THE IMPACT OF FOREIGN DIRECT INVESTMENT (FDI) ON THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT (GDP) IN KENYA

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Doctor of Philosophy -Business

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Abstract

THE IMPACT OF FOREIGN DIRECT INVESTMENT (FDI) ON THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT (GDP) IN KENYA

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The consumption of energy plays a pivotal role in the economic growth globally. In a developing economy such as Kenya, where there are still policy frameworks under development, it is important to understand this relationship between the consumption of energy and growth in the economy with foreign direct investment being a moderating variable. This paper considers 5 variables – foreign direct investment (FDI), gross domestic product (GDP), petroleum energy consumption (PEC), electricity energy consumption (EEC), and renewable energy consumption (REC).

The data used is secondary for Kenya for the period 2002 to 2021 and quantitative research design is then utilized. Quarterly statistics are obtained from the Kenya National Bureau of Statistics (KNBS). This being a macro economic study, secondary data is more suitable and reliable.

The Vector Error Correction Model (VECM) is used to test the short-run and long-run relationships of these variables. The results conclude that there is a short-run bidirectional relationship between FDI & EEC and between FDI & REC.

This means that the Kenyan Government needs to boost the consumption of electricity, petroleum, and renewable energy in order to attract foreign direct investments into the country. Renewable energy has not been taken up well in Kenya. This study shows how renewable energy contributes to growth of the Kenyan economy with the assistance of foreign direct investment. For future research, there is need to incorporate the carbon emissions as climate change is now a major issue globally.

Declaration

I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where states otherwise by reference or acknowledgment, the work presented is entirely my own.

AI Acknowledgment

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Dedication

I wish to dedicate this work to my husband Dennis Simiyu, my daughter Taraji Nambuba, to my son Takiri Gabriel and to my sister Elizabeth Mukele. I would also like to dedicate it to my friends Kelvin Maingi (Who unfortunately passed on in 2021) and Njeri Kimani for encouraging me over the years.

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I am grateful to God for giving me the opportunity, strength, and perseverance to do this research study. I thank my supervisor, Professor Ali Saleh, who dedicated his time to guiding me and correcting me in every stage of this dissertation and has always been available and prompt despite our territorial time differences and his busy schedule. I also want to thank UNICAF university in Zambia for all the support given over the full dissertation journey and for ensuring that the work is thorough and meets International Standards.

Table of Contents

List of Abbreviations …… xii
List of Tables…… xv
List of Figures …….…… xiv
Chapter 1: Introduction 1
Statement of the Problem and purpose of the study 8
Research Aims, and Objectives 10
Nature and Significance of the Study 11
Research Questions and Research Hypotheses 13
Motivation of the study 15
Research Organization 18
Summary 19
Chapter 2: Literature 20
Economic Growth 20
Background of Economic Environment in Kenya Connected with GDP 29
Gross Domestic Product (GDP) 30
Gross Domestic Product (GDP) in Kenya 40
Energy Consumption 41
Energy Consumption in Kenya 58
Energy Consumption and its elements (Petroleum Energy Consumption, Electricity Energy Consumption and Renewable Energy Consumption) 59
Petroleum Energy Consumption and Economic Growth 61
Electricity Energy Consumption and Economic Growth 76
Renewable Energy Consumption and Economic Growth 91
Renewable Energy Consumption and Economic Growth 127
Foreign Direct Investments (FDI) and Background of FDI in Kenya 134
Energy Consumption (Petroleum Energy Consumption, Electricity Energy Consumption and Renewable Energy Consumption) and FDI. 148
Foreign Direct Investment and Economic Growth 150
The Environment (Kuznet Curve), Energy and Economic Growth 156
Theoretical/Conceptual Framework 170
The Energy Consumption Theory 170
Kuznets Curve 172
Growth Hypothesis 173

Neutrality Hypothesis 173
Feedback Hypothesis 174
Conservation Hypothesis 174
Summary 175
Chapter 3: Research Methods and Data Collection 176
Introduction 176
Research Approach and Design 176
Population and Sample of the Research Study 178
Data Collection Method 179
Data Collection Tool 179
Data Validity 179
Proposed Software Analysis Technique 183
Summary 189
Chapter 4: Discussion of Research Findings 190
Introduction 190
Trustworthiness of Data 190
Results of Findings 192
Evaluation of findings 201
VEC Model 201
Post-estimation Tests 208
Summary of the Section 217
Chapter 5: Implications, Recommendations, and Conclusions 219
Gross Domestic Product (GDP) 220
Foreign Direct Investment (FDI) 220
Electricity Energy Consumption (EEC) 221
Petroleum Energy Consumption (PEC) 221
Renewable Energy Consumption (REC) 222
Research Implications 223
Electricity energy consumption and gross domestic product 223
Petroleum energy consumption and gross domestic product 223
Renewable energy consumption and gross domestic product 224
Electricity energy consumption and foreign direct investment 225
Petroleum energy consumption and foreign direct investment 226
Renewable energy consumption and foreign direct investment 226

Foreign direct investment and gross domestic product 230
The Energy Consumption Theory Implications 232
Recommendations for application 233
Foreign direct investment and electricity energy consumption 233
Foreign direct investment and petroleum energy consumption 233
Foreign direct investment and renewable energy consumption 237
Renewable Energy Consumption and Gross Domestic Product 240
Gross domestic product and foreign direct investment 242
Limitations of the research 243
Recommendations for future research 243
Conclusions 244
References 245
Appendices 272
APPENDIX I 272
APPENDIX II 310
APPENDIX III 313
APPENDIX IV 314
APPENDIX V 315
APPENDIX VI 316
APPENDIX VII 317
APPENDIX VIII 320
APPENDIX IX 333

LIST OF ABBREVIATIONS

HQIC	Hannan-Quinn information criterion
AIC	Akaike information criterion
BEA	Bureau of Economic Analysis
EEC	Electricity Energy Consumption
EPRA	Energy & Petroleum Regulatory Authority
ERC	Energy regulation commission of Kenya
FPE	First prediction error
FEVDs	Forecast Error Variance Decomposition
FSA	Fuel Supply Agreement
GDC	Geothermal Development Company
GDP	Gross domestic product
H_o	Null Hypothesis
H_a	Alternative Hypothesis
IA	Implementation Agreement
IEAPVPS	International Energy Agency's Photovoltaic Power System Program
IPPs	Independent Power Producers
IRFs	Impulse response functions
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electricity Transmission Company
KNBS	Kenya National Bureau of statistics
KNEB	Kenya Nuclear Electricity Board
KWh	KiloWatt Hours
LR	likelihood ration
MBIP	Malaysian Building Integrated Photovoltaic
MBIPV	Malaysian Building Integrated Photovoltaic
MENA	Middle East and North Africa region
MtCO2e	Carbon dioxide equivalent
MTPs	Medium-Term Plans
NEMA	National Environment Management Authority
NDC	Nationally Determined Contribution

PEC	Petroleum Energy Consumption
PPA	Power Purchase Agreement
PPIB	Private Power and Infrastructure Board
REC	Renewable Energy Consumption
R&D	Research and Development
REREC	Rural Electrification and Renewable Energy Corporation
SIC	Schwartz Information Criterion
SBIC	Schwarz Bayesian information criterion
STATA	Statistical software for data science
SMI	Stock Market Index
SDG	Sustainable Development Goals
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Autoregressive
VECM	Vector Error Correction Model

List of Figures

Figure 1: Quarter One GDPs (2015 – 2020) 2
Figure 2:FDI and GDP in Kenya 3
Figure 3: Triangles of causality 4
Figure 4: Electricity Generation by Source 5
Figure 5: Conceptual Framework 11
Figure 6: The Evolution of GDP per capita in the US, India, South Korea, UK, Brazil, Botswana, Guatemala, Singapore and Spain (1960 – 2000) 21
Figure 7:GDP of the World 36
Figure 8: Kenya GDP Growth rates (1960 – 2003) 41
Figure 9: US Energy Consumption by Sector (2016) 42
Figure 10: Kenya key indicators and policy initiatives 60
Figure 11: Kenya primary energy demand and GDP 60
Figure 12: FDI inflows to Kenya in Millions USD, (1970- 2003) 148
Figure 12: Combined Trend Plot of Variables 194
Figure 13: Trend Plot for Cointegration 200
Figure 15: Overall impact of Variables Diagrams 231

List of Tables

Table 3. 1 Operational Definition of Variables (Source; Author, 2022) 181
Table 4. 1 Summary Table of Variables……..193
Table 4. 2 Correlation Matrix 195
Table 4. 3 Dickey Fuller Test..... 197
Table 4. 4 Phillip-Perrons unit root Test 198
Table 4. 5 Lag Selection Criteria 199
Table 4. 6 Johansen co-integrating Test 201
Table 4. 7 Model Fitness 202
Table 4. 8 Speed of Adjustment 203
Table 4. 9 Vector Error Correction Estimates 206
Table 4. 10 Jarque-Bera test..... 208
Table 4. 11 Skewness test 208
Table 4. 12 Kurtosis test..... 209
Table 4. 13 Impulse Response Function Tables 211
Table 4. 14 Factor Error Variance Decomposition Tables..... 214
Table 4. 15 Model Stability 217
Table 16 1Data Collected..... 302

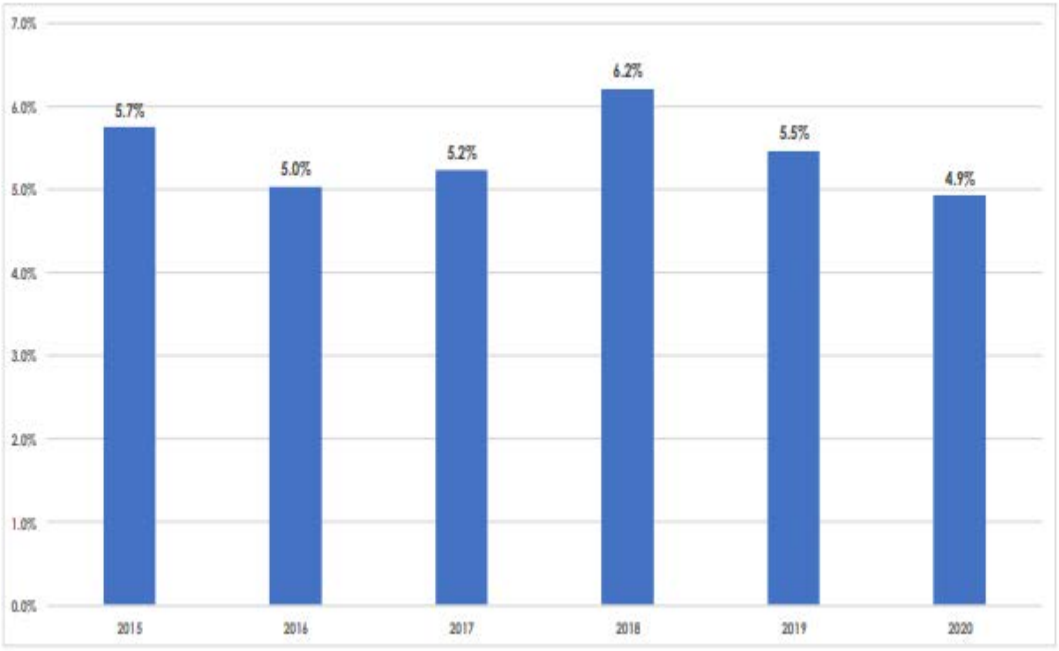
Chapter 1: Introduction

Paul Samuelson, an esteemed Nobel laureate in economics, made substantial contributions to economic theory and education. Although he may not have directly addressed the importance of GDP in his works, his influence undoubtedly highlights GDP's centrality in economic analysis. It's probable that Samuelson's widely used textbook, "Economics," extensively covers GDP and its significance within the broader framework of national income accounting and macroeconomic analysis. In "Economics," Samuelson likely discusses how GDP serves as a fundamental measure of a country's economic output and activity. He would probably underscore its role in evaluating economic performance, shaping policy decisions, and discerning trends in economic growth and development. Mankiw (2016) describes GDP as the aggregate market worth of all completed goods and services generated within a nation during a specified timeframe. Samuelson and Nordhaus (2010) define GDP as the total value of finished goods and services produced within a country's borders within a particular time frame, typically a year or quarter. Blanchard, O. (2017) characterizes GDP as the summation of consumption, investment, government spending, and net exports. Romer (2001) asserts that GDP gauges the total market value of all completed goods and services produced within a nation throughout a specific period, usually a year or quarter. Lieberman and Hall (2012) delineate GDP as an inclusive gauge of a nation's economic activity, covering all goods and services generated by labor and property situated within a country's confines. The Bureau of Economic Analysis (BEA) gives a clear definition for GDP: Gross domestic product (GDP) is the value of the goods and services produced by the nation’s economy less the value of the goods and services used up in production. GDP is also equal to the sum of personal consumption expenditures, gross private domestic investment, net exports of goods and services, and government consumption expenditures and gross investment. The most closely watched aggregate economic indicator and one which is so often used as a measure of the standard of living. As per Callen (2020) GDP is important because it gives information about the size of the economy and how an economy is performing. The growth rate of real GDP is often used as an indicator of the general health of the economy. In broad terms, an increase in real GDP is interpreted as a sign that the economy is doing well.

When real GDP is growing strongly, employment is likely to be increasing as companies hire more workers for the industries and the population has a lot of money to pocket. When GDP shrinks, as it has done in most economies this 2020, employment levels decrease.

Kenya is a country that is considered among one of the fastest growing economies in Africa and first in Eastern Africa. According to the Kenya National bureau of Statistics (2020) the country has averaged about 4.9% annual GDP growth in the first quarter of 2020 {compared to 5.5% in 2019 and 6.2% in 2018 for the first quarters). The year 2020 is not a very good comparator due to the effects of COVID-19 which hit hard globally.

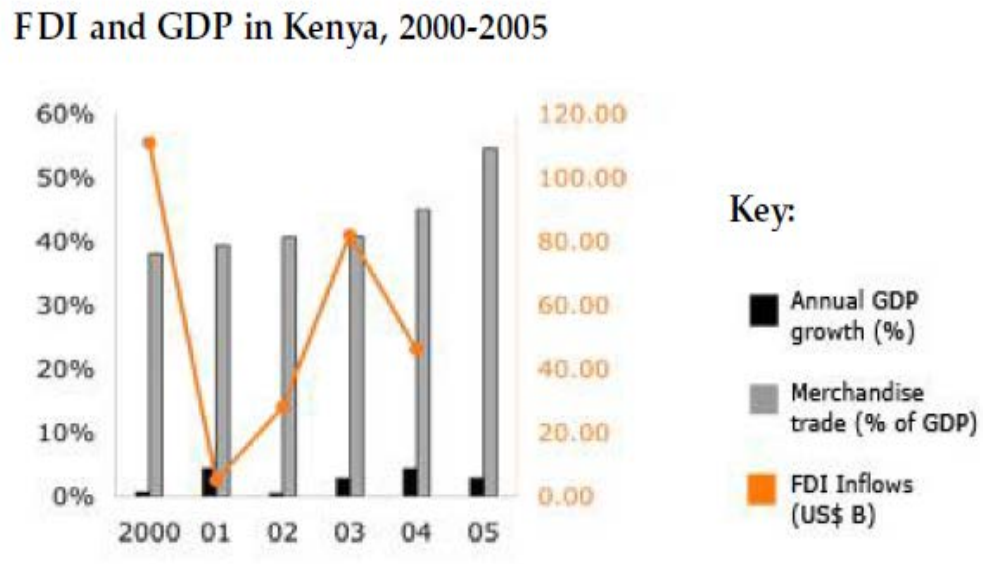
Figure 1: Quarter One GDPs (2015 – 2020)



Note. Adopted from *Kenya National Bureau of Statistics (KNBS),* 2020, p. 20.

Moosa (2002) defines Foreign direct investment (FDI) as the process where the population of a host country acquires the ownership of assets in another country known as the host country with an intention to control the production, distribute and perform other activities. As per United Nations Conference on Trade and Development (UNCTAD) (1999) FDI is a long-term investment that reflects lasting control and interest of an entity in one country in an organization which is resident in another country.

Figure 2:FDI and GDP in Kenya



Note. Adapted from *World Development Report* by The World Bank, 2005, p. 25.

Gökmenoğlu & Taspinar (2016), noted the existence of a causal relationship running from economic growth to FDI in the case of Turkey. The conclusion shows that FDI in Turkey is driven by the growth in the economy, which means stable economic growth creates a safe investment environment for foreign investors. Additionally, Fung (2009) in his study concludes that an efficient financial system creates more products, and the inputs for these products increase the energy requirements. Hence, financial development is a component that should be considered in the consumption of energy. Jensen (1996) revealed that having a well-developed financial sector facilitates in attracting FDIs and may encourage economic growth, and therefore, increase industrial pollution and reduce environmental quality. The key functions of FDIs include transfer of new technology, improving managerial skills and knowledge, increasing productivity, international production network, creating connections to foreign markets and decreasing unemployment. He concludes that the relationship between FDI and economic growth is important for countries that are developing.

