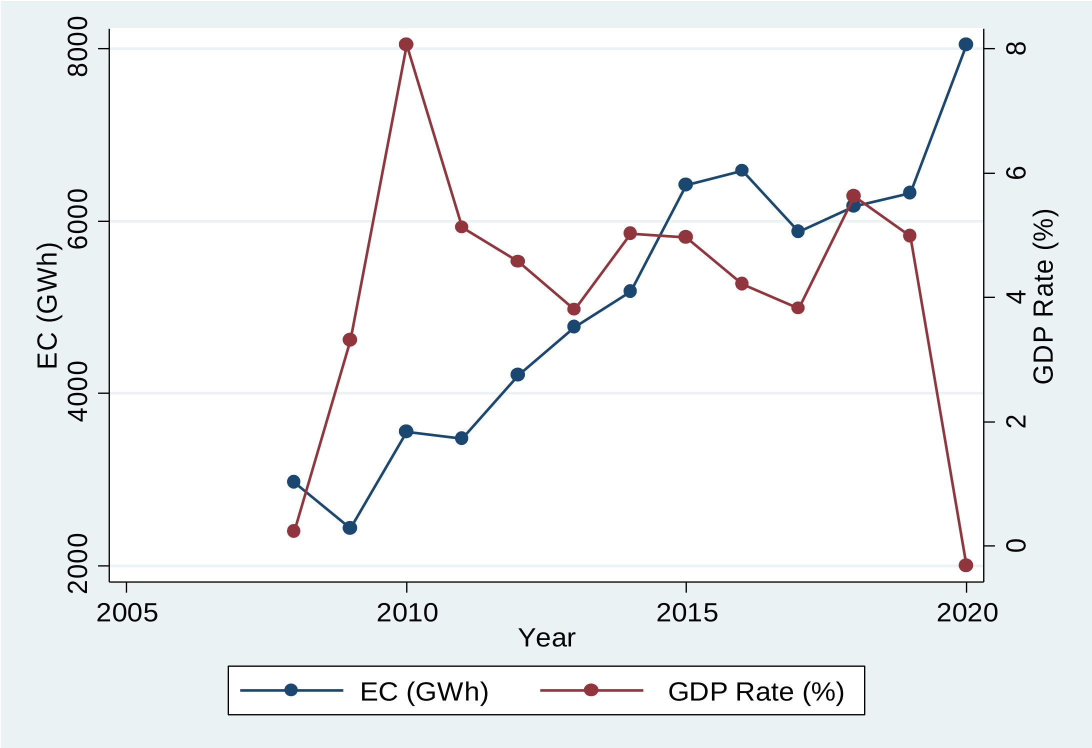


Figure 4. 6: Trend of Annual Electricity consumption and GDP for period 2008-2020

Source: Author (2022)

In figure 4.5, increase in electricity consumption led to an increase in GDP growth rate and vice versa. From 2008 to 2017 there has been rise in electricity consumption and thereafter a drop as at 2020 which is equivalent to the GDP rate drop

Graphical trend of annual GDP growth rate and petroleum consumption is depicted in figure 4.7