Figure 3: Triangles of causality

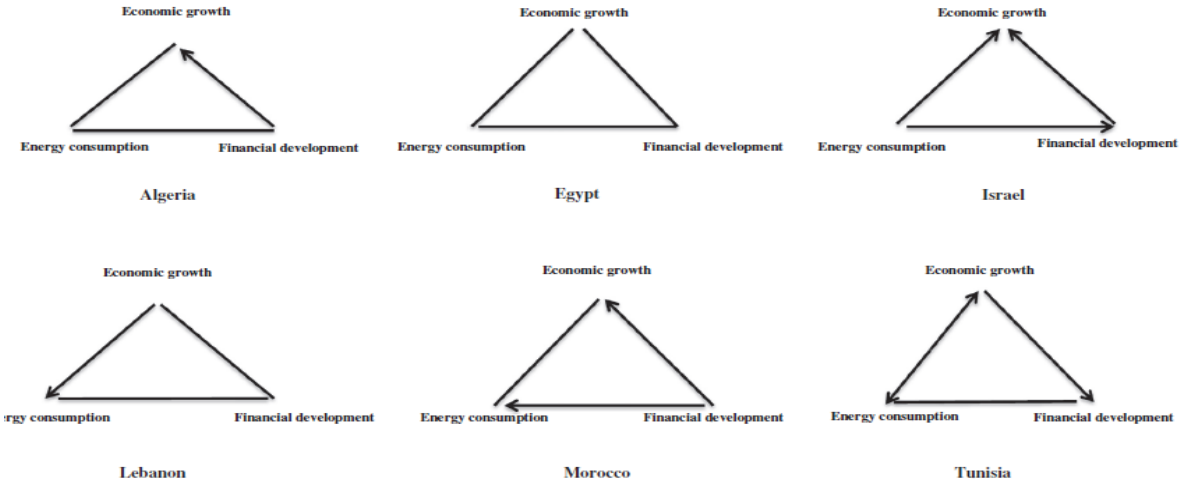


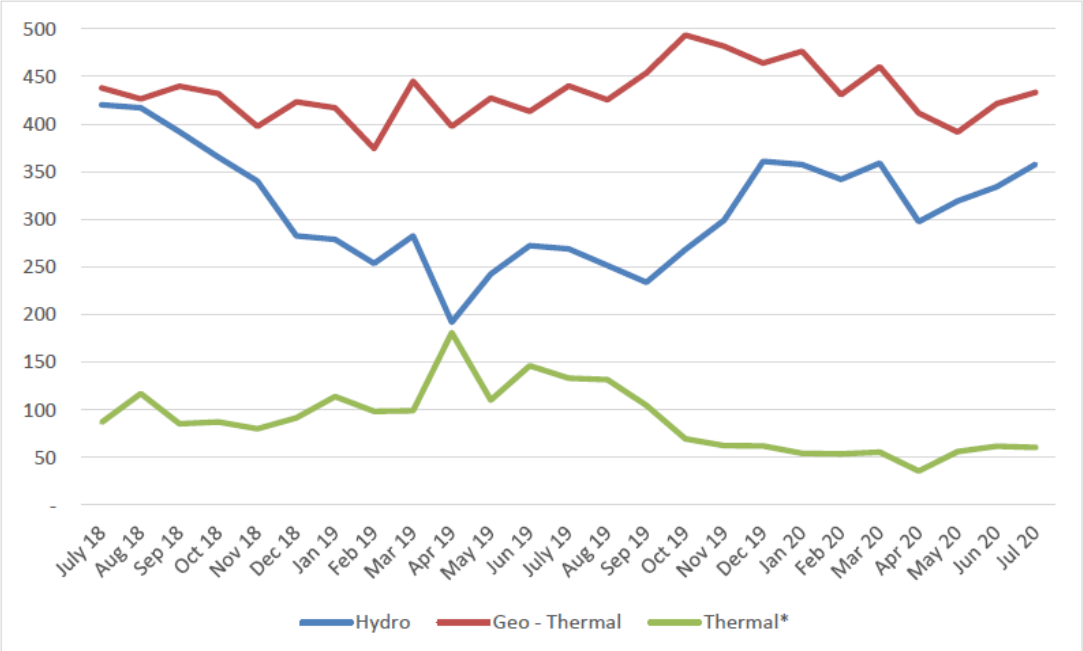
Fig. 1. Triangles of causality.

Note. Adopted from *The short and long run causality relationship among economic growth, energy consumption and financial development: Evidence from South Mediterranean Countries (SMCs)* by Kahouli. 2017, p. 10.

As per different scholars such as Lee (2013); Batten & Vo (2009); Mallampally & Sauvant (1999); Reiter & Steensma (2010); Hermes & Lensink (2003); and Fernandes & Paunov (2012); FDI holds a key role in the growth of the economy for countries that are developing which do not have sufficient capital for investing. FDI contributes to the economic growth of developing countries not only with capital financing, but it also helps those countries to increase their productivity by transferring advanced production technology, managerial skills, and know-how to modernize the economy and encourage innovation. FDIs create new job alternatives and encourage competitiveness and entrepreneurship, which are the vital machinery for the accelerated growth of developing countries.

In Kenya, the total local electricity generation increased from 940.40 million KWh in December 2019 to 986.09 million KiloWatt Hours (KWh) in January 2020. The national average domestic retail oil prices of motor gasoline premium rose from KES. 109.91 per liter in December 2019 to KES. 110.61 in January 2020. The price of light diesel oil rose from KES. 102.28 in December 2019 to retail at KES. 102.81 in January 2020. On the other hand, the average price for Kerosene rose from KES. 102.81 to retail at KES. 104.46 in January 2020.

Figure 4: Electricity Generation by Source



Note. Adapted from *Kenya National Bureau of Statistics (KNBS),* 2020, p. 33.

This research ensured that the Energy regulation commission of Kenya (ERC), now changed to EPRA (Energy and Petroleum Regulatory Authority) makes regulatory policies while considering the role of foreign investments in the energy sector and putting the effect on country's income/GDP into consideration. In his studies, Chelimo (2008), found out that the Energy Regulatory Commission has measures in place addressing the regulations, as well as the challenges being encountered. These challenges include the review of power tariff guides, capacity building in the institutions, regulatory & legal frameworks and capacity building. In accordance with the research of Kiplagat, Wang, and Li (2011) there are different stakeholders in the Kenyan energy sector; the Ministry of Energy has the mandate of providing and implementing policies, preparing energy development plans for Kenya, and facilitating the mobilization of resources in developing the power sector.

The Kenya Power Company is mandated to transmit and distribute electricity after purchasing power from KenGen and Independent Power Producers (IPPs), based on long-term power purchase agreements. The Kenya Electricity Transmission Company Ltd. (KetraCo) is established with the responsibility of building transmission lines. The main aim of the company is to remove the initial investments costs of capital from

electricity customers. As per Semboja (1994) the Kenyan Government can implement energy-efficient policies which would lead to a reduction on the dependence on foreign energy purchases, advancement of reliable local energy purchasing and the conservation of different energy sources, hence saving of foreign currency and boosting good environmental practices.

The renewable energy space in Kenya is developing rapidly. The Rural Electrification and Renewable Energy Corporation (REREC) has the mandate of spearheading Kenya's green energy drive, in addition to implementing rural electrification projects. According to Kiplagat, Wang and Li (2011) Kenya is endowed with a huge amount of renewable energy resources inclusive of: solar, geothermal, hydropower, wind and biomass. The largest form of primary fuel in Kenya, in terms of wood is biomass which accounts for seventy-four percent of the entire basic energy supply. At the time of the study, the exploited large hydropower supply is at 709 Megawatts and small hydropower is at 31 Megawatts, these contributed to over seventy percent of the country's yearly electricity generation. There is an active market for solar energy established in Kenya in the recent past to provide electricity to industries and homes, remotely from the country's national grid. They opine that wind energy has been utilized in Kenya mostly for pumping water for thousands of years. Their findings is the first country in Sub-Saharan Africa in exploiting geothermal energy is Kenya.

Kahouli (2017) analyzes data for the years 1995 to 2015 for six different countries including Israel, Lebanon, Algeria, Morocco, Tunisia and Egypt. He observes three different variables i.e. the real GDP, energy consumption per capita and financial development. From the findings of different countries, the variables have different causality relationships as shown in the above triangles; in Algeria, financial development causes economic growth; in Egypt there is no causality amongst the three variables; in Israel energy consumption causes economic growth, financial development causes economic growth & energy consumption causes financial development; in Lebanon, economic growth causes energy consumption; in Morocco, financial development causes both energy consumption and economic growth and lastly in Tunisia economic growth causes financial development and there is a bidirectional relationship between economic growth and energy consumption.

This paper seeks to examine what role foreign direct investment has on the association between the consumption of energy and the GDP of Kenya. In determining the role of FDI this would enable the Kenyan government to enforce friendlier regulations for foreigners to invest. There is already a Kenyan Foreign Investments Protection Act in place. According to the African Economic Outlook (2020) published by the African Development Bank, the Real GDP in Kenya grew by an estimated 5.9% in 2019, driven by household consumption and investment on the demand side and services on the supply side including public administration, information technology, finance & insurance, and transport and storage. GDP is down from 6.5% in 2018, caused mainly by unfavorable weather and reduced government investments in 2019. Public debt rose to 58% of GDP in 2019, up from 41% in 2013, and became more non-concessional (67%) than concessional (33%).

Both Zhang (2001) and Nyamwenga (2009), opine that an increase in FDI specifically in the energy sector has led to industrialization, increase in employment levels, improved living standards especially in the rural areas and reduction in poverty levels. Nyamwenga (2009) further observes that FDI inflows to Kenya is important since it acts as a capital source, given the fact that foreign assistance has been declining in the past years. The study concludes that FDI promotes investments in the local country, generates employment opportunities and boosts economic growth. In addition, he found out that FDI does not only grants capital to African countries for domestic investment, but it also assists in transferring managerial & technical skills and avails employment chances, all of these factors are a contribution to economic development. With the recognition that FDI contributes immensely to economic development, then all governments in Africa inclusive of Kenya would want to attract it.

Many researchers have attempted to find the causality between consumption of energy and revenue. There are original studies by Kraft and Kraft (1978) who found evidence in favor of causality running from income to energy consumption in the United States, by using data for period 1947–1974. This shows that energy conservation policies may be initiated without affecting the economy. Other empirical studies have been extended to focus on many developing countries as well in order to aid the execution of proper energy policies. Instead of only relying on the standard Granger (1987) causality test, other scholars such as Asafu-Adjaye (2000), Masih and Masih (1996) and Glasure

and Lee (1997) presented a different review of recent studies covering this topic with the goal of showing the causal relationship between energy consumption and income for developing economies, using co-integration and error-correction techniques.

The findings of the studies have been mixed and conflicting. Soytas and Sari (2003) likewise estimated the causal relationships for emerging markets for the period 1950–1992 and concluded that there is a bi-directional causality for Argentina, but the co-integration vector is rejected for Indonesia and Poland. In addition, Oh and Lee (2004) computed a Divisia energy aggregate and substituted it for a simple BTU energy aggregate for South Korea, which indicates the existence of a long-run bi-directional causal relationship between energy and GDP as well as a short-time unidirectional causality running from energy towards GDP.

Statement of the Problem and purpose of the study

Several studies assessing whether consumption of energy has an effect on the gross domestic product or income of a country and vice versa have been done. For a developing country like Kenya, it is important to study this relationship so as to put in place the correct energy conservation measures, as well as energy regulatory policies. The early works have been done by Kraft and Kraft (1978), who found evidence supporting causality from income to the utilization of energy in the US, which showed that energy preservation policies can be put up without worsening the economic conditions. Many other scholars have studied this relationship such as Asafu-Adjaye (2000), Lee (2005) and Masih and Masih (1996). These studies made use of other empirical tests other than the usual Granger-causality test, such as the vector error correction model.

When there is a relationship from energy utilization to income, it means that energy conservation strategies may negatively affect economic growth. Therefore, an economy may opt to put resources in technology to make other sources of energy more economically feasible, which includes policies that reduce carbon emissions and add on energy efficiency and intensity through substituting them for cleaner sources such as solar, wind and geothermal. Contrary, when there is causality only from income to energy consumption, promoting energy conservation and minimizing domestic energy consumption would be the main steps in decreasing domestic emissions. When there is a bi-directional relationship, then a coordinated and balanced mix of various policies may be possible. This study is based on Kuznets curve hypothesis studied by Jebli, Youssef

and Ozturk (2016). Soytas and Sari (2003) tested the causality for developing economies for the years 1950–1992. They discovered that there is a bi-directional causality for country Argentina, but the co-integration vector is not accepted for countries Poland and Indonesia.

There have been mixed results with findings from different scholars differing in their conclusions. Scholars Adewuyi and Awodumia (2017) reviewed a hundred and thirty-six articles showing the linkage between energy consumption and economic growth which are published in the last thirty years. 41% of them validated the feedback effect – showing that the two variables have a bi-directional causality; 25% of them conclude on the growth hypothesis – which indicates that energy consumption causes economic growth; 21% found out that the relationship is on the conservation hypothesis – where economic growth causes energy consumption and 13% pointed towards the neutrality hypothesis concluding that the relationship between economic growth and energy consumption is not statistically significant.

There are very limited papers done on this topic in the African market which have focused on West and South Africa, no research has been done in the East African market more so the Kenyan market. This study aims to introduce a moderating variable – foreign direct investments (FDIs) which relates to both energy consumption and economic growth in a developing economy such as Kenya. This is the first study to examine the function of foreign direct investment in the link between energy consumption and economic growth in Kenya. This study considers if the bidirectional relationship exists between these variables. This study fills the gaps in the regulations in Kenya once the relationship between consumption of energy, GDP and FDI is established for Kenya. The EPRA Energy & Petroleum Statistics report, (2021), data from the Kenya Power company shows that electricity prices have been on a steady increase from 01st October 2008 to 01st August 2013, prices increased by 16%, then to 01st December 2015, increased by 21%, to 01st September 2017 increased by 54%, to 01st March 2020 increased by 15% and finally to 01st September 2023 has shot up by 8%. These escalations have a negative effect on the consumption of electricity energy as both individual consumers and industries will tend to consume less. The Uptake of the renewable energy sources has been very low. From the EPRA Energy & Petroleum Statistics report, (2021), it states that “The percentage of solar energy harnessed for commercial and domestic applications is

insignificant relative to the potential.” According to The Kenya Biogas Program (KBP) a lead entity in implementing the Africa Biogas Partnerships Program (in Kenya), Kenya has only 8000 biogas plants with a potential of potential of 3,000,000 biogas plants. From the 2023 United Nations General Assembly (UNGA) amongst the 10 actions for climate include switching to electric vehicles and switching homes sources of energy to renewable which would be a big move for Kenya. The Kenya Finance Act (2023) increased the VAT on petroleum from the subsidized 8% to 16% which will have a huge reaction on the consumption of petroleum energy consumption in the country.

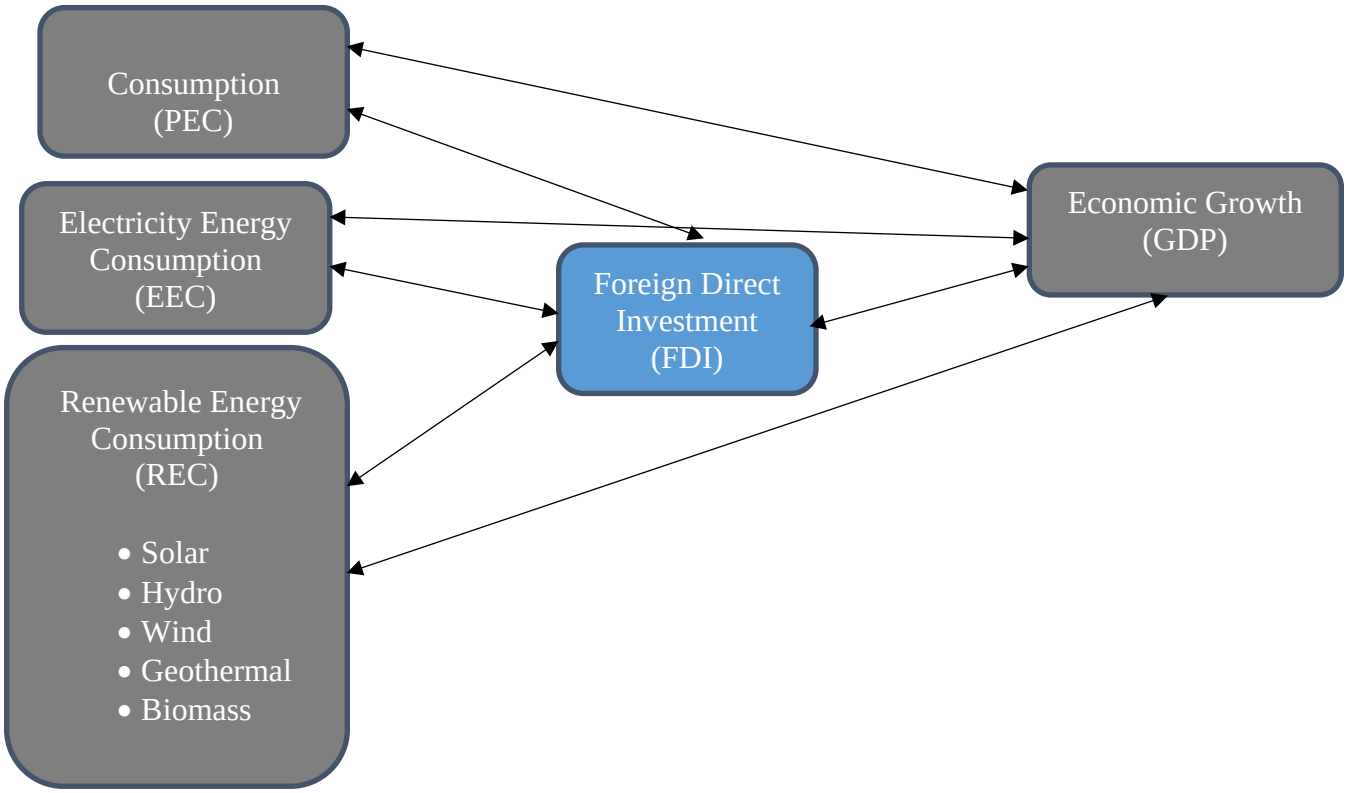
Calgar et.al (2023) observe that through the collaborative efforts of the United Nations, environmental sustainability has emerged as a focal point for countries worldwide. Policymakers and researchers closely monitor the environmental aspects of Sustainable Development Goals (SDGs). This study introduces a fresh perspective on European Union (EU) economies, focusing directly on SDG 9 and incorporating environmental sustainability policies in the selection of variables. Specifically, the paper examines the outcomes of economic growth, trade openness, renewable energy, human capital, and competitive industrial performance on the load capacity factor across EU countries from 1995 to 2018. The empirical analysis reveals that while economic growth, trade openness, and competitiveness have adverse effects on environmental quality, renewable energy and human capital contribute positively to environmental sustainability. The panel data results indicate continued reliance on fossil fuels by EU economies to maintain competitiveness in the industry. However, the EU, with its 2030 and 2050 targets, could mitigate the drawbacks of competitiveness by enhancing the environmental quality through the expansion of renewable energy and human capital. Furthermore, the study offers SDG-oriented policy recommendations tailored to EU countries.

Research Aims, and Objectives

The general objective of this study is to examine the relationship between energy generation and economic growth in terms of GDP (Growth Domestic Product) in Kenya. The main objectives are as follows.

1. To examine the relationship between petroleum energy consumption and Economic Growth (GDP)
2. To examine the relationship between electricity energy consumption and Economic Growth (GDP)
3. To examine the relationship between renewable energy consumption and Economic Growth (GDP)
4. To examine the relationship between foreign direct investments, Energy Consumption and Economic Growth (GDP)
5. To examine if there is a bi-directional relationship between energy consumption and economic growth in Kenya.