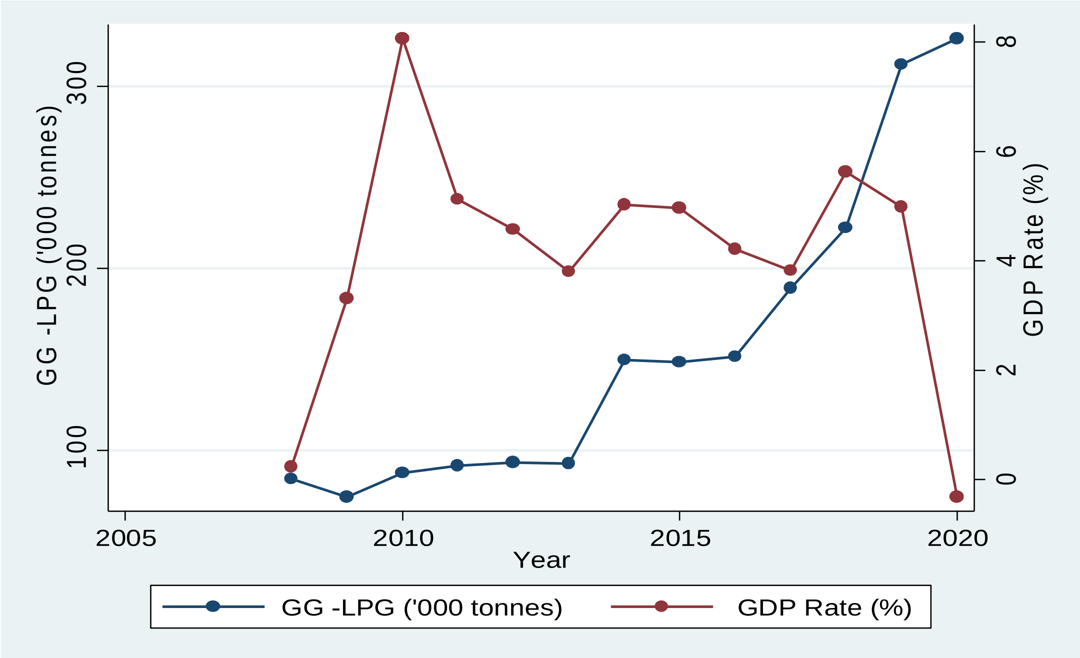


Figure 4. 7: Trend of Annual Gas consumption and GDP for period 2008-2020

Source: Author (2022)

In figure 4.7, increase in gas consumption led to an increase in GDP growth rate and vice versa. From 2008 to 2017 there has been rise in gas consumption and thereafter a drop as at 2020 which is equivalent to the GDP rate drop.

4.3 Diagnostic Tests

The diagnostic tests performed were normality test, over-identification test and multicollinearity.

4.3.1 Normality Test

For the normal distribution there should a symmetric distribution with well-behaved tails. In this study, the normality test was conducted on the regression residuals and the skewness and kurtosis were observed. The null hypothesis for the normality test was that the data was normally distributed. The findings of normality test are presented in table 4.2.

Table 4. **2: Skewness and Kurtosis Test for Normality**

Variable	Obs	Skewness	Kurtosis		Joint
		Coef.	Coef.	Z	P>Z
InGDP (Ingdp)	13	0.0030	0.0540	9.75	0.0076
InElectricity Consumption *InEC*)	13	0.3640	0.6072	1.22	0.5441
InPetroleum Consumption (*InPC*)	13	0.8835	0.1555	2.38	0.3039
InGas Consumption (*Ingas*)	13	0.3577	0.3662	1.92	0.3834

Level of significance at 5%

Source: Author (2022)

The findings indicated that the independent variables did not violate the normality assumption since all individual p-values for skewness and kurtosis for all the variables were greater than 0.05.

4.3.2 Suitability of Instruments

The results for the suitability of the instruments is presented in table 4.3.

Source	Sum of Squares	Df	Obs.=13 F(3,9)=2.81 P>F=0.1
Model	1.318	0.4395	
Residual	1.409	0.1565	
Total	2.727	0.2274	

Table 4. 3: F-Statistic Results

Level of significance at 5%

Source: Author (2022)

F=2.81 P=0.1 meaning the model could be used in the study. R-squared, R2=48.35. This indicated that the variables, that is, logpc, logec and loggas explained 48.35 percent of economic growth

4.3.3 Multicollinearity Test

Multicollinearity test results is presented in table 4.4.

Table 4. **4: VIF Results**

Variable	VIF	Tolerance
Natural Log Electricity Consumption	4.82	0.2074
Natural Log Petroleum Consumption	4.57	0.2187
Natural Log Gas Consumption	3.23	0.3097
Mean VIF	4.21	0.2375

Source: Author (2022)

The results showed that VIF for natural log of Electricity Consumption, natural log of Petroleum Consumption and natural log of Gas Consumption were 4.82, 4.57 and 3.23 respectively. This showed that the independent variables had VIF less 10 implying that there was no multicollinearity values greater than 10 as supported by (Nachtscheim, 2004).