Figure 5: Conceptual Framework



Nature and Significance of the Study

This research focuses on the role of Foreign Direct Investment (FDI) on the relationship between energy consumption and Gross Domestic Product (GDP) in Kenya. This is the first time that these three types of energy {i.e., petroleum, electricity and renewable energy} are being examined in relation to the economic growth together with

the moderating variable- FDI. This study focused on Kenya as a country. This is due to the fact that very few studies on the topic have been done, especially for the growing markets or developing economies and more so the East African countries. This study is significant as it highlights the present pressing issue of energy consumption. Given that consumption of energy is a vital component in both household and industrial setups. Understanding how consumption of the many types of energy contributes to the growth of the economy and the impact of foreign direct investment in this relationship. With Kenya Power being a monopoly in the electricity industry in Kenya, diversification into other sources of energy will be of value to the country and policymakers. This study will enable significant policy changes to production and uptake of renewable energy sources. Policies on attracting foreign investments into the country will also be drafted and implemented based on the results of this study.

Renewable energy has not been taken up well in Kenya. This study shows how renewable energy contributes to growth of the Kenyan economy with the assistance of foreign direct investment.

Contributions from this research are as below.

Literature

This study adds to the current literature about energy consumption and economic growth. The study provides evidence from Kenya (a developing country) regarding the association between energy consumption and economic growth. The study examines the role of foreign direct investment (FDI) on the relationship between energy consumption and economic growth (GDP).

Theory

This study uses the Energy Consumption Theory as the main theory of study. The study also makes use of the commonly used hypotheses in all the energy consumption studies – the feedback hypothesis, the growth hypothesis, the conservation hypothesis, and the neutrality hypothesis.

Users

The study seeks to examine the role of foreign direct investment in the relationship between energy consumption and economic growth in Kenya. This is useful to various stakeholders in the following ways: Policy makers and industry players– these include the Government specifically the Ministry of Energy as well as the Ministry of Mining and Petroleum, the Energy and Petroleum Regulatory Authority, the Kenya Power Company, KenGen Company would use the recommendations in the study to make, amend or do away with certain policies affecting the different sectors in addition to the company policies; potential investors – there are many potential investors in the Energy sector such as Tullow oil company which has been drilling oil in the Turkana region of Kenya for a few years now; scholars - the scholars who wish to do further research and studies on this area, can use this research as a knowledge base.

Research Questions and Research Hypotheses

The study seeks to answer these main research questions.

1. What is the relationship between petroleum energy consumption and economic growth in Kenya with foreign direct investment as a moderating variable?
2. What is the relationship between electricity energy consumption and economic growth in Kenya with foreign direct investment as a moderating variable?
3. What is the relationship between renewable energy consumption and economic growth in Kenya with foreign direct investment as a moderating variable?
4. What is the relationship between foreign direct investments, energy consumption, and economic growth in Kenya?
5. What is the type of bi-directional relationship between energy consumption and economic growth in Kenya with foreign direct investment as a moderating variable?

There are eight hypotheses in this study described as below.

Hypothesis 1.

H_0; There is a statistically significant relationship between petroleum energy consumption and economic growth.

H_1; There is no statistically significant relationship between petroleum energy consumption and economic growth.

Hypothesis 2.

H_0; There is a statistically significant relationship between petroleum energy consumption and foreign direct investment.

H_1; There is no statistically significant relationship between petroleum energy consumption and foreign direct investment.

Hypothesis 3.

H_0; There is a statistically significant relationship between electricity energy consumption and economic growth.

H_1; There is no statistically significant relationship between electricity energy consumption and economic growth.

Hypothesis 4.

H_0; There is a statistically significant relationship between electricity energy consumption and foreign direct investment.

H_1; There is no statistically significant relationship between electricity energy consumption and foreign direct investment.

Hypothesis 5.

H_0; There is a statistically significant relationship between renewable energy consumption and economic growth.

H_1; There is no statistically significant relationship between renewable energy consumption and economic growth.

Hypothesis 6.

H_0; There is a statistically significant relationship between renewable energy consumption and foreign direct investment.

H_1; There is no statistically significant relationship between renewable energy consumption and foreign direct investment.

Hypothesis 7.

H_0: There is a statistically significant relationship between foreign direct investment and economic growth.

H_1: There is no statistically significant relationship between foreign direct investment and economic growth.

Hypothesis 8.

H_0: There is a statistically significant bi-directional relationship between energy consumption and economic growth.

H_1: There is no statistically significant bi-directional relationship between energy consumption and economic growth.

Motivation of the study

This study is motivated by economic, technological, social, policies & regulations, and environmental factors as described below. The fact that countries also have different contexts motivated this study.

Economic Factors

This research is motivated by economic factors. The energy sector in Kenya employs many people, it has reduced the unemployment levels in the country. The renewable energy sector has brought about new industries such as selling solar panels, enabling established companies and citizens to be employed. Foreign companies have pumped a lot of money into the economy ensuring that the economy grows. The major companies in energy Kenya Power Company and KenGen are listed in the Nairobi stock exchange contributing to the economy.

According to De Mello (1997), FDIs speed the growth of the economy in the host country by enhancing the knowledge and skills spillovers, which depends to what extent there is extrusion or complementarity between domestic investment and FDIs. In their studies, Qiang and Kunrong (2001) examine human capital and FDI in an endogenous growth model and utilized panel data from 1987 to 1998 from China. They conclude that the growth in foreign direct investments increases the rate of economic growth.

Social Factors

Socio-economic factors are another motivation for this study. Both energy development and investments from foreign entities uplift the living standards of communities and decrease the poverty levels especially for developing economies. Amenities emerge due to activities such as oil drilling bringing about schools, hospitals

and other social amenities including infrastructure. The rural electrification program has improved counties in Kenya which would otherwise have been cut off from the rest of the economy. Tullow Oil company which started drilling in Turkana shifted the economic activity of the locals from nomadic life. There have also been cultural changes bringing about westernization from expatriates.

As per Kazmerski (2008) energy is vital for the progress of human life in addition to social development. For the economy to grow, energy is required for power. He found out that in most developing countries, the consumption of rural energy has caused a lot of damage to the eco-environment and has led to detrimental effects from a socio-economic viewpoint. Contrarily, the traditional utilization of biomass is the major method for lighting & heating and cooking.

Technological Factors

Another driver of the study is technology considerations. The energy sector has brought about tremendous advancements in industrialization which has encouraged technology to improve including modern machinery in Kenya. As per Wang, Gao and He (2012) China has experienced tremendous growth in economy leading to increased demand for energy. China got a significant amount of foreign direct investments. As per the studies of Alfaro, 2010, foreign direct investments in China have led to advancements in energy efficiency using technology effects. He further notes that the boost of foreign direct investments for the tertiary industry in China, expedited the optimization and upgrading of Shanghai's industrial design. It is therefore important for the government to make use of in-depth management styles and innovative technologies to better efficiencies for all forms of energy. The advancement in new technologies would lead to an environment-friendly country and resource-saving.

Environmental Factors

Environmental elements are driving this research. The environment is directly affected by energy generation, production, and utilization. Oil drilling has adverse effects on the PH of the soil, displacement of wildlife & people, and health issues for both animals and humans including cancer from oil spills. According to Arouri, Youssef, M’henni, and Rault (2012) a majority of the empirical studies including among others, Soytas et al. (2007) and Kraft & Kraft, (1978) have put their focus on the emissions of different pollutants including Sulphur and carbon dioxide in developed countries. They focused

their analysis on the Middle East and North Africa region (MENA). Their conclusion suggested that other countries in the MENA region need not sacrifice their economic growth to reduce the discharge levels because they can achieve carbon dioxide discharge reduction through energy conservation without having a negative long-run impact on the economic growth.

Over the years there have been guidelines on carbon dioxide emissions, example being the 1997 Kyoto protocol which aims to reducing greenhouse gases (GHG) which is the cause of climate changes by reducing these emissions to 5.2%, enforceable from 2005. Kenya's total GHG emissions in 2013 is 60.2 million metric tons of carbon dioxide equivalent (MtCO2e), totaling 0.13% of global GHG emissions. The agriculture sector emitted 62.8% of total emissions, followed by the energy sector (31.2%), industrial processes sector (4.6%), and waste sector (1.4%). Kenya's Intended Nationally Determined Contribution (INDC) commits to reducing GHG emissions by 30% (143 MtCO2e) relative to business-as-usual levels by 2030, contingent on receiving international finance, investment, technology development and transfer, and capacity-building support. The carbon dioxide emissions in Kenya are not significant as Kenya is not as industrialized as the developed countries. This paper, therefore, does not focus on the CO_2 emissions as part of the variables.

Policies and Regulations

Rules, policies, and regulations are drivers in this study. Most especially the tariff rates applied for power for the different consumers. There are many policies, rules and regulations that are formulated and implemented by the different players in the energy sector in Kenya. These include Kenya Power Company, Kenya Electricity Generating Company (KenGen), Kenya Renewable Energy, Independent Power Producers (IPPs) who build and own power stations, Energy & Petroleum Regulatory Authority (EPRA), the Ministry of Energy, Rural Electrification and Renewable Energy Corporation (REREC), Kenya Electricity Transmission Company (KETRACO) who construct transmission lines with the funding from the Kenyan Government, Geothermal Development Company (GDC) and Kenya Nuclear Electricity Board (KNEB).

Different Country settings

Developed countries differ greatly from developing economies. The African countries vary as well from region to region. Kenya is the leading country in the East

African region. This is an interesting research area as there is a lot of debate on various energy matters in Kenya including complaints about the high costs of electricity, debate on whether electricity generation and distribution can cease to be monopolies, tapping into solar energy, high costs of fuel and restrictions being placed on the petrol drilling in the Turkana region due to tribal lines.

This research would add value to the energy sector in Kenya by explaining how energy consumption affects the country's income. This would help to reduce or mitigate emissions- Kenya is rampantly growing into an industrial hub, and this comes with emissions of gases which must be managed and controlled. The research would aid in coming up with several policies including reducing energy consumption, increasing energy efficiency, decreasing energy intensity, and increasing efforts towards forestation- since there are so many encroached forests in Kenya. Kazmerski (2008) found out that generally, varying or comparable conditions together with socio-economic backgrounds, have brought about the same patterns in domestic energy utilization for developing countries all around the globe such as Nigeria, Bangladesh, India, Sudan, and Sri Lanka. He observes that there have been varying outcomes on the socio-economic environment that has resulted from using biomass including limited education opportunities, health deterioration, and degradation in land.

Research Organization

The research is organized from chapter one to chapter five. Chapter One is as covered in the research organization section of this document. Chapter two covered literature review on past studies done on the relationship between energy consumption and economic growth together with the role of foreign direct investments.

This chapter has theoretical reviews delving deeper into the different theories applicable on the topic. Chapter three describes the data and the methodology for the research. The research design, data collection techniques & analysis procedures and models are reviewed here.

Chapter four shows the findings from the data as well as highlighting the results of the analysis per area. Chapter five summarizes the results of the different variables tested in the previous chapter, gives discussions, conclusions, recommendations and limitations of the study as well as providing recommendations for further research.

Summary

This chapter covers the introduction of the study where the dependent - GDP, independent variables which are energy consumption and the moderating variable-FDI. The chapter goes ahead to give the background of this research stating the purpose of the study, what is intended to be examined and the reasons, the problem statement giving the research gap, and empirical reviews of other scholars. The research questions and research objectives are defined here. The motivation of the study is given showing the economic factors, social, technological, and environmental factors as well as the focus on the different country context, Kenya being a developing country. The chapter goes ahead to analyze the scope of the study by stating the country of study, the industry to be reviewed, the period of study, and the reasons for each. The chapter ends with the contribution of the study in terms of the motivation in the literature, theory, and how it aids other users.

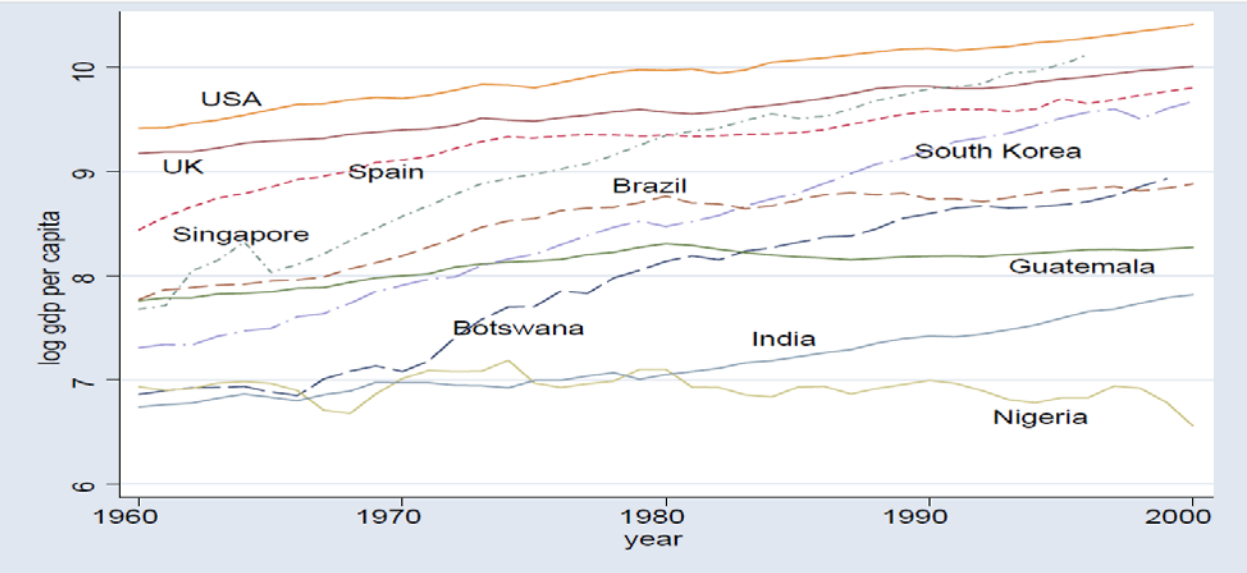
Chapter 2: Literature

Economic Growth

Ivic (2015) describes economic growth as the consistent increase in the volumes of production in an economy, or increased GDP which is the most important quantitative indicator for one economic year. Development of the economy of a country entail both qualitative changes and quantitative changes. Qualitative changes include the emergence of new industry sectors, changes to the structures of the economy, and the creation of new job opportunities. Economic growth ensures that there is a complete and improved satisfaction of all human needs for the population. Economic growth entails reforms to material production over a short period, taken annually. Economic theory states that economic growth is the yearly increase in material production value shown either as the National income or growth rate of GDP. Growth is easily achieved as it covers a short period, but economic development is measured over a long period, say five years. Another vital factor of economic growth is labour productivity which represents the aggregate total output divided by a total number of working hours for a specific sector of an economy.

Acemoglu (2010), demonstrates a different perspective on the economic growth patterns using a graph where he plotted the log GDP per capita for some economies from the year 1960 to the year 2000. At the top of the graph are the US and the UK which have had expeditious growth in their GDP and expansion at a steady rate but a slightly higher growth for the US in the year 2000 than in the year 1960. Spain started in a much poorer position than both the UK and the USA in 1960 but grew steadily between the year 1960 to the mid 70’s, hence bridging the gap between itself and both the UK and US. The 3 countries which showed very accelerated growth in the below graph are Botswana, Singapore and South Korea.

Figure 6: The Evolution of GDP per capita in the US, India, South Korea, UK, Brazil, Botswana, Guatemala, Singapore and Spain (1960 – 2000)



Note. Adapted from *Introduction to Modern Economic Growth* by Acemoglu, 2010, p.35.

Singapore started in a poorer position compared to Spain and the UK in the year 1960 but grew very speedily and in the mid-1990s it became richer than both Spain and the UK, and even surpassed all the other countries with the exception of the USA. South Korea shows the same trajectory as Singapore, but it starts even poorer and grows slightly less speedily overall, such that by the year 2000 it is still in a poorer position than Spain. The country that represents the African success story is Botswana which was a very poor country in 1960. The fast growth, mostly after the 70's, has made Botswana go to the middle-income economies ranks by the year 2000. Guatemala and Brazil which are the Latin-American countries plotted here, portray the often-discussed Latin American economic malaise of the post-war era.

Brazil starts at a richer position than Botswana, South Korea, and Singapore, and grows rapidly between the year 1960 and the year 1980. Brazil then stagnates from year 1980 going forward, such that in year 2000, Singapore, Botswana and South Korea are all richer than Brazil. Guatemala has the same experience as Brazil or even worse, with minimal growth between the years 1960 to 1980, and zero growth between the years 1980 to 2000.

Despite having started at the same point as Botswana in 1960, India and Nigeria also have minimal development until the 1980s, when the Indian economy exploded.

Unfortunately, this is not enough for its expansion per capita to keep pace with that of other countries. Typical of the economies in sub-Saharan Africa, Nigeria has its economy decline in the year 2000, making it poorer than it has been in 1960. Acemoglu (2010) attempted to comprehend these trends by bringing up a number of questions, such as how the United States, which is relatively wealthy in 1960, is able to maintain rising steadily, how three countries—Botswana, South Korea, and Singapore—managed to keep developing for 40 years, why Spain rapidly expanded for about 20 years before slowing down, how Guatemala and Brazil became economically stagnant in the 1980s, and what might account for the catastrophic decline of the Soviet Union.

There is an urgent need to examine the factors that influence growth in the economy in Africa, as sustaining economic expansion is still one of the continent's greatest development concerns (Anyanwu, 2014). Meanwhile, many developing countries, particularly in Africa, have taken notice of China's economic progress despite the country's recent minor slowdown. This is because China can leap from a lack of development and abject poverty to a rising global economic power in just thirty years thus attracting attention from African nations. Some significant questions arise in the process: To what extent might China serve as an example of successful development for Africa? Moreover, what can be learned from China's rapid economic development? Therefore, they examine the factors that led to economic expansion in Africa (both sub-Saharan and North Africa) by utilizing a sample consisting solely of African countries and a cross-sectional data set covering the years 1996-2010, divided into three-year averages. In examining the current state of trading, investments, and aid/debt connections between China and Africa, they also include data for China from 1980 to 2010. Consistent with previous research, they find that urban population, government effectiveness, domestic investment, education, net ODA inflows, and metal prices all have a positive and significant effect on economic growth in Africa. China's economic growth is being propelled by several factors, the most important of which are the country's trade openness, domestic investment, rural population share, and baseline income. On the other hand, China’s economic growth is being held back by several factors.

These include domestic lending to the private markets, population growth, inflation, net ODA inflows, telephone density, and agricultural and oil commodities prices. They

particularly find that while Africa is nearly twice as liberal as China, this fact does not work particularly well for the continent's economic development. One reason is that China exports more than it imports, while the opposite is true for Africa (with consumer products being the main import). In addition, unlike China which has made a quick transition toward manufacturing, Africa's export structure is skewed toward conventional primary commodity exports. Moreover, the amount of money invested in China's home market is roughly twice as much as Africa's. The most important takeaways for the African continent from the Dragon's epic journey are explored. As a continent, Africa is seeing its highest annual rate of growth in decades. In the years after the middle of the 1990s, the Continent's economic growth accelerated, eventually reaching annual growth rates of above 5 percent. The difficulty lies in sustaining this momentum and turning it into real change through quick job creation, less poverty and inequality, and an economically more diversified society. Using the gains of the current economic boom to lessen the continent's reliance on those commodities is a massive undertaking.