4.3.4 Test of Over-Identification

In addition to the requirement that instrumental variables be correlated with the endogenous regressors, the instruments must also be uncorrelated with the structural error term. The null hypothesis was that there was no over-identification while the alternative hypothesis was that there was over-identification. The result for establishing whether there was over-identification test is presented in table 4.5.

Table 4. 5: Results for Establishing Over-Identification Test

Output	Coeff.	Std. Err.	Z	P>|Z|
Natural Log Electricity Consumption	-5.0664	1.7716	-2.86	0.004
Natural Log Petroleum Consumption	11.0739	4.1338	2.68	0.007
Cons	-20.8446	9.8943	-2.11	0.035
Overall				0.0470

***Level of significance at 5%**

Source: Author (2022)

The results showed that the significance value of p was 0.047 indicating that there was no over-identification in the instruments. This implied that the test of over-identification could be performed. This implied that the model was not over-identified, meaning that the number of additional instruments did not exceed the number of endogenous regressors.

4.4 Correlation Results

The results for correlation of coefficients is presented in table 4.6.

Table 4. **5: Correlations of Variables**

	InGDP	**InPetro**	**InElect**	**InGas**
InGDP Rate	1	0	0	0
InPetro	0.3230	1	0	0
InElect	0.0244	0.8088	1	0
InGas	−0.1152	0.7971	0.8694	1

Source: Author (2022)

The results in table 4.6 showed that correlation between GDP growth rate and petroleum consumption had a positive coefficient of 0.3230. This shows that positive correlation between the natural log of GDP and natural log of petroleum. For the correlation between GDP growth rate and electricity consumption, the correlation coefficient was a positive but very low value of 0.0244. This showed a weak but positive relationship between natural log of GDP growth rate and electricity consumption. The correlation between natural log of GDP growth rate and natural log of gas consumption had a negative value of 0.1152. This showed that the relationship was negative but weak.

4.5 GMM Estimation Result

This section presents the results of the examination of the effect of petroleum consumption, electricity consumption and gas consumption on GDP growth rate in Kenya using the GMM approach. The results for the GMM estimation is shown in Table 4.7.

	Coefficient	Std. Error	Z Value	P > |Z|
Constant, β_0	-22.0789	8.9434	-2.47	0.014
InElect, β_1	-0.1155	0.9934	-0.12	0.907
InPetro, β_2	7.6514	2.8261	2.71	0.007
InGas, β_3	-2.1673	0.9620	-2.25	0.024

Table 4. 6: Results of GMM Estimation

Level of significance at 5%

Source: Author (2022)

The results in table 4.7 showed that the intercept coefficient was negative 22.0789, $P = 0.014 < 0.05$, which significantly determined the GDP growth rate. The intercept is the parameter in an equation derived from a regression analysis corresponding to the expected value of the response variable when all the explanatory variables are zero (Everitt, 2002). From the above regression equation it was revealed that holding petroleum, electricity and gas consumption to a constant zero; the intercept coefficient was negative meaning the study accounted for most of the determinants of GDP growth rate, that is, petroleum consumption, electricity consumption and gas consumption.

The findings in table 4.7 indicated that the coefficient of electricity consumption ,β_1, was -0.1155, $p = 0.907 > 0.05$, which was not significant at 5% level. This depicted that electricity consumption did not influence GDP growth rate in Kenya.

The results in table 4.7 showed that the coefficient of petroleum consumption ,β_2, was 7.6514, $p = 0.007 < 0.05$, which was positive and significant at 5% level. This implied that for every increase in one percent of petroleum consumption, led to an increase in GDP growth rate of 7.6514 percent. This implied that petroleum consumption increased productivity in the country resulting in the increase of output which could boost the economic growth rate. The cost of petroleum need to be competitive to the investors so that' they can use in production leading to improvement of the economic growth in Kenya.

The results in table 4.7 showed that the coefficient of gas consumption ,β_3, was -2.1673 , $p = 0.024 < 0.05$, which was negative and significant at 5% level. This implied that for every increase in one percent of gas consumption, led to a reduction in GDP growth rate of 2.1673 percent. Considering that gas consumption reduced economic growth rate, this meant that the consumers could be utilizing gas in activities which do not increase production. This is true since most of the consumers of the gas could be subsistence which do not increase the production. The government of Kenya could be subsidizing the prices leading to low cost but the usage is subsistence. This means that this leads to reduction of the economic growth in the country.

4.6 Discussion of Results

This section provides discussion of the examination of the effect of petroleum consumption, electricity consumption and gas consumption on economic growth in Kenya.

4.6.1 Electricity Consumption and Economic Growth Rate

The findings in table 4.7 indicated that the coefficient of electricity consumption 'β_2' was -0.1155, $p=0.907>0.05$ which was not significant at 5% level. This depicted that electricity consumption did not influence GDP growth rate in Kenya.

The results are similar to that of Apergis & Payne (2011) which examined the relationship between renewable and non-renewable electricity consumption and economic growth for 16 emerging market economies within a multivariate panel framework over the period 1990–2007. The Pedroni heterogeneous panel cointegration tests indicated that there is a long-run equilibrium relationship between real GDP, renewable electricity consumption, non-renewable electricity consumption, real gross fixed capital formation, and the labor force. However, the long-run elasticity estimate for renewable electricity consumption is positive, but statistically insignificant. The results from the panel error correction model reveal unidirectional causality from economic growth to renewable electricity consumption in the short-run and bidirectional causality in the long-run. Furthermore, there is bidirectional causality between non-renewable electricity consumption and economic growth in both the short-run and long-run.

Enu and Havi (2014) carried a study aiming at examining the extent to which electricity consumption influences economic growth in Ghana The study employed Augmented Dickey Fuller test, Co-integration test, Vector Error Correction Model and Granger Causality test. The study revealed that, in the long term, a hundred percent increase in electricity power consumption will cause real gross domestic product per capita to increase by approximately fifty two percent. However, in the short run, electricity consumption negatively affects real gross domestic product per capita. The study again revealed that unidirectional causality run from electricity consumption to economic growth meaning that any policy actions taken to affect the smooth consumption of electricity in Ghana will definitely affect her gross domestic product per capita.

The findings of this study contradicted the results of Ubong and Atan (2021) who observed that electricity consumption was positive and significant as per their study in West Africa. The cointegration result, through the use of the residual test, showed that the variables were cointegrated. They estimated both the short run and long run estimates of the functions. In respect to gross domestic product per capita, it was observed that electricity consumption per capita exerted a positive and significant effect on gross domestic product per capita both in the short run and in the long run.

The error correction mechanism indicated that 6.89% of the short run errors in gross domestic product per capita is corrected annually. In terms of electricity consumption per capita, it was discovered that gross domestic product per capita have a positive and significant long run effect on electricity consumption per capita. Meanwhile, gross domestic product per capita exerted a positive but insignificant effect on electricity consumption per capita in the short run. The error correction mechanism indicated that 12.24% of the short run errors is corrected annually. The VAR results shows that both electricity consumption per capita and gross domestic product per capita have a strong endogenous impact; while electricity consumption is weakly exogenous but gross domestic product per capita is strongly exogenous. The feedback thesis on electricity consumption and economic growth was validated since the causality test revealed a bidirectional causality between the two variables.

Stern *et al.*, (2016) found that electricity use and access are strongly correlated with economic development, as theory would suggest. Despite large empirical literatures and suggestive case evidence, there are, however, few methodologically strong studies that establish causal effects on an economy-wide basis. There is some evidence that reliability of electricity supply is important for economic growth.

Kasperowicz (2014) obtained results that there is the causal relationship between electricity consumption and economic growth in Poland and the relationship is bi-directional. We also discovered the bi-directional causality between capital and economic growth.