On the contrary, the rapid economic development in China has led to significant enhancements in people's quality of life. Over the past three decades, China's per capita income has increased dramatically largely due to the country's consistently high economic growth rates of around 10 percent. China's per capita GDP in 1978, the same year its amazing transition began, is only a third compared to sub-Saharan Africa. China has achieved upper-middle-income status in just three decades. This resulted in more than 500 million individuals being taken out of poverty throughout the country. Africa has a lot to gain from studying China's economic success. African nations are eager to follow China's lead, but it's not easy to duplicate China's rapid economic development. The 54 sovereign nations that make up Africa have their own unique institutional frameworks and socioeconomic situations. For example, many African countries lack high-quality institutions and the skilled manpower necessary to implement a developmental state model, like China's. As a result, the suitable growth concept for every African country would vary according to the unique set of binding constraints faced by each nation and its level of implementation capacity.

Nonetheless, there are shared features and lessons that these nations can take away from China's economic development. They can learn from China's success by focusing on the following factors: a strong central government; domestic investment and

saving; export-oriented trade policies; institutional reforms; export diversification; public-private partnerships (PPPs); and technical innovation and adaptation. These insights can be utilized to tailor growth strategies to the specific needs of certain African nations. Furthermore, a well-functioning economy, major devotion to institutions and policies that support manufactured exports, etc., are all necessary for Africa to achieve consistent and robust economic growth. In particular, export diversification and international manufacturing competitiveness call on a system of efficient institutions connecting the domestic market with global markets. More innovative approaches are required to encourage infrastructure investment, particularly of the regional variety, including regional integration and public-private partnerships (PPPs).

Last but not least, as African countries undertake a massive structural reconfiguration of their economic systems, it will be crucial for the state to play a proactive approach, supporting role in trying to compensate for externalities developed by innovator corporations in industrial growth and organizing the favorable investments and advancements in hard and soft infrastructure, over which businesses cannot rationalize in their policy choices (Lin, 2011). This will aid these nations in harnessing the benefit of their relative underdevelopment to create robust, long-term growth that benefits everyone.

Sub-Saharan Africa's poverty is one of the world's most significant challenges (Bloom & Sachs, 1998). This area has been the poorest and most slowly developing in the globe since the advent of the Industrial Revolution. During the period between 1820 and 1992, Angus Maddison calculated the most reasonable estimate of global and regional GDP. Forecasted long-term growth trajectories for some regions are displayed in Figure 6. Sub-Saharan Africa (henceforth, Africa) reportedly started the modern era with an income bracket that is roughly one-third that of Western Europe, the wealthiest region at the time. In 1992, its per capita income is roughly 20 per cent of that of the wealthiest region, which is Maddison's "western splinter groups," which consists of Canada, Australia, the United States, and New Zealand.

According to Maddison’s estimates, Africa's 1992 per capita GDP is comparable to that of Western Europe in the year 1820.

The history of good governance and effective institutions in Sub-Saharan African countries is complicated. Good governance and strong institutions are becoming more valued by economists and policymakers as essential to fostering prosperous economies

(Fayissa and Nsiah, 2010). African Heads of States since joined hands to form the “New Partnership for Africa's Development” (NEPAD) in October 2001. Although initiated by African leaders, NEPAD has received the backing of G8 members including China, the European Union, and Japan. It aims to eradicate poverty, promote sustainable development and growth, integrate Africa into the global economy, and speed up women's empowerment. The principles of NEPAD rest on the notion that sustaining high levels of good governance, civil rights, democracy, and dispute resolution is crucial to fostering an environment that attracts investment and sustains economic growth over the long term. This research set out to examine the crucial aspects of poor governance to the sluggish expansion of African economies, taking into account the more obvious causes of slow expansion. Their findings indicate that differences in per capita income between wealthy and poor African countries are partly attributable to differences in governance. The findings also suggest that the impact of governance on national income development varies by both type and level (income growth). The objective of the research is to determine whether there is a correlation between excellent governance and increased GDP per capita in Sub-Saharan African countries and, if so, whether or not this correlation varies depending on the GDP per capita’s conditional distribution. One overall indicator of good governance is examined alongside six separate sub-categories of effective governance (political stability, voice and transparency, government effectiveness, quality of institutions, legal system, and corruption control). The empirical findings stem from a panel of data collected annually for 28 African countries from 1995 to 2005. Results from the alternative estimated models indicate that, regardless of the proxy chosen, effective governance is positively and significantly correlated to economic growth. Additionally, the findings show that the effect of good governance varies depending on GDP per capita’s conditional distribution. The most important takeaways from this research emphasize the significance of strong governance in fostering economic growth in low-income nations in sub-Saharan Africa. Domestic and international policymakers may need to place heavy emphasis on issues like citizen participation and participation in decision-making, government transparency and accountability, government efficiency and effectiveness, institutional quality and legal system, and corruption control if Sub-Sahara Africa is to break its trend of persistently low economic growth.

Adusei (2016) contends that there appears to be some doubt regarding how much of an asset entrepreneurialism is to the expansion of developing countries. The widespread prevalence of replicative entrepreneurship (entrepreneurialism that is widely thought to be non-growth-oriented) in emerging economies such as Africa contributes to the general cloudiness of skepticism around the topic. Motivated by this hypothesis, the research set out to determine if entrepreneurial activity contributes in any way to the development of 12 African nations. The findings support the hypothesis that entrepreneurialism is a primary driver of the observed differences in economic development across the sample set. Therefore, it is acceptable to argue that entrepreneurship, even if replicative, is essential to economic progress in emerging economies like Africa. In this study, researchers analyze the economies of 12 different African countries to see if entrepreneurialism contributed to economic growth.

According to the study's findings, entrepreneurial activity is positively correlated with economic development. As a result, the researchers believe it is possible that entrepreneurialism will drive economic growth in Africa. The findings also show that the economies of the countries under study benefit from greater economic freedom. Experts say that factors like inadequate trade policies, poor human resource management and government regulations that are dismissive to entrepreneurialism in Africa contribute to the low competitiveness of the continent's raw agricultural products. Since this research has shown that entrepreneurialism is a growth-promoting factor, researchers believe it is imperative that policymakers give these factors the attention they require in promoting economic growth. How can government officials help spur business growth in Africa? According to Kanter (1983), preferred behaviors can be promoted through conversation and cultural cues. Nonetheless, public discourse and national culture are essential at the national level in order to encourage entrepreneurship among the community. Growth in entrepreneurial activity may result from the dissemination of information about markets and technologies on a national scale.

This can be greatly aided by the development of a country's "knowledge infrastructure," which is the sum of the number and variety of channels through which ideas can travel and the degree to which a significant proportion of a nation's population enjoys access to the techniques and media (Kshetri, 2011). For Africa's economies to flourish, it is

imperative that education, internet connectivity, and mobility not be the exclusive purview of a privileged few.

Onafowora and Owoye (1998) analyze the potential effects of recent reforms to trade policies, investment, and exports in 12 countries in sub-Saharan Africa (SSA), with a focus on their impact on economic growth. Their analysis of 12 SSA nations utilizing vector error correction model (VECM) shows that trade policy, investment rate shocks, and exports all have a substantial role in GDP growth in ten of the 12 countries. That could mean that some African countries could benefit from a more export-oriented economic approach. The findings also highlight the significance and urgency of trade liberalization initiatives in the modern global economy, particularly for African countries. It is seen that when policies transition from being highly inward-looking to being more outward-looking, economic growth improves. Trade policies have hindered expansion in four African countries including Nigeria, Ethiopia, Ghana, and Tanzania. Statistics show that trade policies have a considerable negative impact on economic growth in Tanzania and Ethiopia out of the four nations. Moreover, the data indicate that the export expansion's contribution to economic growth appears to be autonomous of each nation’s trade strategy. Significantly, their empirical findings affirm the hypothesis that trade liberalization, which encompasses national policy reforms that diminish government restraints and regulations, may result in a better utilization of assets and promote maintained economic development in growing SSA states. Lastly, Table 3 contains the results of the breakdown of the forecast-error variances. Considering their central focus is on changes in economic growth that is likely to emerge from impacts to trade policies, investment, and exports, they only showcase the variance decomposition for the authentic output growth equation for 12 prediction timelines. These findings are particularly interesting since they demonstrate the uniqueness of each predictor variable in clarifying the differences in real GDP growth for each sampled nation. These findings are particularly interesting since they demonstrate the uniqueness of each predictor variable in clarifying the differences in real GDP growth for each sampled nation. For instance, they used Cote d'Ivoire and Cameroon as an illustration as these two SSA nations who have continually maintained a strong outward-oriented economy, per the World Bank. The variance decomposition findings support the outcomes which is shown in one of the tables in their findings. In other words, trade policy innovations have a big

impact on actual output growth prediction. The findings for Nigeria, Burundi, and Sudan indicate that real production growth is heavily dependent on its own shocks, which account for more than 70 per cent of real GDP growth variance even after 12 prediction horizons. Overall, the variance decompositions' findings demonstrate the importance of each predictor factor in determining actual output increase. The findings suggest that improvements in investment rates and/or exports, but not trade policy, have a major predictive impact on real production growth in some of these nations.

Ajide, Ajisafe & Olofin (2019) examine the relationship between economic growth and entrepreneurship in low-income nations, focusing on the significant role played by capital controls. Data for 44 developing nations is collected and analyzed utilizing panel generalized technique of “two-stage least square” and moments from 2005 to 2014. The findings suggest that entrepreneurship significantly contributed to economic expansion. The research also showed that the strength of the interaction between economic growth and entrepreneurship in emerging nations is influenced by the severity of capital regulations. Not only do these findings line up with conventional logic and experience, but they also meshed perfectly with the data from prior investigations. On a theoretical level, it supported the position taken by Keynesian economists who advocate for capital regulations. Capital limitations, especially those imposed on emerging nations, have been connected to the degree to which potential expansion influences entrepreneurship. The current investigation empirically pursued this approach to thinking by analyzing the impact of capital regulations on economic growth and entrepreneurial activity in a cross-section of forty-four (44) emerging nations between 2005 and 2014. Methods for estimating panels of data (generalized method of moments and two-stage least-squares, respectively) is utilized in the study to investigate central issues and assess key questions. As a result, the researchers came to the following observations. To begin with, their estimated findings demonstrate that entrepreneurship has a positive and significant impact on economic growth in low- and middle-income countries. The intensity of capital controls varies geographically, with beneficial and significant impact on economic development in emerging nations. To be more precise, capital controls strengthen and encourage entrepreneurialism, which in turn stimulates economic expansion. Consequently, the productivity function of the model for economic growth should incorporate the intensity of capital control and entrepreneurialism as key variables. All

things considered, these findings are in line with prior empirical research and consistent with both intuition and experience.

Additionally, they concur with Keynes economists who advocate capital regulations as a measure to protect against the volatility of the global economy and the potential for capital outflows, which, among several other things, reduces potential growth, erodes the tax system, and redistributes wealth from the poorer to the wealthier. Numerous policy implications can be inferred from these findings. It is worth mentioned that the intensity of capital control is crucial for enhancing and securing the beneficial link between economic growth and entrepreneurship. As a result, it is the responsibility of decision-makers to guarantee that effective or selective (and not necessarily total) capital controls are implemented. Empirical research demonstrates the need for an entrepreneurial setting policy, as a method to combat unemployment, to be developed and implemented in order to promote entrepreneurial activity. The biggest improvements in entrepreneurship would come from programs that support entrepreneurial activity, such as tax incentives and subsidies, as well as by lowering the responsibilities that the government places on entrepreneurs.

Background of Economic Environment in Kenya Connected with GDP

M'Amanja and Morrissey (2005) analyze how the Kenyan economy is performing in the first decade after the independence in the year 1963. From the year 1964 to the year 1973, GDP is an average of 6.6% for each year, this is much better than the other East African countries which is newly industrialized. This is due to a consistent economic guideline, the promoting of small-scale agricultural farmers, high demand in the domestic market and expanding the market to carter for the local outputs within the countries in East Africa. In the decade following, the options leading to easy economic growth are curtailed by the happenings of forceful external shocks which, in conjunction with reckless monetary and fiscal policies, caused a period of slow and relentless economic slow-down averaging a real GDP of 5.2% in the period. The impacts of the expansion in fiscal policies are felt in the third decade leading to the development of a very protected and grossly ineffective private sector and government agencies, which led to a strain on the already scarce resources. Imports and exports declined, there were budgetary shortfalls, and the performance of the economy fell to an average of 4.2% within this period. The downward trajectory went on even after 40 years of independence, poor monetary and fiscal

regulations & policies coupled with internal and external shocks led to the worst-performing economy in Kenyan history averaging a real GDP of 2.2% between the years 1990 to the year 2002.

As per Jacques (2010), he delves into the economic growth of 10 countries in the Sub-Saharan region using time-series data for South Africa, Kenya, Angola, Ghana, Cameroon, Senegal, Congo, Liberia, Cote d'Ivoire and Nigeria. He noted that in the two decades prior these countries have enjoyed significant inflows in foreign direct investments in these economies leading to higher per capita GDP. He further observed that many of these African countries rely on the export of goods such as minerals, cocoa, coffee, and rubber. He further observes that in order to attract even more foreign direct investments, these countries have implemented a number of guidelines and institutional frameworks in order to increase the population welfare and general incomes.

Gachunga (2019) explores how foreign direct investments affect the growth of the Kenyan economy. UNACTAD (2013) explained how Kenya received huge amounts of foreign direct investments in the 1960s and 1970s but these have ever since declined significantly in the past decades. This is despite Kenya being a country with a lot of movement and whose economy is characterized by major knowledge-based enterprises, exports, and technology. The Kenyan economy is currently very encouraging economy towards foreign investors, offering numerous opportunities to venture and grow locally. United Nations states that FDI is the foundation of ensuring Kenya has a sustainable growth in its economy. As per UNCTAD (2013), the Kenyan Government has sought more active strategies for enticing FDIs by focusing on issues like promoting agricultural activities, enhancing production of consumer goods, and diversifying export processing zones to make Kenya a territorial center.

Gross Domestic Product (GDP)

As per OECD (2009), Gross domestic product is a measure of output and nationwide income for an economy at a particular period in time. GDP is defined based on the entire value of the market for the final services and goods produced in an economy at a certain period, usually defined annually. The appraisal procedure for GDP involves the aggregate of all value additions at each production step including the intermediary stages to achieve the commodities made in a country for a period of time in monetary terms. Gross domestic product (GDP) is the vital measure of a country’s economic growth

and development. It shows the market value of the aggregate final goods and services produced in an economy at a certain time period. GDP uses the market values which are the prices used to value production of final services and goods which are produced for the final consumers. The time period for GDP is always defined as annually, monthly or quarterly. The theoretical framework of Keynesian viewed; savings, investments and government expenditure as the major factors which determine the rate of GDP. GDP is an aggregate of the foreign and domestic demand of national goods. Foreign demand arises when there are goods for export.

Further OECD (2009) explains that GDP is vital as it shows information on the size of the economy of a country and how a country is performing. The GDP's rate of growth is usually an indication of the general health of an economy. Broadly speaking, a boost in GDP shows that the economy is performing well. As real GDP grows rapidly, then employment is likely to increase as industries would employ more staff for their offices and factories therefore the population would have more income at their disposal. The dwindling of the GDP causes a decrease in employment as is witnessed for many economies during the past worldwide economic crisis.

GDP measures the overall health of a country's economy. GDP is a measure of the economic value of all new finished goods and services produced within a country's boundaries in a given year. GDP measures the overall health of a country's economy. The GDP is a measure of the economic value of all new finished goods and services produced within a country's boundaries in a given year. To aid in America's economic recovery from the Great Depression, its pioneer, gross national product (GNP), was created in the 1930s. There is an absence of complete economic data available to the government at the time, making it hard to tell if policy measures are having an effect. Simon Kuznets, a Russian-born American economist, created the first national GNP measurements. His approach was straightforward: reduce all information about economic output to a single figure that would rise in good times and fall in bad (Fioramonti, 2013). During World War II, Kuznets's system of national accounting is crucial. It helped the United States identify underutilized sectors of the economy and achieve record levels of output previously considered impossible. This is because, as remarked by Cobb et al. (1995), "in the US, the Manhattan Project earned far more fame. However, the creation of GNP accounting is just as significant of a technological achievement. After World War

II, the 1946 Employment Act formalized GNP as the United States' economic policy. Consequently, an international framework for a standardized national accounting system account is released by the United Nations in 1953. During that time, Simon Kuznets's theories have been discussed all around the world. Economists began to hope they might eventually master the feared "business cycle" (Cobb et al. 1995) by appropriate fiscal management and precise understanding of economic strength (as represented by GNP). However, there are many who do not agree with GNP. For instance, to assess economic growth, the Soviet Union relied on a different metric than GNP called net material product, which counted only tangible commodities and not services. In the communist model, services are not the source of wealth but rather its byproduct. Both the United States and the Soviet Union employed the two measures as propaganda tools all throughout the Cold War, with each side claiming superior economic growth rates based on their own indicator. However, following the collapse of the Soviet Union in 1991, GNP remained the only game on the scene (Fioramonti, 2013). At the same time, the term "national" product is quietly dropped in favor of "domestic" product. Even though the two metrics are linked, they do not have the same meaning. For instance, suppose one uses the GNP to track the success of a global corporation, they'll see that the money made by that corporation is credited to the country of origin for its owners. When calculating GDP, however, the region where the company is located, and the resources are extracted receives credit for the earnings even if some of those profits are repatriated. This modification to economic analysis has substantial effects, most notably bolstering globalization. "The countries of the North are strolling off with the resources of the South, and calling it a win for the South," wrote Cobb et al. (1995). Even back in 1934, Simon Kuznets cautioned that "the prosperity of a country can barely be derived from a calculation of national income." Kuznets turned into a vocal critic of how his method of accounting was being applied, by 1962, arguing that "goals for 'greater' growth should clarify more expansion of what and for what". GDP's fundamental weakness is that it counts all economic activity equally, without distinguishing between bad and good activities. An individual's spending habits like buying a beer or a bicycle influence the GDP. Government spending on education also boosts GDP. Both are costs that can be perceived as having a net positive effect. But if there's an oil leak and the government must foot the bill to clean it up, that adds to

GDP as well. Moreso, expenditures on divorce processes have a positive effect on GDP, especially if they occur at a higher rate.