4.6.2 Petroleum Consumption and Economic Growth Rate

The results in table 4.7 showed that the coefficient of petroleum consumption 'β_1' was

7.6514, $p = 0.007 < 0.05$, which was positive and significant at 5% level. This implied that for every increase in one percent of petroleum consumption, led to an increase in GDP growth rate of 7.6514 percent.

The results of this study was supported by Musavir (2019) who found that economic growth and petroleum consumption were cointegrated and hence there was a long-run relationship between the petroleum consumption and economic growth; conversely speaking, petroleum consumption has a significant impact on the economic growth of India in the long run. So the reduction of petroleum consumption when undertaken would have the serious repercussions on economic growth of India in the long run. The Granger causality test confirmed that there was unidirectional causality running from petroleum consumption to economic growth in the short run but not vice versa. Hence, the study found that to achieve the dual goal of economic growth and environmental sustainability, the policymakers should focus on conserving the non-renewable petroleum resources. But at the same time, the investment in the renewable energy sector ought to be pursued so as to maintain the same level of energy consumption as well as achieve the sustainable development.

Narayan *et al.*, (2019) results indicated that for the low- and middle-income states, increases in petroleum consumption could adversely affect economic activity in the short and long run. These findings relate to the aggregate data on petroleum. Examining the short-run and long-run energy-growth linkages using disaggregated data on petroleum consumption reveals that only a few types of petroleum products have stable long-run relationships with economic growth. In fact, with disaggregated petroleum data, the vector error correction model (VECM) and cointegration results support the neutral hypothesis for high-incomes states. For the low- and middle-income groups, while the conservation effect is found to prevail in the short run and the long run, higher economic growth appears to reduce consumption of selected types of petroleum products.

Wanjiku (2021) found the estimation results of the long-run relationship revealed that the relationship between petroleum consumption and GDP, and private capital and GDP was positive and statistically significant. Estimation of Error-correction model showed that in short run there was a positive and statistically insignificant relationship between GDP and lagged petroleum consumption. Finally, Granger causality tests imply a unidirectional Granger causality running from petroleum consumption to GDP.

Odhiambo and Nyasha (2019) Using the newly developed autoregressive distributed lag (ARDL) bounds testing approach to cointegration and the Error-Correction Model-based Granger-causality framework, the results of the study revealed that there is distinct unidirectional Granger-causality flowing from economic growth to oil price in the study country. These results are found to apply both in the short run and in the long run. Thus, it can be concluded that in Kenya, it is the real sector that pushes oil prices up.

Onono (2020) findings indicated that crude oil prices had a positive but insignificant effect on economic growth. The study recommended that the government diversifies its sources of energy to ensure that economic activity economy is not deeply connected to crude oil prices because of their volatility.

Tamba *et al.*, (2017) results showed that there was a bidirectional causality relationship between gasoline consumption and economic growth in Cameroon. This means that an increase in gasoline consumption affects economic growth with feedback effect. In view of the result of causality, reducing gasoline consumption without appropriate and established energy policies is not a feasible situation to maintain Cameroon's economic growth.

4.6.3 Gas Consumption and Economic Growth Rate

The results in table 4.7 indicated that the coefficient of gas consumption was -2.1673 with a p value of 0.024 which was lesser than 0.05. This implied that coefficient of gas consumption was negative and statistically significant at 5 percent level of significance. This implies that one percent increase in gas consumption results in reduction of 0.024 percent of GDP rate.

Sohail *et al.,* (2022) mentioned that the outcomes from the nonlinear autoregressive distributed lag model analysis show that in the short-run, positive changes in the natural gas consumption levels increase Pakistan's economic growth. On the other hand, in the long-run, positive and negative changes in natural gas consumption levels increase and decrease the nation's economic growth level, respectively. Furthermore, the Hacker–Hatemi-J causality analysis verifies that natural gas consumption causally influences the economic growth level in Pakistan; thus, verifying the energy consumption-led growth phenomenon. In line with these key findings, several policy level suggestions are put forward for Pakistan to enhance its natural gas consumption level in order to boost its economic growth rate in the future.

Makala and Zongmin (2020) stated that the result of this study indicates that there is no long-run relationship between gas consumption and economic growth. On top of that, causality is only found in Gas consumption to FDI.

According to Seyi and Ada (2018), using the autoregressive distributed lag technique for cointegration, stated that natural gas consumption, both in the short and long-run have no significant impact on output. However, real gross fixed capital formation exhibits positive and statistically significant impact both in the short and long-run on economic growth. By applying the Toda and Yamamoto methodology to test for causality, they found a unidirectional causality running from real gross domestic product (GDP) to natural gas consumption and a unidirectional causality running from real gross fixed capital formation to natural gas consumption. We found non-Granger causality relationships between natural gas consumption and real GDP and between natural gas consumption and real gross fixed capital formation in the long-run. From the empirical results, we infer that, natural gas consumption lacks a role in domestic output as it does not stimulate economic growth, though real gross fixed capital formation does.

Farhani and Rahman (2020) results showed that variables are cointegrated for the long-run relationship. They also indicate that natural gas consumption, exports, capital and labor are the contributing factors to economic growth in France. The causality analysis indicates that feedback hypothesis is validated between gas consumption and economic growth. The bidirectional causality is also found between exports and economic growth, gas consumption and exports and capital and gas consumption.

4.7 Hypotheses Testing Results

Applying Generalised Method of Moment Approach, the stated hypotheses were tested in various sections in this study and the summary of the results were as follows:

H_{01}: There is no significant influence of electricity consumption on economic growth in Kenya.

The observed test statistic, $P = 0.907 > 0.05$ for the coefficient of electricity consumption implying that electricity consumption influenced the economic growth in Kenya at 5 percent level of significance. Therefore, the null hypothesis relating to electricity consumption was accepted at the 5 percent level of significance.

H_{02}: There is no significant effect of petroleum consumption on economic growth in Kenya.

The observed test statistic, $P = 0.024 < 0.05$ for the coefficient of petroleum consumption implying that petroleum consumption influenced the economic growth in Kenya at 5 percent level of significance. Therefore, the null hypothesis relating to petroleum consumption was rejected at the 5 percent level of significance.

H_{03}: There is no significant impact of gas consumption on economic growth in Kenya.

The observed test statistic, $P = 0.007 < 0.05$ for the coefficient of gas consumption implying that gas consumption influenced the economic growth in Kenya at 5 percent level of significance. Therefore, the null hypothesis relating to gas consumption was rejected at the 5 percent level of significance.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This chapter consists of the summary of our findings, conclusions made from the study, contribution to knowledge, policy implications, recommendations and limitations of the study with areas for further study have been presented.

5.2 Summary of Findings

The overall objective of this study was to analyse the influence of energy consumption on economic growth in Kenya. To achieve this objective, the study used the following major techniques: first, descriptive analysis of the socioeconomic background was conducted followed by extensive review of the theoretical foundations and the empirical studies of the economic growth. Secondly, GMM was used to examine the influence of electricity, petroleum and gas consumptions on economic growth in Kenya.

Utilizing GMM, the results showed that the influence of coefficient of electricity consumption on economic growth in Kenya was not significant at 5 percent level, $p = 0.907 > 0.05$. This implied that electricity consumption, (β_1), did not influence economic growth in Kenya at 5 percent level of significance. The second estimated sample moment indicated that coefficient of petroleum was positive and significant at 5 percent level of significance, $p = 0.007 < 0.05$. This implied that for every increase in one percent of petroleum consumption (β_2), economic growth rate increased by 7.6514 percent in Kenya. In addition, the findings on the third estimated sample moment indicated that the coefficient of gas consumption (β_3), negative and significant at 5 percent level of significance, $p = 0.024 < 0.05$. The indicated that for every increase in one percent in gas consumption, economic growth rate in Kenya reduced by 2.1673 percent.

5.3 Conclusions

The first hypothesis stated that there was no significant influence of electricity consumption on economic growth in Kenya. The GMM estimation indicated that coefficient of electricity consumption was not statistically significant at 5 percent level. Therefore, it was concluded that coefficient of electricity consumption did not influence economic growth in Kenya, at 5 percent level.