The primary index of national progress includes the effects of war, criminality, and environmental degradation. This is a calculator without a "minus" button and has a huge "plus" button. However, as no money is exchanged during activities such as volunteering or household work, many positive activities like those are not included in the GDP. The GDP is not increased if I do my laundry. Conversely, if I was to pay someone $10 to do my laundry and they also pay me $10 to do theirs, GDP would increase by $20 despite the fact that the quantity of clean clothes would remain the same. Furthermore, GDP does not address the issue of income distribution.

If the increase in GDP per capita is only shared by the wealthiest, then the standard of living for the majority of people may not improve. According to van den Bergh (2009), when wealth and income aren't shared fairly, it means that people aren't afforded the same opportunities. Several social indices imply that growth seems to be no longer enhancing people's lives in wealthy nations, making a policy of perpetually expanding GDP all the more concerning. Once one's annual salary exceeds roughly $20,000, it seems that no amount of money can make one any happier. American candidate for President Robert Kennedy was especially critical of GDP in 1968, saying that it "quantifies neither our intelligence nor our heroism, neither our intellect nor our knowledge, neither our tenderness nor our love to our country." In short, all aspects of life are quantified, except those that truly matter (Fioramonti, 2013). However, GDP continues to carry substantial influence despite these critiques. According to Fioramonti (2013), the field of economics has fallen victim to a dangerous sort of "groupthink," in which the fear of being wrong leads experts to avoid bringing up contentious issues and offering novel solutions. Even though there is no empirical support for this theory, policymakers worry that inadequate growth would cause economic instability and increased unemployment. He went further to note that, the GDP is more than just a numerical measure because it represents a social structure founded on the notion that marketplaces are the only sources of income. Therefore, to question GDP is to question the market system itself. If this is the case, replacing GDP would primarily be a political endeavor rather than a technical one. However, there is an increasing awareness that GDP is indeed a poor indicator of performance and a greater determination to take action as a result. Two Nobel

Prize-winning economic experts who head the “Commission on the Measurement of Economic Performance and Social Progress,” which former French President Nicolas Sarkozy established, came to the conclusion that among the possible explanations the global financial crisis caught everyone off guard is that they are focusing on the wrong indicators (Stiglitz et al., 2009). So, if our collective objective changes from growth to degrowth, what metrics should people be using? It could be enticing to use GDP as a measure of degrowth by simply shifting the target (from, say, +3% annual growth to -3% annual growth), but this is not a smart idea. A fall in GDP might indicate that environmental pressure is lessening, but it wouldn't indicate if the degree of economic activity remained environmentally sustainable. Furthermore, a drop in GDP still wouldn't necessarily indicate social advancement. Changing the aim for a subpar indicator does not change the reality that GDP is still a poor indication of progress.

The smartest way people can do regarding GDP, in the words of environmental economist Herman Daly, is to forget about it. An alternative strategy that calls for two distinct kinds of indicators is necessary to measure degrowth: (1) A combination of socioeconomic factors to gauge whether the life quality of people is improving and (2) a collection of biophysical metrics to gauge how society's level of resource consumption is evolving over time and if it is within ecological bounds. I use "combinations of variables" rather than "one variable" to highlight the fact that degrowth could serve a variety of purposes, each of which may call for a different type of measure. Degrowth contrasts sharply with neoclassical economics, which places a singular emphasis on utility maximization. I have developed a set of "Degrowth Accounts" to gauge whether degrowth is happening and how stable it is, in part based on the resolution from the first global degrowth conference, which is held in Paris in 2008 (O'Neill, 2012).

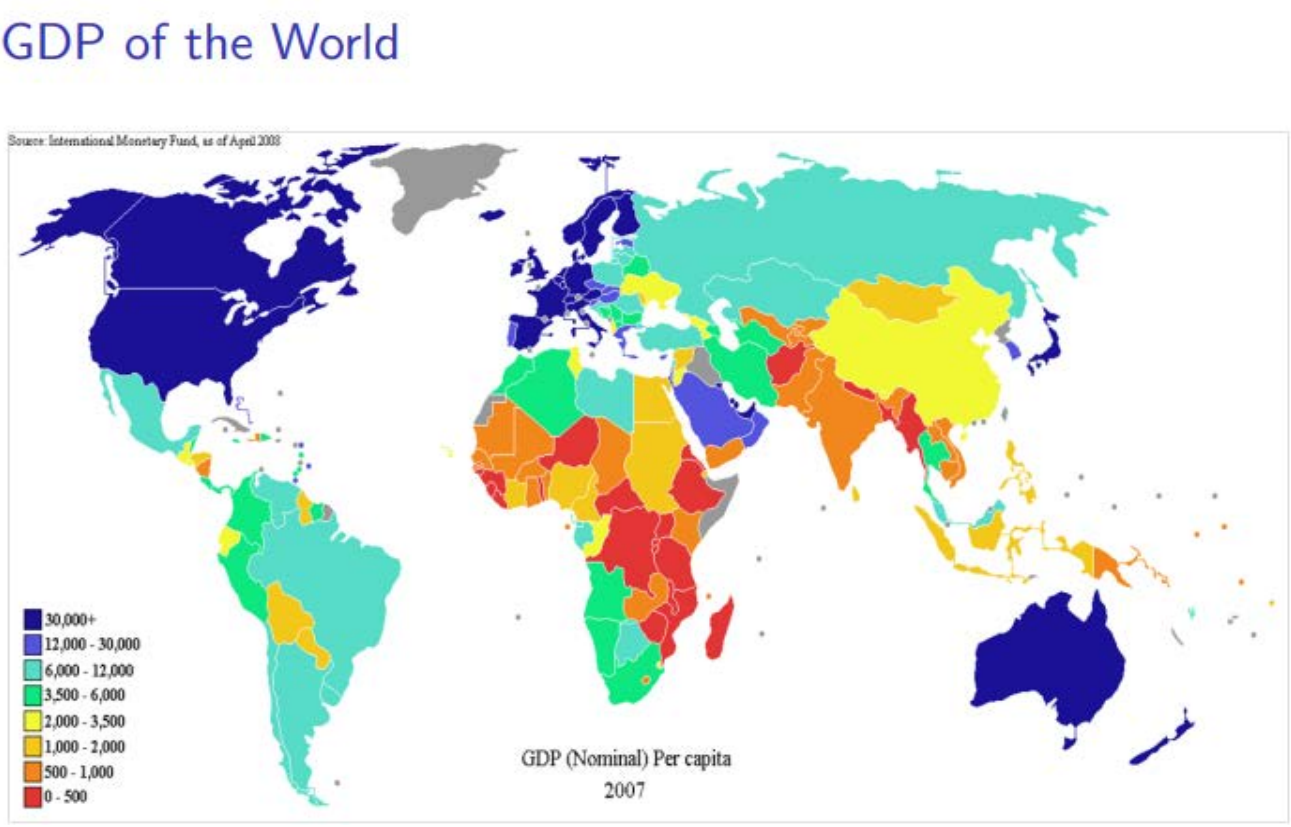
These accounts comprise nine social indicators (health, working hours, equity, social capital, poverty, happiness, participatory democracy, inflation, and unemployment), in addition to seven biophysical variables (energy consumption, built capital material use, CO2 emissions, human population, ecological footprint, and animal population). These do not incorporate GDP, and no contemporary set of economic metrics should either. GDP developed during a time when society faced substantially different problems than it does now. Now that people no longer live in a time of perpetual war, our greatest challenge is to increase human happiness within the limits of our home planet's

ecosystems. To make the transition from economic growth to sustainable degrowth, developed countries will need to adjust their metrics of success. It is imperative that they move away from GDP and adopt new, more useful metrics.

Boldeanu and Constantinescu (2015) state that there are several determinants of economic growth that are interrelated. The vital factors determining economic growth are divided into 6 but categorized as undersupply, demand, and efficiency. Supply determinants include technology, human resources, natural resources, and capital goods, these have a direct impact on the value of services and goods. The increase of the different components affecting economic growth has varied impacts. The components include private investment, public expenditure, public investment, capital formation, rates of employment, and exchange rates which all have varied impacts depending on the development of the country. Social and political elements, as well as events, have a significant effect on the economic development of a country.

According to Acemoglu, (2010), economic growth determinants are divided into economic aspects known as proximate and non-economic aspects referred to as Ultimate. Economic determinants include accumulation of capital, and progress in technology and labor, while non-economic determinants include political systems, administrative networks, government efficiencies, social factors, cultural elements, demographical and geographical aspects. Several scholars came to the conclusion that spending on defense has a negative effect on economic growth such as Pieroni (2009), Ho and Chen (2014) and Benoit (1973), who delve into the impact of military spending on economic growth. Arusha (2009) explores how governance affects economic growth for seventy-one transitional, developed and developing economies from year 1996 to year 2003. He concludes that economies with weak governance structures grow slower than those with strong governance frameworks.

Figure 7:GDP of the World



Note. Adapted from *Introduction to Modern Economic Growth* Source by Acemoglu, 2010, p. 12.

Mahadevan and John (2007) re-investigated the energy consumption–Gross Domestic Product growth nexus for data on twenty net energy exporters and importers between the years 1971 to 2002. In developing economies, consumption of energy triggers economic growth only in the short run while for the energy-exporters, there is a bi-directional causality between growth in the economy and consumption of energy for developed economies for both the long and short run. Lian, Suocheng, Lia, Quanxi, and Wangzhou (2011) apply different panel techniques in order to investigate the co-association between the consumption of energy and the growth of the economy in 30 provinces in China between 1985 and 2007. They conclude that there exists a long-term positive relationship between the variables of real GDP per capita and consumption of energy. The growth of the economy for East China is purely energy-dependent, and the income elasticity of consumption of energy for West China is only half of that of East China.

Maamar and Mehdi (2011) question the relationships between consumption of energy and economic development for whole Tunisian economy including performance of industries, residential and transport sectors between year 1980 to 2007. Their conclusions have vital policy ramifications. Whilst at a total economic level, energy acts as a vital component for the advancement of Tunisia, it does not seem to have any effect on the performance of the economy at a sectoral level. The findings seem to depend on the degree of disaggregation and hence policy recommendations should be given with caution.

Mircea and Neagu (2019) examine the long run linkage in an EU panel of countries between complexity of the economies, framework of energy consumption and discharges of greenhouse gases by distinguishing them into two subpanels: ones with lower levels of complexities and the ones with higher complexities. For all the 3 panels tested, findings showed that there is a long-run equilibrium link between complexities of the economies, discharges from the greenhouses and energy-consumption framework. Complexities of the economies and the frameworks of energy-consumption have a statistically significant effect on the discharges from greenhouse for all the panels, but this impact is more for the sub-panel of economies which have a low level of complexity in their economy, showing that there is a higher risk of discharges as the economic complexities grow and therefore the energy balance leans to favor non-renewable consumption of energy.

Salazar, Francisco, and Miguel (2019) explore if there exists a causal linkage amongst; carbon dioxide discharges per capita, fundamental energy consumption per capita, and GDP per capita for seventy-nine countries grouped by income levels from 1980 to 2014. There are mixed findings for the lower middle income and low income there are mixed results. The Granger tests showed that for high-income, upper-middle income and lower-middle-income groups, the gross domestic product has a bidirectional linkage with the fundamental energy consumption in both the long and short runs. A bi-directional linkage between carbon emissions and economic growth is detected for the low-income group in the short run.

Mehrara (2007) examines the linkages between the consumption of energy in per capita and the growth domestic product per capital for eleven countries in the oil-exporting region. He concludes that for the oil-exporting economies there exists a very strong

unidirectional linkage from the growth of these economies to consumption of energy which is very important for policy makers with macroeconomic matters. Sultan and Tarek (2019) attempted to comprehend how real output interacts with energy in India from the year 1971 to the year 2014. They discover that in the long rum there is a linkage which is stable between real output and energy consumption. For the short run, a unidirectional linkage is found for the two showing that energy causes economic actions for India. In the long-term, a bidirectional linkage exists between economic accomplishments and energy usage in India.

Yıldırım and Seda (2019) delve into the linkage between the consumption of energy and the growth of the economies of South Africa, India, Brazil, China, Turkey, and Russia which are the (BRICS-T) economies from the year 1990 to the year 2014. They conclude that there exists a bi-directional linkage between consumption of energy and growth of the economies of the BRICS-T countries. Increasing the GDPs leads to an advancement in the consumption of energy and also advancement in the consumption of energy leads to an increase in their GDPs. Balcilar, Ozdemir, and Yalcin (2010) analyze causal linkages between the consumption of energy and the growth of the economies in the G-7 economies from the year 1960 to the year 2006. They discover that the causal relationships in the different countries are inconsistent. Nonetheless, there are relationships existing between the different sub-samples. Additionally, the sub-sample periods corresponded to significant events in the economy, showing that these conclusions are not mere statistical effects, but tally to real economic shifts.

African context

While looking at studies done in the African context, Hedi, Adel, M'henni and Rault (2012) investigated the linkage between discharges of carbon dioxide, consumption of energy and the real gross domestic product for twelve North African and Middle Eastern Countries starting from 1981 to 2005. They conclude that not all the Middle Eastern countries have to let go the growth of their economies in order to reduces the carbon discharges, they can decrease their discharge levels as through policies aimed at conserving energy which would not have long term impacts on their economic growths. Esso (2010) aims to relook at the link between growth in the economy and foreign direct investments for 10 countries in the sub-Sahara. By engaging two emerging econometric approaches i.e., the Toda and Yamamoto (1995) causality and Pesaran et al. (2001)

approaches, he observes that there is a long-run positive linkage between FDI and growth of the economies of South Africa, Senegal, Liberia, Angola, Kenya, and Cote d'Ivoire.

Nonetheless, FDI unquestionably causes growth of economies for Kenya, Cote d'Ivoire, and Angola, whilst economic growth causes FDI for South Africa and Liberia. Adewuyi and Olabanji (2017) explore the linkage between consumption of biomass, carbon discharges, and the growth of economies for West African countries between the year 1980 to the year 2010. They confirmed feedback effects amongst consumption of biomass, economic growth, and carbon discharges for five of the countries -The Gambia, Togo, Nigeria, Mali, and Burkina Faso. For the remaining countries, the linkages are not significant. In addition to these, Pierre and Khobai (2017) investigated the linkage between consumption of energy consumption, discharges of carbon dioxide, urbanization, openness of trade and the growth in the economy in South Africa from 1971 to the year 2013. Findings indicated that there is a long run inter-relation between consumption of energy, discharges of carbon dioxide, openness of trade and the rate of urbanization for South Africa. In the long term, there is a bidirectional linkage that flows between consumption of energy and growth of the economy.

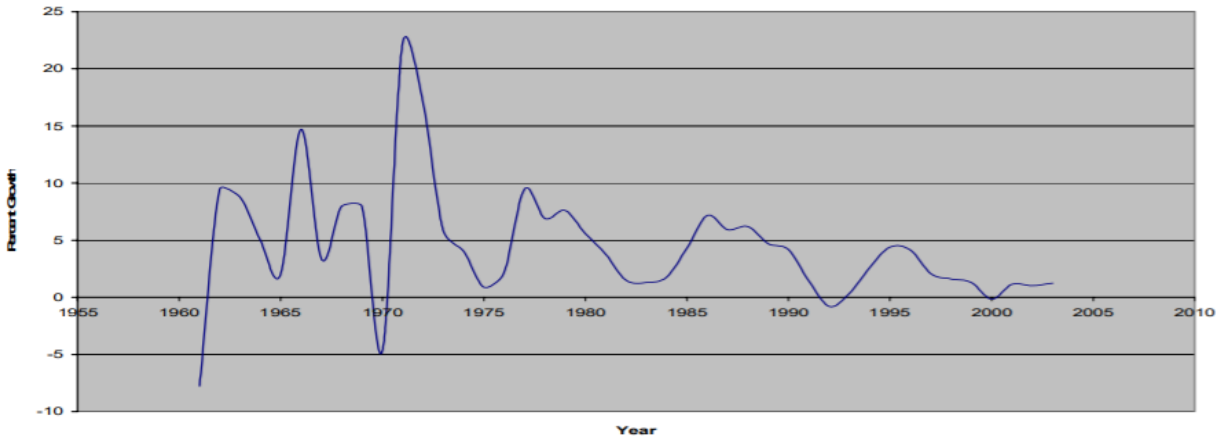
Zhang, Li, Sadiq, and Chien (2023) delve into the transformations observed globally in recent decades, emphasizing the significance of concepts like sustainable economic development (SED). With globalization intensifying competition among firms, the imperative for sustainable development (SD) has become paramount for survival in this competitive landscape. Within this context, the authors propose that SED and enhanced energy efficiency can be attained through the implementation of an effective sharing economy. The phenomenon of the sharing economy has garnered considerable global attention and has become the subject of numerous recent studies. This article specifically investigates the impact of the sharing economy, including its users and values, on energy efficiency and SED across the top ten Asian economies. It also considers inflation, employment rate, and population growth as control variables. Utilizing secondary data extracted from databases such as Statista and World Development Indicators (WDI) spanning from 2006 to 2020, the study employs the method of moments quantile regression (MMQR) to explore the interconnectedness of these variables. The findings indicate a positive association between sharing economy users, sharing economy values, inflation, employment rate, population growth, and both energy

efficiency and SED within the top ten Asian economies. These results serve as a valuable guide for policymakers in formulating relevant policies aimed at promoting SED and enhancing energy efficiency through the utilization of the sharing economy model.

Gross Domestic Product (GDP) in Kenya

Dunne and Aslay (2005), describe Kenya as a nation in Africa to the eastern part of the continent, which has endeavored to work for the stability of its economy from when it got its independence from Britain in 1964. Despite several efforts by the central bank and the government of Kenya to grow the economy, the country has remained in a pattern of domestic deficits and huge external debts with a slow-moving GDP growth rate. The GDP for Kenya in 2003 was at KES. 1.04 trillion translated as 13.8 billion USD. To the year 2003, Kenya experiences a very slow and varying growth from one year to the next. In the 60's and 70's, the GDP in Kenya fluctuated uncontrollably from 23% to minus 5%, due to several factors, which included; shortages in the World oil in the 70s, gaining political independence from the British, an increase in the global coffee demand– being a dominant export for the country in the years 1976 and 1977 as well as the fall of the East African Community which occurred in 1977. The East African Community which is an economic partnership amongst the East African countries- Uganda, Tanzania, and Kenya failed because of differences in ideologies. Since the year 1980, the GDP of Kenya has been relatively stable compared to the 60's and 70's but still has notable variations from one year to another. From the late 80's the Kenyan GDP growth rate has been averaging 3% per year which is low, but this is comparable to the aggregate African GDP growth rate which has also been between three to four percent from the early 90s or so.