Secondly, it was hypothesized that there was no significant influence of petroleum consumption on economic growth in Kenya. Based on the findings, it was observed that coefficient of petroleum consumption was positive and statistically significant at 5 percent level. This implied that petroleum consumption influenced economic growth in Kenya. An increase in petroleum consumption resulted in an increase in economic growth in Kenya.

Thirdly, it was hypothesized that there was no significant influence of gas consumption on economic growth in Kenya. Based on the findings, it was observed that coefficient of gas consumption was negative and statistically significant at 5 percent level. This implied that gas consumption influenced economic growth in Kenya. An increase in gas consumption resulted in a reduction in economic growth in Kenya.

5.4 Contribution to Knowledge

This study was different compared to previous studies in three ways: This study utilized current data for a period (2008-2020) on annual basis to analyse the influence of energy consumption on economic growth in Kenya and; the. Rationally, more recent data was necessary for the analysis in order to capture the maritime sector performance in enhancing economic growth in Kenya.

Secondly, analysis of the energy consumption on economic growth in Kenya was carried out using GMM model which has become the most preferred method used in estimating Dynamic Stochastic General Equilibrium. DSGE models anchored in rich micro-foundations have become a preferred methodology used in analysis in recent years (Tovar, 2008).

Thirdly, in analysing influence of energy consumption, this study used the individual components of energy consumption, these were, electricity, petroleum and gas consumption in analysing influence of energy consumption on economic growth. This made this study rich in microeconomic analysis of the independent variables on economic growth in Kenya.

5.5 Policy Implications

From the findings, petroleum consumption is a key driver of economic growth in Kenya hence its availability and reliability are key to the continuation of production. Policy directives should be aimed at up-scaling the energy infrastructure either through increasing the production capacity or increasing efficiency by reducing technical losses that result in shortages of petroleum sources. While this would not only add to the increased production but also increase economic growth in Kenya.

Since petroleum consumption has a positive influence on economic growth, policies could be put in place which could aim at diversifying the energy sources to utilization of renewable sources so as to take care of exhaustibility attributed to petroleum. Policies to the use of renewable resources such as solar energy from the sun, geothermal energy from heat inside the earth, wind energy, biomass from plants and hydropower from flowing water and its susceptibility to price shocks that has an effect on the country’s balance of trade could be put in place.

Policy directives should consider checking on the existing policies on gas provision so as to reverse the effect of gas consumption on economic growth in Kenya. This could mean that more policies on subsidies on gas consumption could be put in place with analyze on the effect on economic growth in Kenya.

Policy makers to consider putting in place policies which can ensure that electricity consumption could reverse the effect of economic growth. The mode of provision considering that electricity provision is monopolistic and government regulated could be checked considering that competition always results in better provision of the services and consequently could lead having a significant effect on economic growth in Kenya.

5.6 Recommendations

Firstly, from the results and the analysis of this study, it would be recommended that Kenyan government could increase petroleum supply around the country since it has been found that petroleum consumption influenced economic growth. This would mean that increasing petroleum supply in Kenya would have a positive influence on economic growth. The government could sustain and enhance petroleum infrastructures through good maintenance practices of existing petroleum infrastructure and construction of new and efficient ones.

Secondly, government and the stake holders in the energy sector in Kenya should increase research and development in the energy sector because there is need to increase research and development in the energy sector so that innovation can be fostered. Research and development into renewable sources of energy could be fostered and this could enhance economic growth.

Thirdly, promotion of petroleum efficiency and conservation is also another area the Kenyan government should focus. This could include educating the public on petroleum conservation and efficiency. Furthermore the government could increase the budgetary allocation to the energy sector, in particular, petroleum consumption and making the release of funds as fast as possible without delays such the subsidy funds in order to avoid the curtailing of the supply of petroleum in Kenya.

Fourthly, it would be paramount that energy sector, petroleum, is fully supported in the country. The government should ensure that petroleum supply could be beefed up in diversity so that more economic activities could thrive in Kenya. Research and development backed up by petroleum efficiency would be beneficial to the nation. Also increased investment would be needed to foster increased petroleum production with the aim of more generation of petroleum availability.

Finally, the government and policy makers could follow up on the gas consumption provision. From the results from this study, gas consumption need to be changed by ensuring that the mode of provision could be supported by the government, which could be through subsidies. This could be checked to ensure that the effect is reversed from negative to positive effect on the economic growth in Kenya.

5.7 Limitations of Study

One of the limitation of the study was the literature relevant to the country in study were not adequate since very few studies had been done with regard to this study case. This was overcame by utilizing the existing local literature coupled with the literature done from other countries and the continent as a whole.

The second limitation is that energy was used as a variable, where the components of energy were, electricity, petroleum and gas consumption. This ensured that the effect of each individual component on economic growth in Kenya was analyzed.

The third limitation is period of study, 2008-2020, could be increased to include current years, such as 2021 especially after the effect of Corona-Virus Disease of 2019 on economic growth. The period was relevant for this study considering that research time was just one year after the period of study.

5.8 Areas for Further Research

Other scholars could explore more on the effect of energy on economic growth in Kenya and consider including infrastructure, agriculture and several other variables captured in vision 2030. The period was relevant for this study considering that research time was just one year after the period of study. There is need for the continuous research so as to always remain relevant and ensure development in the energy sector so that innovation can be fostered. Research and development into renewable sources of energy could be fostered and this could enhance economic growth. This can be a room for further research by other scholars.

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APPENDIX

A. 1: Data Used in the Study

Year	LogGDP	LogPC	LogEC	LogGas
2008	-0.634	3.484114691	3.472419997	1.926342447
2009	0.51943	3.54853682	3.385909995	1.872738827
2010	0.90623	3.565599917	3.550680762	1.943494516
2011	0.70935	3.57591491	3.540717288	1.961895474
2012	0.65982	3.549542728	3.624694531	1.971275849
2013	0.57955	3.558108302	3.678190486	1.968015714
2014	0.7007	3.5784329	3.714614724	2.1752218
2015	0.69618	3.661803224	3.807149268	2.172018809
2016	0.62469	3.689530834	3.818377672	2.180985581
2017	0.58161	3.697342698	3.769081787	2.277150614
2018	0.75043	3.696085416	3.790158447	2.346939463
2019	0.69732	3.689752696	3.800710206	2.494293769
2020	-0.5003	3.638718823	3.905358668	2.513483957

A. 2: Introduction Letter from School of Business and Economics-Moi University

MOI UNIVERSITY
POSTGRADUATE OFFICE
SCHOOL OF BUSINESS AND ECONOMICS

Tel: 0790940508
0771336914
0736138770
Fax No: (053) 43047
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P.O. Box 3900
Eldoret
Kenya

RE: MU/SBE/PGR/ACD/21B

DATE: 21st April, 2022

TO WHOM IT MAY CONCERN:

RE: MOLLY MERCY JERONO - SBE/PGE/06/18

The above named is a bonafide student of Moi University, School of Business & Economics, undertaking **Masters in Economics** degree;

She has successfully completed coursework, defended her proposal, and is proceeding to the field to collect data for her research titled: "***Influence of Energy Consumption on Economic Growth in Kenya.***"

Any assistance accorded to her will be highly appreciated.

Yours faithfully,

SCHOOL OF BUSINESS & ECONOMICS
MOI UNIVERSITY
P. O. Box 3900 ELDORET 30100

DR. RONALD BONUKE
ASSOCIATE DEAN AND CHAIR-POSTGRADUATE STUDIES

/pn

(ISO 9001:2015 Certified Institution)

A. 3: National Commission for Science, Technology and Innovation (NACOSTI) Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 282947

Date of Issue: 04/May/2022

RESEARCH LICENSE

This is to Certify that Ms.. Molly Mercy Jerono of Moi University, has been licensed to conduct research in Uasin-Gishu on the topic: Influence of energy consumption on economic growth in Kenya. for the period ending : 04/May/2023.

License No: NACOSTI/P/22/17268

282947

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY &
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