Figure 8: Kenya GDP Growth rates (1960 – 2003)

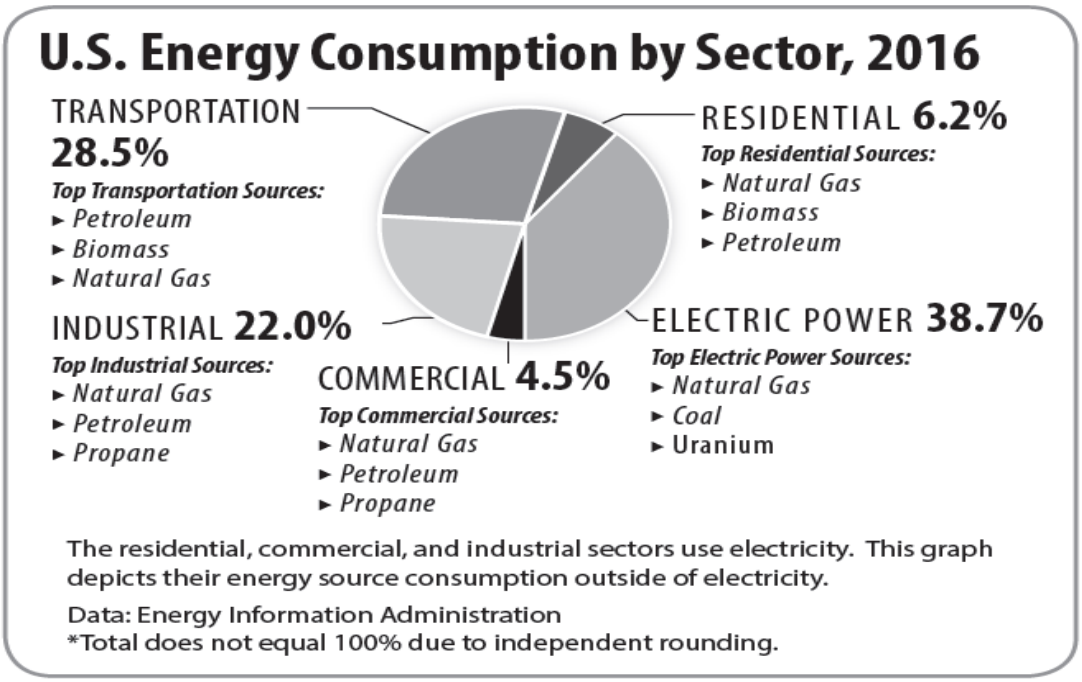


Note. Adapted from *Country Report: Kenya* by Dunne and Aslay, 2005, p. 5.

Energy Consumption

According to the Independent Statistics & Analysis of the US Energy Information Administration (EIA) in 2021, energy consumption is described as energy usage for the American population, and they measure this energy usage in a household in terms of gallons of gasoline. The United States Energy Department divides the users of energy into different categories: transportation, commercial, residential, electric power, and industrial which are the sectors in the country's economy. For residential and commercial sectors energy is used for heating and cooling as well as lighting and appliances. For the industrial sector, energy is used for food processing, aluminium and steel Manufacturing textile manufacturing, petroleum Refining, pulp & paper manufacturing, cement, chemical manufacturing, construction, mining, forestry, agriculture, and fishing.

Figure 9: US Energy Consumption by Sector (2016)



Note. Adapted from *The US Energy Information Administration*, 2021, p. 10.

Popp (1998) analyzes the impact of new technologies on energy use. The research uses patent data to estimate the impact of new technology on energy usage. Each of the thirteen energy-intensive industries has its stock of energy expertise. The average long-term cost reduction from a patent application is close to $9 million. The outcomes are utilized to simulate the impact of an energy tax of 10%. In the long run, the energy savings through induced innovation are found to be substantially bigger than factor substitution as a result of the cumulative nature of study, even while in the short run factor substitution is observed to have a significant role than induced innovation. According to the research in this paper, induced technological development will be crucial in lowering energy usage following a price increase. Specifically, the savings through induced innovation are more significant over the long term, even though the short-run direct effect of factor substitution is more significant than induced innovation. Because patent elasticity with regard to energy prices typically exceeds one and due to the cumulative impacts of study on the knowledge stock, induced innovation is significant over the long term. Legislators should consider these findings when creating environmental policy and create regulations that

promote innovation. This finding offers yet another argument in support of market-based environmental policy because prices are more likely to encourage a consistently high degree of innovation than standards.

Darby (2006) evaluates the efficiency of energy consumption feedback. For the average person, their home's energy consumption is largely unnoticeable. In general, individuals have only a blurry notion of their own energy consumption patterns and the potential impact of making small adjustments to their daily habits or making financial investments in energy-saving technologies. This highlights the significance of feedback in making energy increasingly transparent and therefore more susceptible to interpretation and management. In this article, Darby (2006) takes a look at the research done on the topic of how useful homeowner feedback might be. Consequently, more important than the specifics of the technology being employed is the way in which individuals adapt their behaviour to energy consumption.

While the feedback literature has a wide range of perspectives, many recurring patterns do appear. Some of the earliest research on the topic dates back to the 1970s, and it found that feedback (primarily via display monitors) has measurable impacts and is worth exploring, either alone or in conjunction with other procedures. As time went on, people began to view feedback as a means of learning; it enabled consumers of energy to educate themselves by trying new things and seeing what worked. As a whole, the research shows that having access to timely, correct billing (a type of indirect feedback) in addition to synchronous direct feedback is essential for long-term success in reducing demand for energy. As a result, the utilization of feedback in and of itself is beneficial. It's also apparent that it helps other information and recommendations work better, leading to deeper comprehension and more precise management of energy consumption. Millions of people still don't have a good grasp on their home energy usage, which is a major contributor to waste. Saving energy requires consumption feedback. Without feedback, it's impossible to learn successfully, but it's not always enough on its own. More often than not, people need guidance in understanding and acting on their feedback. Real-time, personalized feedback has the potential to be quite helpful, especially when it comes to making daily behavioural changes that result in non-heating final-use reductions. Consequently, billing and seasonal energy reports that are both informative and easy to understand can encourage investment and shape consumer

behaviour over the long run and on a wide scale. The study demonstrates cost reductions of 5-15% for direct input and 10% for indirect feedback. Darby (2006) further recommends that any new meter design must provide an intuitive user interface. At a bare minimum, he says, it would be helpful if monitors displayed current usage, current costs, and past comments. More advanced monitors might also provide information on tariffs, microgrids, and carbon emissions. There is value in feedback on its own as a teaching tool, but this value is only fully realized when feedback is considered in its proper setting. Results from feedback could differ depending on the context; however, feedback in collaboration with instruction and data can occasionally improve outcomes.

Allouhi et al. (2015) investigate efficiency in buildings and energy consumption: focusing on the current status of the construction industry and implications on future trends. The construction industry is considered as a major single contributor to greenhouse gas emissions and global energy consumption. It is imperative, then, that climate change and future energy strategies be based on a solid awareness of the structure and nature of energy usage in buildings. The capacity to access the most recent data is growing in importance for conducting in-depth research. In this study, researchers present the most up-to-date information available on the global energy consumption of buildings of all types. Different countries' histories, current conditions, and projected future tendencies are dissected and studied. To pinpoint the most important factors, energy usage in buildings is broken down. This study devotes significant space to providing a global perspective on the regulations and programs that have been put in place in many nations to better track, control, and reduce building energy use. Feedback from early adopters is used to discuss key components of these regulations. Several facets of the issue of energy usage in the construction industry are addressed in this work. Real World situation: by reporting the most recent data on building energy usage, obtained by compiling as much official data as possible from various sources. Next, propensities for the near future: In order for policymakers throughout the world to envision the next steps that must be taken, updated projections of energy usage in the construction industry for both commercial and residential activities must be made. This knowledge can also be used to foresee and assess the results of energy policy changes.

Furthermore, an examination of the most important aspects affecting building energy use: Energy consumption data from the past and projections for the future must be combined and analysed from multiple angles if the research is to get insight into the temporal and spatial patterns at play. With the help of this analysis, researchers can identify the driving forces behind this sector's energy use. Energy conservation measures: In reality, policymakers are well aware that energy efficiency improvement in the construction industry is a key strategy for accomplishing these goals. This research found and discussed in depth the thermal standards, labels, and certifications applicable to buildings. Building energy efficiency roadblocks: Unfortunately, several barriers must be overcome before energy-saving measures can be put into place. The research classifies the factors as social, economic, political, and ‘others.’ Lastly, the research provides possible recommendations for overcoming obstacles and making buildings more energy efficient.

According to Zhou et al. (2015), energy conservation, reduced emissions, and long-term sustainability are all on the rise as a result of concerns about rising energy prices, the depletion of global resources, and the impact of climate change. Research shows that machine tools are the single most energy-intensive part of any production system, making it imperative that their energy consumption be modelled and their energy efficiency evaluated to achieve significant industrial energy savings. According to this research, some related concepts are unclear, and the accuracy of models still needs to be emphasized; thus, a systematic literature study is necessary. First, researchers define their meaning when discussing machine tools and energy efficiency. From the standpoint of productive output and input, the efficiency of machine tools’ energy is reflected in their particular energy consumption, which is defined as the proportional interaction between the processing parameters and energy consumption. Second, energy-efficient considerations are integrated into the planning, production scheduling, modification, and evaluation of machine tools and their impact on the surrounding environment. Thirdly, this paper categorizes the current energy consumption models into three types: 1) the material-removal-rate-based linear model of reducing energy consumption, 2) precise parameter models of reducing energy correlation, 3) the process-based energy consumption machining model.

Finally, two main observations are obtained for further research: 1) More scientific evaluation indexes are needed for the assessment and testing of the energy efficiency of machining tools, and 2) the validity of present energy consumption models might be enhanced by integrating the correlation coefficient of machine tools, components, tools, and the condition of the process. Companies in the manufacturing sector are under increasing social, legal, and financial pressure to cut their consumption of energy and carbon emissions. Understanding how much energy a machine tool uses and developing strategies to reduce that energy use are crucial first steps on the path to a more sustainable manufacturing sector. Research in this area has, therefore, been a major focus in the academic community in recent years. The paper focused on the efficiency of energy in machine tools and its meaning. Next, researchers introduced the concept of designing, scheduling, optimizing, and evaluating machine tools based on their energy efficiency. For the first time, this article classifies existing models of energy consumption into three groups and summarizes their respective application properties. Figures 7 and 8 depict historical targeted interventions and projected future directions, from which they deduce the following: (1) Clearly defining the study system boundary and unifying different unit of output and input variables are required for accurate evaluation of machine tools' energy efficiency or machining system. From a thermodynamics or output/input standpoint, machine tool energy efficiency is typically defined. The SEC covers the mapping relationship between energy consumption and the MRR, which reflects production efficiency, and is widely used for estimating energy consumption and evaluating machine tools' energy efficiency. A simplistic evaluation of a machine's energy efficiency based on its total energy consumption is meaningless due to the multifaceted nature of most machine tools. In addition, establishing a standard for measuring energy efficiency that is applicable across industries is crucial. This means that research into a more science based metric system, or an objective evaluation predictor of machine tools' energy efficiency is still needed. (2) Design and operational considerations both contribute to machine tools' overall energy efficiency. Developing low energy consumption may necessitate substantial financial and technological investment on the part of businesses. As a result, they frequently opt for use optimization, despite its evident potential for energy savings. Energy consumption for machine tools is typically highest in the background, which varies depending on the machine tool type and production interval,

and lowest during processing, which is directly proportional to the processing conditions and parameters. The energy efficiency of a system as a whole can be improved by using a system-level approach to combining product design, manufacturing execution, and process planning. (3) This article distinguishes between three types of energy consumption models based on their conveying styles and application characteristics: the linear type of model of trimming energy consumption based on MRR; the comprehensive parameter correlation type of trimming energy consumption models; and the system-based machining model of energy consumption. One primary distinction of the first type is the ease with which one can obtain coefficients between the MRR and the SEC for use in estimating the energy required by machines for cutting. The second type is distinguished by its focus on dissecting the connection between energy use and the processing parameters. These include material cutting tool angle, characteristics parameters, cutting parameters, and so on. The third kind is distinguished by the construction of a generic-type model of energy consumption for the purpose of estimating energy consumption during the components processing process. (4) Experimental data and empirical formulas of fitting methods can be used to build the model of energy consumption; they include, among others, the interpolation technique, mathematical statistics, the surface response approach, the least-squares approach, and the neural network mechanism. The model's accuracy can then be verified by fresh experimental data. The model coefficients are sensitive to the variables and controls used in the experiments. The energy model has been trending toward greater accuracy in recent years. The complexity of computations and prediction accuracy of the energy model are in large part determined by the level of detail with which the influencing factors of consumption of energy and the decomposition of the power of machine tools are evaluated. However, energy consumption is heavily influenced by the design of the part, the material qualities of the tool, the cutting fluid and the cutting parameters, and the features of the machine itself. The first step toward developing a reliable model of energy usage is identifying the most important elements at influence. Thus, it is necessary to conduct a series of trials using various types of machine tools. Energy consumption can be accurately predicted by real-time data and computation based on the evolution of NC code. (5) The accuracy grade of a machine tool is previously determined by its ability to process standard samples, such as those established by ISO10791. Drafting of the ISO

14955 standard has increased interest in the assessment of the energy efficiency of machine tools, and the standard test process for energy consumption and the associated standard test results for energy efficiency have become hot topics in academics.

Soytas and Sari (2006) investigate the relationship between energy consumption and household income in G-7 nations. Several developed nations have pledged to cut back on their output of climate-altering gases by signing the Kyoto Accord. Several measures, such as lowering energy consumption, boosting energy efficiency, lowering energy intensity, and planting trees, may be viable options for reducing or mitigating such emissions. Due to country-specific considerations, the practicality and efficacy of any strategy may vary. This article attempted to quantify the two-way relationship between energy use and GDP in the G-7. With the help of generalized variance decompositions, error correction models, and multivariate cointegration, the researchers find a Granger causation relationship between national income and energy usage across the board. However, it appears that the causality direction varies among nations. This could indicate that while both countries are at the same stage of economic development, they have access to distinct policy options to help implement the protocol. Using annual data from G-7 nations, the research examines the correlation between energy use and income within a production function framework. They found that in all of the G-7 countries, there is a long-term causal relationship between energy consumption and GDP. The direction of causality appears to be both up and down in four nations (Italy, Canada, the United Kingdom, and Japan), from energy consumption to income in the United States and France, and from income to energy use in Germany. As a result, Germany may improve the sustainability against global warming by actively adopting energy conservation measures, while the United States and France may concentrate on technology advancements and mitigation programs. It seems that a mix of alternative strategies is most effective for Italy, Canada, the United Kingdom, and Japan. Since Italy, Germany, and Japan's economies grow in direct proportion to their per capita income, energy conservation has the potential to make a large short-term contribution to the battle towards global warming without slowing economic expansion. Short- and long-term energy policy considerations suggest that the United States and Canada should choose approaches that are consistent with one another. Together, the results of the GVD and the causality test indicate that energy can be regarded a key element in determining

economic growth. Their findings suggest that lower energy usage could have a detrimental effect on growth in the long run, notably in the economies of the United States and France. Canada, Italy, Japan, and the United Kingdom all appear to have high levels of endogenous energy use. Germany is the sole probable exception, where economic growth would not be significantly impacted by energy efficiency measures. Although the propensity of renewable and environmentally friendly energy sources is still untapped, environmental policies that aim to reduce energy intensity, increase energy efficiency, increase public transportation utilization, establish a price system that may inspire the use of environmentally friendly and renewable energy sources, establish a supply chain for emission reduction, and invest in technology that encourages alternative sources of energy more feasible may help alleviate the strain on the environment. Their findings suggest that including energy use in economic growth forecasting equations will enhance growth projections, which has policy implications. As Lee (2005) states, policymakers should be wary while implementing energy conservation measures so as not to impede economic growth goals, and they should instead focus on securing a sustainable energy supply as they devise plans for said growth. As conventional energy sources become increasingly scarce, another possible long-term implication of the close relationship between energy consumption and economic growth is that governments may have to depend more on alternative energy sources to maintain constant supply if they are to achieve sustainable development.

Pereira et al. (2014) contend that school buildings carry more civic duty due to their importance in society as places of learning than any other type of public structure. This means that the efficiency of the building's energy use is crucial. The study's main objective is to conduct a comprehensive literature review on school energy consumptions in order to arrive at a functional benchmarking based on actual operating environment of school buildings, with the results made public for use by the relevant parties. The survey is conducted to collect data on energy consumption in educational institutions, with responses recorded across a wide range of fields and units, such as multilateral energy usage values, consumption of electrical energy, heating fuel consumption, and the cost of heating and cooling annually expressed in one square meter of floor space ($/m2), one cubic meter of space ($/m3), and one student ($/year) respectively. The literature is examined to ascertain the feasibility of establishing a global comparison of the published

data. The findings imply that the following should be taken into account when establishing an energy benchmark: the conventional “indoor environmental conditions (IEC)” for classrooms, heating and electrical consumption values are to be kept separate and distinct education levels typically call for distinctive energy consumption values. A climate adjustment predicated on Heating Degree Days (HDD) is a useful technique to standardize heating energy consumption. Benchmark reference levels should be stated in terms of billed energy data for a fair comparison of data based on either an operating rating or a computation conducted out for reference conditions.

Concurrently, Sadorsky (2010) examines energy consumption and trade in the Middle East. In the past three decades, many nations' trade, GDP, and energy use have skyrocketed. This raises a fascinating investigation. What effects does an increase in trade have on energy usage? Using panel cointegration data estimate methods, this research examines the effect of trade on energy usage in a group of eight Middle Eastern nations from 1980 to 2007. According to the research findings, in the short run, exports have a Granger causal effect on domestic energy consumption, and imports have a feedback effect on domestic energy use. Moreso, according to long-run elasticities computed from FMOLS, an increase of one percent in exports leads to a rise of 0.11 percent in energy consumption per capita. In comparison, an increase of one percent in imports leads to an increase of 0.4 percent in energy consumption per capita. This study's findings are significant because they establish the long- and short-term effects of greater trade on Middle Eastern consumers' need for energy. In executing policy reforms regarding energy and the environment, these implications should be taken into account. When looking at short-run Granger causality tests, the energy export and import models demonstrate a positive feedback link between energy consumption and economic output. These findings contradict (from Middle East panel studies) those of Mehrara (2007) and Al-Iriani (2006) who present unidirectional causality ranging from GDP to energy usage, and of Narayan and Smyth (2008) who discover unidirectional causality that runs from electricity usage to GDP. The implications of research showing a causal relationship between energy consumption and income are clear. This indicates that efforts to reduce energy consumption will have a dampening effect on economic development. Because of this, Middle Eastern countries present a challenge (which is not particularly studied in this research) for energy conservation measures because they are among the world's

fastest rising users of energy and also show among the world's highest surges in emissions of greenhouse gases (International Energy Agency, 2008). This research finds that reducing energy consumption per capita is the most effective approach to reduce greenhouse gas emissions, but that doing so will have a chilling effect on economic expansion. Improving energy efficiency itself is an approach to lowering emissions of greenhouse gases and cutting back on energy use without severely slowing economic expansion. In the short run, using Granger causality, the study observes that shifts in exports are related to increases or decreases in energy use, but they don't find any evidence that the reverse is true. In order for these nations to expand their exports, they must also improve their energy production. Future projections of energy consumption for these nations could be affected by the fact that more trade openness, as measured by exports or imports, is associated with higher energy demands. The results of the short-run Granger causality test indicate that there is a positive feedback link between trade openness and income, and this result holds regardless of whether trade liberalization is measured by per capita exports or imports. While not the primary emphasis of this article, these findings highlight how trade restrictions can dampen economic growth in these nations and how weak economies can create barriers to trade.

Darby (2001) investigates the process of designing feedback in an energy consumption model. Feedback on consumption encourages consumers to reduce energy waste by cutting back on unnecessary purchases, but this set of evidence is rarely acted upon systematically. This study provides a literature assessment on the usefulness of three forms of domestic consumer feedback: feedback given directly within the home, input given indirectly through billing, and 'incidental' feedback (a technical, social changes or household by-product). A survey of the potential for improved consumer feedback is conducted, taking into account the lessons learned about the significance of clear, immediate, and user-specific information in regard to the technology, configuration, and placement of display panels and meters, energy billing, and services like audit work and advice programmes. The research finds that there is potential for designing feedback into energy-related systems, and that this might lead to greater energy awareness and a reduction in usage of the order of 10%. The same holds true for learning about home energy use as it does for any other subject: feedback is crucial. There are many other kinds of feedback, but research on only three of them—direct, indirect, and involuntary

that they play a crucial role in fostering greater sensitivity to energy issues and leading to at least a 10% reduction in energy use. It is possible to draw several conclusions from the published literature. There needs to be a simple, aesthetically pleasing, and understandable metering display option for every home. Although load-activated signals may have potential, they should not be tested in a vacuum, without the ability to learn from the results, and furthermore, they should be evaluated with extreme caution in low-income homes. The use of customer testing to develop and refine an informative billing system before rolling it out to the masses shows potential. Audits are becoming increasingly popular as a tool for evaluating the condition of the housing stock because of the baseline information they provide on individual dwellings. When conducting an audit, it's important that the language used is consistent with that employed by the provider and the homeowner. Feedback design should consider the fact that discussion over whether energy-saving programs are succeeding or failing is typically based on insufficient evidence. Finally, advancements in technology have opened the door to home power generation, extremely accurate automatic meter reading, and improved lines of communication between providers and their consumers. If these innovations are managed with the concepts of urgency, clarity, and precision in mind, they could lead to better education and management of energy consumption.

Soytas, Ramazan and Ewing (2006) investigate the relationship between the United States' energy output and consumption and the country's overall carbon footprint. The existence of a Kuznets curve in nature has previously been investigated, however this work neglected to account for energy use. Researchers incorporate labour and gross fixed capital creation into the model as they look into the Granger causality connection between energy consumption, wealth, and carbon emissions. In the United States, the researchers show that energy consumption, and not wealth, is the long-term driver of carbon emissions. Therefore, increased prosperity might not solve our ecological woes. In this article, researchers look into the dynamics between the US economy, people's standard of living, and their carbon footprint through time. Evidence against the presence of an EKC-type link in the US is discovered using the TY technique, generalized impulse response, and multiple regression in a multivariate context that included both labour and expenditure in fixed capital. Based on their findings, energy use is likely the primary (statistical) contributor to Carbon dioxide emissions in the United States. In the US,

lowering emissions does not appear to be at odds with rising incomes. As a result, contrary to what Dinda and Coondoo (2006) argue, the United States does not have to tolerate a loss in income levels in order to bring about a decrease in emissions. Energy consumption is the key indicator for emission reduction policies. Carbon emissions can be lowered by cutting energy use. In light of the lack of evidence between energy consumption and income growth, the United States may want to adopt energy efficiency measures as a serious ecological policy without risking its future economic growth. Alternative strategies that take into account the make-up of energy consumption and technology shifts may also be used to reduce environmental stress. While people wait for technology to allow a full transition from carbon fuels to sustainable energy sources, alternative policies such as reducing energy intensity, enhancing the efficiency of renewable energy use, and increasing the use of sustainable energy sources (natural gas, wind, solar) may help alleviate environmental pressure and buy us some time. These findings are generally in agreement with official US policy, which aims to slow the rate of environmental degradation by slowing the rate at which energy consumption is increasing. Results may vary from place to place because of differences in the composition and strategic significance of sources of energy in various economies. Additionally, economies may be able to boost their use of environmentally beneficial sources thanks to technological advancements. Therefore, the connection between wealth, energy use, and pollution might shift throughout time. Limits to substitution, or the inadequate switching costs of energy sources, combined with an unexpectedly rapid depletion of oil reserves, could force the United States to rely on coal, a dirtier fuel source. This would prevent the United States from switching to cleaner energy sources. Therefore, energy use will continue to play a significant role in global warming and pollution. In this research, the authors look at energy usage as a whole. The correlation between production and environmental deterioration may be easier to understand if energy use is broken down by source and/or industry. However, technological factors are not taken into explicit consideration by their model.

Karekezi (2002) sought to have a summarized view of the energy spectrum in the whole continent of Africa and in brief look at the relationship between energy in Africa and poverty levels. He used data from the whole continent but emphasized on the sub-Saharan part of the continent where there is a greater need for boosting services in the

energy sector for those people who are very poor. The study begins energy services for the poor is particularly acute. For readers who are unfamiliar with Africa, the paper starts with a comprehensive overview of Africa specifying the important socio-economical and demographical features. He goes ahead to bring forth the vital features of Africa's consumption of energy and how these are supplied to the various sectors of the economies. He goes on to indicate the major drivers which would have an indicator on how the future days of energy in Africa would move. The study puts a lot of emphasis on the major factor which will be of significance in future and checks how the policy makers of different regions resolve huge challenges in the modern world to ensure that energy matters are tackled to meet current and future technology. The policy makers must keep in mind the state of the poor population in sub-Saharan Africa.

Until 2025, Turkey's GDP and energy consumption are predicted to increase by 7% and 5.9% yearly, respectively (Lise and Montfort, 2007). This research uses annual data for Turkey (1970-2003) and a cointegration approach to unravel the relationship between energy use and GDP. In this study, researchers demonstrate the cointegration between GDP and energy use. What this means is that the two are causally related to one another in a (potentially bidirectional) manner. They find that energy savings would not damage economic growth in Turkey by establishing a unidirectional causality between GDP and energy consumption. Meanwhile, as long as Turkey's economy expands, their findings indicate that energy consumption will continue to rise. Lise and Montfort (2007) determine, through statistical analysis, that energy use and GDP are positively correlated. This suggests a (potentially bidirectional) chain of causality linking the two. The researchers show that the flow of causality is unilateral between GDP to energy usage, with the total of GDP over the prior two years serving as a reliable indicator of energy usage in the prevailing year. In other words, the analysis demonstrates that energy consumption has a relatively tiny role in the Turkish economy, but it doesn't mean it doesn't matter at all. This has significant policy implications because it shows that Turkey's energy limitations are having no discernible effect on economic development. For Turkey, the EKC theory is similarly discredited by these findings. Research in the future will need to confirm whether or not the EKC hypothesis could be refuted for other rapidly developing economies like the one in Turkey. Policy implications of rejecting the EKC hypothesis include the expectation that rising energy demand will accompany

growing economies. Two options exist for lessening the strain on the natural environment. To begin, a shift in the composition of energy sources can naturally lead to reduced emissions. Second, since the co-integration analysis shows that cutting energy use will not slow down the economy, an energy-cutting program can be implemented. In addition to helping Turkey in her discussions for EU membership, the finding that energy constraints do not appear to slow economic growth also suggests that Turkey has an economically stable energy sector. Due to the current low inflation rate and the possibility of becoming a European Union member in the near future, the boom-bust pattern of the economy is also likely to become a thing of the past. Turkey can also serve as an important link connecting Central Asia and Europe. Turkey's potential to become a major energy frontier is bolstered by the fact that it can reduce its energy consumption without stalling the economy. There is a correlation between rising GDP per person and rising energy usage per person. In this study, researchers investigate the hypothesis that energy usage and economic growth in Turkey are interconnected. This indicates that Turkey's economy is continuing to expand without hindrance.

According to Fettweis and Zimmermann (2008), the foundation of today's knowledge-based society is built on information and communication technology (ICT) infrastructures. There has been a meteoric rise in the use of information and communication technologies around the world in recent years, and the pace of innovation in this space is staggering. But there is a cost to this phenomenal expansion: by some estimates, ICT systems now generate as much carbon dioxide as all international air travel combined. If the current rate of increase in the energy consumption of ICT systems is maintained, it will threaten ambitious ambitions to cut carbon dioxide emissions and address climate change. Thus, it is abundantly evident that improving ICT systems' energy efficiency will be the next decade's foremost research and development priority. The innovation capacity, and by extension, the economic performance of developed and emerging nations, is dependent on their adoption of cutting-edge ICT systems, which present unique difficulties and opportunities for research and development. Since the data speeds and processing capabilities of ICT systems have dramatically increased, new problems have arisen that necessitate intensive study of ICT systems' energy efficiency.

The French politician and activist, Viviane Reding, is quoted as saying: A high-growth, low-carbon economy is essential if Europe is to achieve its renewable energy goals by 2030. New, effective ICT solutions need serious study and swift implementation. The use of ICT will boost EU industry's competitiveness while also making a significant contribution to the global effort to combat climate change. McKinsey Global Institute research shows that there are significant financial benefits to increasing energy productivity. By 2020, the yearly savings in energy costs reached $900 billion thanks to these investments, with an estimated IRR of 17%. The study of wireless networks that consume less energy is thus essential not only from an environmental standpoint but also economically. The use of high-temperature electronics and other alternatives to batteries for emergency power storage are two promising areas for further study. As a result, data centers and cell towers can reduce their overall energy usage by eliminating the need for air conditioning. Minimizing the energy requirements of future peer-to-peer as well as information distribution systems requires energy-aware techniques for decentralized computing and information warehousing (distributed data centres). For instance, to limit the amount of energy used on "pilot pollution" in vacant cells in the radio access system without reducing coverage, adaptive power management must be implemented across all domains of ICT systems. In today's data centres, which frequently operate at maximum performance despite a light load on the system, massively parallel computing is used. In highly integrated systems on a chip used in telecommunications equipment, instead of using macro cells, which have a low population density but a high transmit power, new network topologies will rely on microcells with a high population density and relay them. The trick is to strike a balance between how much power the digital and analogue hardware components utilize. This can be done through signal transmission using high-efficiency power amplifiers with a high peak-to-average power ratio; digital baseband processors that are both more flexible than ASIC embedded processors and more energy efficient per function because of their programmability, application specificity, high parallelism, and power efficiency; maximizing energy efficiency through optimizing both the physical and media access control (MAC) layers as well as utilizing cross-layer optimization.

High energy efficiency requires transmission systems that are spatially, temporally, and spectrally tailored to reduce the amount of energy required to transfer a single bit of data. When compared to spread spectrum methods, this strongly Favors OFDM-based PHY/MAC systems (LTE and beyond) (3G). The creation of appropriate utility functions that permit the efficient and transparent resolution of multi-criteria optimization issues brought on by the addition of energy efficiency to existing optimization criteria such as spectral efficiency and coverage. Ecologically and economically sustainable expansion of ICT is unattainable without answers to these difficult concerns. As a benefit, solving these problems will make it possible to alter the fundamental assumptions upon which cellular networks are based. By reducing base station power usage to the tens of watt range, it will be possible to construct stations that run on renewable energy alone, such as solar or wind. These sites will be very simple to set up because of the wireless backhaul (for instance, based on microwave lines). Access to electricity and broadband networks is frequently a limiting factor; therefore, this will again assist in bridging the digital gap between developing and developed countries. A relatively new but constantly expanding area of the ICT business is sensor networks, making it all the more important to increase the efficiency of energy ICT components to the point whereby power autarchy can be realized. A fundamental enabler for widespread sensor network deployment is the removal of constraints on sensor node longevity and form factor imposed by the need for a wired link and operation from a battery. Applications where the stated limitations have impeded the tremendous use of sensor nodes include the surveillance of structures like industrial facilities, bridges, buildings, and the composite materials reinforced with carbon/fiber used in today's planes and cars, as well as machine and facility surveillance in the industrial sector. For this reason, the WWRF's goal of one thousand wireless devices per person is within reach.

Energy Consumption in Kenya

Onuonga (2012) probed the sources of energy in Kenya which encompass non-commercial and commercial usage. The non-commercial alternatives are mostly biomass and to a small extent, there is biogas, solar energy, and wind energy while commercial energy sources include electricity and petroleum products. Petroleum fuel is the leading source of modern energy for Kenya with a proportion of about 20% of the total consumed energy. Petroleum consumption in 2006 3038.2 thousand tones and went up to 3121.8 thousand tones in the year 2007. There are a lot of petroleum explorations being conducted in Kenya, but the harvest has not yet begun hence, Kenya is reliant on imported petroleum to cater for the local consumption. Electricity is a vital source of energy in the country. It accounts for almost 10% of the aggregate energy usage. It is extracted from thermal oil, geothermal, and hydro sources. The electric installed capacity in the year 2007 is 389.3, 128, and 677.3 Megawatts for thermal oil, geothermal, and hydrothermal respectively. A long time ago, Kenya Power company was involved in both the generation and distribution of electricity but with recent reforms, these functions are separated. KENGEN (Kenya Electricity Generating Company Ltd) is the largest producer of electric energy for Kenya but it still does not meet the full demand of electricity for the country. Due to this reason, private energy producers have been sourced by KENGEN to supplement this electric power produced more so during drought times.

Onuonga (2012) described these two private producers of power as the Emergency Power Producers (EPPs) and the Independent Power Producers (IPPs). A big part of Kenya's electricity is hydro based. Additionally, Kenya has engaged the Uganda Electricity Board (UEB) for the supply of 30 Megawatt of electricity yearly to Kenya. Electricity is used in all the country's sectors, but mostly in the medium and large, industrial & commercial, small and domestic, and urban and rural areas. Electricity consumption has increased from year to year, and it is anticipated that it should continue to increase as the rate of economic growth increases more so if Kenya is to achieve its vision 2030.

Another important source of energy is biomass in the country. Biomass resources are extracted from forest materials like farms, grass, forests, plantations, bushes closed forests, wood, and industrial & agricultural residues. She observes that almost eighty percent of the Kenyan people are dependent on wood fuel for domestic use which provides a big percentage of the urban and rural households' energy needs. These energy forms are mainly utilized in the manufacturing commercial, residential, and transport sectors. In order for Kenya to meet its expanding needs for energy, it must overcome both the demand and supply side constraints.

Energy Consumption and its elements (Petroleum Energy Consumption, Electricity Energy Consumption and Renewable Energy Consumption)

From the Independent Statistics & Analysis of the US Energy Information Administration (EIA) in 2021, America produces and uses various types of energy which have different sources. These can be categorized as fossil fuels, non-renewable & renewable, and secondary & primary. The primary energy sources include fossil fuels which are natural gas, coal, and petroleum, then renewable energy sources, and nuclear energy. Electricity is classified as a secondary source of energy which is produced or generated from the primary sources of energy. The sources of energy are measured in different units: coal is measured in tons, liquid fuels are measured in gallons or barrels, electricity is measured in kilowatts and kilowatt-hours and natural gas is measured in cubic feet.

As per the Africa Energy Outlook (2019), Kenya has set major KPIs (Key Performance Indicators) in order to achieve the Millennium Development Goals, (MDGs) which are set for the years 2030 to 2040, including producing a hundred thousand barrels of oil from the year 2022, developing over two thousand two hundred Megawatts of geothermal power, the national electrification plan where the aim is to achieve a universal electricity service to all businesses and households in Kenya by 2022 at an acceptable SLA (service level agreement).

In developing the hypothesis for this section.

$H_{0:}$ There is a statistically significant bi-directional relationship between energy consumption and economic growth in Kenya.

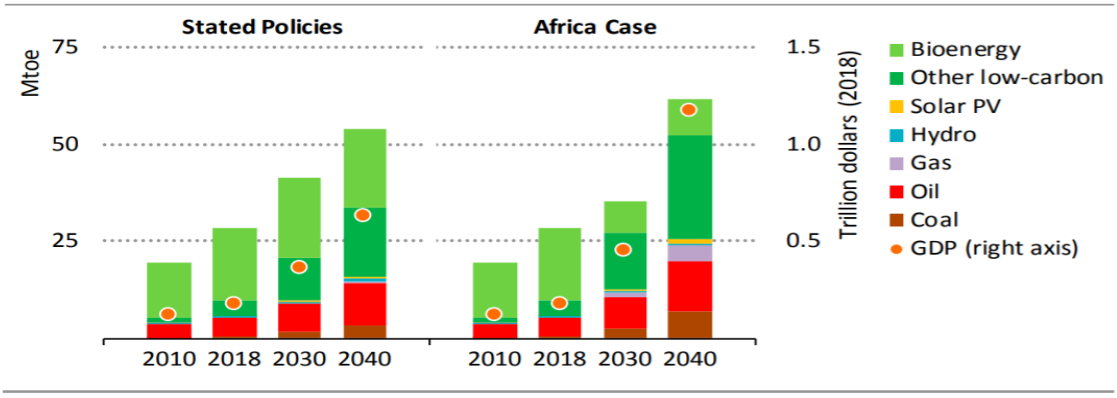
$H_{1:}$ There is no statistically significant bi-directional relationship between energy consumption and economic growth in Kenya.

Figure 10: Kenya key indicators and policy initiatives

			Stated Policies		Africa Case	
	2000	2018	2030	2040	2030	2040
GDP ($2018 billion, PPP)	76	177	358	627	453	1 176
Population (million)	31	51	66	79	66	79
with electricity access	8%	75%	100%	100%	100%	100%
with access to clean cooking	3%	15%	46%	70%	100%	100%
CO_2 emissions (Mt CO_2)	8	16	27	40	33	60

Note. Adapted from *Africa Energy Outlook,* 2019, p. 208.

Figure 11: Kenya primary energy demand and GDP



Note. Adapted from *Africa Energy Outlook,* 2019, p. 232

Petroleum Energy Consumption and Economic Growth

According to the US Energy Information Administration (2020), Crude oil and other liquids produced from fossil fuels are refined into petroleum products that people use for many different purposes. Biofuels are also used as petroleum products, mainly in mixtures with gasoline and diesel fuel. The order of petroleum products consumption is gasoline, diesel fuel, hydrocarbon gas liquids (HGLs), and kerosene followed by still gas.

Hai-Tao, Hui-Ping, and Yu-Xia (2014) find that currently, the transportation industry consumes around a third of the world's total energy; in China, this percentage is closer to 20%. China's energy consumption has skyrocketed over the past few decades as the country's economy has expanded, and in 2009, China surpassed the United States as the world's largest consumer of this resource. In the meantime, China's transportation sector is a major contributor to the country's overall energy consumption growth, particularly as regards the energy used at transportation hubs. Energy consumption and savings in China's transportation sector have been the focus of a variety of recent theoretical approaches and technology systems. In this study, researchers discuss and assess the present scenario of China's transportation energy consumption, including the four major transport sectors of railway, waterway, road, and civil aviation, by evaluating the existing reports. Energy-saving technologies in China's land, sea, and air transportation systems, as well as their current state and future trajectory, are also discussed. In this article, researchers propose several policy changes by assessing the main obstacles to progress in China's transport energy-saving technology and policy. Energy-efficient transportation in China: policy recommendations Modes of transportation with a high energy efficiency rating railways and waterways, which have higher transit capacity and lower energy usage, should be prioritized in China's transportation system. In the coming decades, the administration and related government agencies should take a number of steps to increase investment in railways and inland waters, improve the development of waterway and railway networks, and then make additional efforts to modify and standardize the road structure and enhance the network service level, all in an effort to create an effective transport system in which the railway plays a preeminent role and in which different modes of transportation are closely interconnected. Some scholars and experts offer numerous proposals to help China create a transportation system that is both cost-effective and environmentally friendly. Using energy efficiency as

a metric, Lirong et al. (2016) proposed the following policy for China's continued expansion of traction modes: (a) `electric railway is still the best traction mode despite the high upfront costs; (b) diesel transport should be regulated due to its high cost; (c) steam traction should be kept around in some places despite its low thermal performance and transportation efficiency of energy. The supply-demand structure, operational efficiency, and energy use efficiency are all greatly impacted by how well transport resources are allocated. For dense urban populations and large metropolitan areas, rail transport is the superior mode of transportation. It is important to invest heavily in rail infrastructure, particularly high-speed rail, in economically developed regions. Transport via waterway has a low impact on the environment and a high efficiency rate. Its strength lies in its ability to transport a lot of weight while still using very little power. The Yangtze Region in South China is an ideal location for expanding canal transportation. Civil aircraft is critical in moving people and goods across long distances and higher value chains. In addition to serving as a hub for all other modes of transportation, road transport is flexible enough to accommodate passengers with varying needs. Integration of China's road transport system into different modes of transportation is a crucial step for the country's overall transportation infrastructure. There are several transportation infrastructural disadvantages. The infrastructure used to get people and goods around is essential for today's transportation networks. One of the best ways to improve transportation energy efficiency is to lessen the load on the infrastructure that supports it. Rebuilding China's transportation infrastructure must be prioritized. The infrastructure along the rail and highway corridors must first be rebuilt. Second, it's important to facilitate the widespread use of renewable energy sources in ports by setting up the appropriate infrastructure. As a third recommendation, the government and associated administrative agencies should double down on their efforts to modernize and rebuild the airport's infrastructure for air travel. The airport has to do rid of some of its older, energy-hungry buildings. There is a great deal of antiquated transportation machinery that must be replaced from an administrative and policy perspective. The Chinese government must boost the popularity of fuel-efficient compact automobiles in order to boost sales of these vehicles. Meanwhile, diesel passenger cars need to gain a larger part of the market. Subsidy policy must be consistently adopted in the rail industry to promote the retirement and replacement of aging, high-energy-use, high-emission rolling equipment.

The Chinese government must hasten the modernization of aging transport vessels, banish single-hull oil tankers, and demolish the antiquated ferry that serves rural communities. Next, the study evaluates the mechanisms of management and command. Establishing and improving the legislation and management network of the transit energy saving, rendering them more workable, is a pressing matter for the Chinese government in light of the “Energy Conservation Law and the Environmental Protection Law.” Greater coordination is needed between national and regional plans for reducing energy consumption.

Until then, there needs to be coordination between the various modes of transportation. Cooperated planning between the various transport sectors is something that the government of China and relevant administration bodies should help facilitate and direct. China's transportation energy savings would suffer greatly without the country's enlightened laws, rules, and policies. Establishing and enhancing a system to evaluate the impact of laws, rules, and policies after they have been implemented, and doing so in a timely manner, is a highly effective strategy for government and administrative agencies. China's government and administrative agencies need to monitor, survey, and receive feedback on policy execution so that they can make necessary changes to the rules and regulations. More regulations and measures to stimulate consumer demand are needed to accelerate transportation energy savings. Integrating passenger transport interconnectivity, improving the performance of inland shipping fleet and freight strenuous administration, and working to improve the configuration of commuter stations, shipping services stations, etc., are all examples of ways that China can improve its transport administration and organization, which is essential for increasing its actual loading rate, conserving energy, and lowering pollution emissions. It is essential to build a standardization system for China's railway transport, including the regulation of pallets, packages, and handling equipment, in order to increase transit efficiency and reduce energy consumption in freight transport. Concerning governing, the government's involvement in Energy efficiency in transportation has been a significant focus for the Chinese government and relevant administrative departments in recent years. But most of their efforts are just at the macro management policy level. Because there aren't any local and industry norms that are specific enough to put these ideas into operation, they remain theoretical. In this respect, the Chinese government

would do well to look to Japan and other industrialized countries for examples of best practices while also seeing it as its primary responsibility to push for the systemic and comprehensive improvement of transportation efficiency. The Chinese central government, for instance, should spearhead the development of executive or implemented processes in urban and local governments, and the establishment of effective collaboration mechanisms among various administrative agencies. The results of cutting-edge technologies developed in the lab should be translated into practical output with the aid of market mechanisms. Since automakers play such a pivotal role in the market, stimulating their endeavours would greatly benefit the transport industry in terms of achieving results in the area of energy saving, particularly in the field of research and development of new energy vehicle. Therefore, government of China should use various economic leverage or punitive action as guidance, create and enhance the market mechanisms of energy saving, such as by establishing a gestation platform for the research and development of energy efficiency technology, system a perfect output trading platform, and cultivate related supporting economic and industrial policy initiatives and tax and financial initiative policies.

Worrell (2005) argues that data intelligence has proven to be a significant hurdle in the effort to enhance industrial energy efficiency, which is why the oil refining industry has been slow to implement changes to increase its own energy efficiency. Government programs are available on a voluntary basis to provide information on options that can help the business sector become more energy efficient. Through the provision of energy conservation information tools and techniques, ENERGY STAR aids in the establishment of robust strategic corporate energy conservation programs. This paper is a synopsis of ENERGY STAR's efforts to create an Energy Roadmap for the Oil Refining sector. The United States' petroleum refining business is the biggest in the world, contributing to fields as diverse as transportation and the chemical sector. Energy costs account for a significant portion of refineries' cash operating costs (e.g., ignoring capital expenditures and depreciation), making energy both a significant cost element and an important potential for cost reduction. As the greatest industrial consumer of energy in the United States, petroleum refining uses roughly 3.1 Quads of energy production every year. It is economically feasible to increase energy efficiency in refineries by 20%. The results

indicate that the oil refining industry has significant chances to cut energy consumption in a cost-effective manner, given the current state of resources and technology.

The United States is home to the world's largest petroleum refining industry, which supplies vital components to nearly every other country's economy. In the oil refining sector, energy expenditures are a major influence in production costs, therefore increasing energy efficiency is crucial for lowering expenses, increasing forecastable profits, and shoring up the bottom-line.

Energy efficiency at most oil refineries may be improved by 10-20% at a low cost, according to data from competitive benchmarking. The potential savings for a refinery range from several million to 10s of millions of dollars per year, depending on the facility's existing efficiency and size. Co-benefits from increased energy efficiency may offset the savings in energy costs and lead to a net reduction in emissions. In the research, the authors found ways that oil refineries may save energy. Energy savings estimates are supplied for each energy conservation measure, supported by plant case studies and citations from technical literature. The study builds on the knowledge gained from petroleum refineries all over the world that have implemented energy efficiency techniques. Results from benchmarking studies reveal that there are chances to reduce energy usage in the oil refining business in a cost-effective manner while retaining the manufacturing quality of the goods. Evaluating the viability of implementing selected technologies at various facilities requires more study on the economic concepts of the initiatives and the scalability of those to different refineries.

Becken and Simmons (2001) observe that the growing need for energy, which threatens natural resources and the global environment, is a key obstacle to the industry's long-term viability as a tourist destination. It has been suggested that the recreational aspect of tourism, in particular, may have a significant impact on a country's energy consumption levels. For the objective of deciphering the energy consumption of various groups, sub-groups, and operator types, this study examines New Zealand's most popular tourist sites and activities. A review of numerous tourism-related enterprises revealed that museums and experience centres often use less energy per visitor (10 MJ/visit vs. 29 MJ/visit) than other types of tourist activities. The increasing demand for energy, which is leading to the natural resource depletion and posing a danger to the global climate, is a serious concern to the viability of tourism. It has been suggested that

the recreational aspect of tourism, in particular, may significantly impact a country's energy consumption levels. To decipher the energy consumption of various categories, sub-categories, and controller types, this study examines New Zealand's most popular tourist sites and activities.

A survey of numerous tourism-related businesses (N = 107) found that, on average, visitors to tourist attractions like museums (10 MJ/visit) and experience centers (29 MJ/visit) use less energy than those who participate in tourist activities like scenic airlines (344 MJ/flight) or aircraft boat rides (255 MJ/ride). When tourists use motorized transportation to get around obstacles, their energy costs and consumption rates can skyrocket. Among these are the volume of visitors, the approach used by management, the sophistication of the technological infrastructure, and the composition of the fuel supply. Often, energy efficiency can be increased by analysing a company's energy consumption habits in depth. As a major industry, tourism has a number of subsectors, one of the most important of which is attractions and activities, where energy consumption is a major concern for sustainable resource management. This sector is obviously very varied, offering a wide variety of entertainment opportunities for visitors. The subsector's total energy bill at different energy end-uses has the possibility of increasing because to the wide range of operators and facilities. Costs associated with energy use can be lowered in one of two ways: either by limiting access to high-energy-consumption attractions and encouraging alternatives, or by increasing the efficiency of individual items. While it is true that every business must do its part to conserve energy, reducing energy use by the largest consumers would have the greatest impact on resource sustainability. Places like these include amusement parks, museums, and parks with extensive attractions. However, this isn't solely a tourism problem because it also touches on recreation. Parks may play an expanded role in mitigating climate change by reducing emissions of greenhouse gases by acting as carbon dioxide sinks. The proportion of energy consumption to tourist numbers represents per-tourist consumption and can be used as a reliable metric to evaluate and contrast energy intensities. An energy audit tailored to the needs of a single business is the best way to determine how much money may be saved through energy efficiency measures. The management approach, the quality of service provided (such as shuttle transportation), the fuel combination and

technical equipment, the type of vehicle used, the number of passengers, and the number of trips taken are all likely to play a role, in addition to the volume of visitors.

In general, tourist activities require more stamina than sights and sounds. Since New Zealand's tourism advertising is increasingly centred on the action and adventure that visitors can have while they're there, this is of special importance. Outdoor pursuits are a major selling point for New Zealand as a vacation destination. Tour operators often facilitate these time-consuming and physically demanding pursuits. Energy is required for even independently planned travels, including at the very least the provision of conveyance and basic infrastructure. As the data in this study show, New Zealand's preoccupation with (nature-related) pursuits lead to a rise in energy use. The findings imply that cultural tourism hotspots (like those in Europe) are less vulnerable to rising energy use. Considering this, it makes sense to limit how often people go to places that need a lot of energy. Last but not least, energy consumption is just one indicator of environmental impact; there are many others to take into account. Energy consumption, on the other hand, is a legitimate metric that can be evaluated quantitatively and objectively, which is a benefit. This opens up the possibility of drawing parallels between the tourism industry and other fields of study in New Zealand or beyond.

Martins, Felgueiras and Smitkovác (2018) investigate air pollution and the global warming of the planet. With such dire repercussions anticipated, addressing climate change has been identified as a major problem. Air pollution is a major issue that has contributed to a wide range of medical disorders and has far-reaching social and economic consequences. However, the protection of natural resources is a target of the Circular Economy strategy, and this adds another strategic dimension to the usage of fossil fuels. This study examines the usage of fossil fuels in Europe, along with its correlation with other factors including energy reliance and the proportion of renewable energy to total final energy consumption. Wang and Deluchi (1992) assess how the widespread adoption of EVs would affect demand for both conventional fossil fuels and renewable alternatives. Small vans, large vans, and subcompact vehicles are analysed between 1995 and 2010 in this study. Here researchers evaluate the relative efficiency of electric vehicles (EVs) and gasoline-powered internal combustion engines (ICEVs), as well as the primary energy consumption of four common fuels: natural gas, coal, petroleum, and biomass.

Current-generation electric vehicles use more energy per mile than internal combustion engine vehicles while operating on a grid powered mostly by natural gas, petroleum, or biomass, but future-generation EVs will use less. The energy consumption of both present and advanced technology vehicles will be lower than that of ICEVs in a world where coal is the dominant energy source. Their research shows that the amount of oil displaced by EVs is mostly determined by how much oil is needed to generate electricity. EVs have the potential to cut petroleum consumption by more than 90 percent per mile in many parts of the United States, where a large proportion of power is generated by sources other than petroleum. Electric vehicles cut petroleum consumption by 65 percent for each mile driven in cities where a high proportion of energy is sourced from petroleum, like New York.

Kardena (2015) investigates Indonesia's widespread method for handling waste from the petrol- and gas-based industries. A key issue for the oil and gas sector in Indonesia is the degradation of soils, sediments, surface water, groundwater, and air with harmful and toxic substances. Recent mishaps in Tarakan (East Kalimantan), Cilacap (Central Java), Bojonegoro (East Java), etc., that led to oil spills warrant national-level scrutiny. An organization's environmental management system should include measures to ensure the safe and efficient disposal of trash. Proper management of E and P-generated waste is essential for minimizing the possible harm to the environment and health as well as for lowering operating expenses and potential liabilities. In some places, disposal choices may be limited due to a lack of developed waste management infrastructure. There is a possibility, though, that the gas and oil operator may have to build and oversee these facilities themselves. This strategy frequently reduces long-term responsibilities, but it can be costly in the short term.

Goal seven of the United Nations' Sustainable Development Agenda mandates providing reliable, low-cost electricity to all people around the world (Sajid, Zhang & Rehman, 2022). A decrease in overall energy consumption, including that which is incorporated in demand and supply chains across industries, is necessary to achieve energy sustainability. But few studies have attempted to quantify the quantity of fossil fuels (such as coal, oil, and gas) that is embedded in supply and demand networks (FFEDS). In addition, the connections between and within different energy sectors have received little research.

The world's greatest energy consumer, China, is the focus of this study as people attempt to put a number on its FFEDS. The results show that the highest levels of input demand for coal, natural gas, and petroleum (CNGPC) are found in the building industry. The generation and distribution of electricity and steam accounted for the largest share of intermediate exports (both within and between industries), which in turn stimulated the sector's high coal consumption. The biggest volume of petroleum consumption and natural gas is induced by the aggregate supply of crude oil production industrial gas products and railway freight transport. Intersectoral demand prompted far greater CNGPCs than intra-sectoral demand does. CNGPC, on the other hand, has essentially equal supply amongst sectors.

To reach SDG 7, it will be necessary to adjust existing carbon pricing and credit procedures to account for energy consumed and produced. Reducing one's energy consumption is one of the most effective long-term strategies for reducing air pollution. Most of the world's energy needs are met by burning fossil fuels. Numerous countries reduced their energy use as a result of COVID-19. But in 2020, the year after COVID-19 hit, China's energy consumption rose by 2.2%. Environmental effects from intermediate-level trade on the environment can be traced back to their sources by looking at the interconnections between different industries. More sustainable production methods can be used with the help of cross-sectoral energy strategies. However, the majority of previous research on this topic has focused on what causes energy consumption, the function of energy consumption itself as both a response and a predictor variable, and the practice of projecting future energy consumption. The energy ties between different regions have been the subject of numerous studies, including those between Iran, India, Spain, and China. Energy links between countries have been estimated in this research. In addition, the reverse and forward links are not further broken down into inter- and intra-sectoral ties in the energy-linkage investigations. In this work, researchers aim to fill this knowledge vacuum by providing concrete data on China's natural gas, coal, and petroleum use. This research used Leontief's inverse and Ghosh's supply models to estimate the overall, netted (internal and inter-sectoral), and deconstructed (fragmentation of inter-sectoral links) integrated carbon fuels demand-and-supply chain linkages. Moreover, the estimation process, particularly the conventional multiplier

approaches, is varied, and there is a general dearth of literature on estimating various forms of fossil fuel inter- and intra-sectoral linkages. In this paper, researchers presented a straightforward methodology for calculating supply and demand side links for different types of fossil fuels, along with relevant empirical results. In light of the general lack of research on the connections between different types of fossil fuels, researchers decided to focus on China as a case study. Not only is China the largest consumer of carbon fuels, but only one sectoral case example is studied to keep things easy and concentrate on the estimating technique. The same criteria for connection estimation described in the preceding chapter can be used to a multi-regional scenario, depending on the requirements of the readership.

Furtado and Suslick (1993) utilize the method of the intensity of energy use to predict Brazil's petroleum consumption in the year 2000, utilizing learning, logistic, and translog models. For their forecasting, the models use data spanning 30 years. The structural, content, and scale impacts are used to analyse the development of the petroleum consumption profile through time. The translog model performed best in terms of accuracy while evaluating forecasting models. Two scenarios for GDP growth provided a range of 64,000 to 109,000 metric tons of oil equivalent. The training and translog models indicate that GDP is the primary predictor for future petroleum consumption evolution. The goal of this research is to examine changes in Brazil's intensity of petroleum usages (IPE) and consumption over the past three decades and to project IPE and consumption into the year 2000 using a mix of numerical techniques and economic history for long-range projection that places special emphasis on the IPE method. The decline in petroleum's share of the energy matrix, as revealed by looking at the full time series of consumption, began in 1973. Therefore, it appears that petroleum's status in the overall energy mix will remain stable or possibly improve slightly. Since 1973, IE has been on the rise, as seen by the historical series. Researchers believe this method will soon be exhausted due to its lack of true economic viability. Both the translog and learning models demonstrated that GDP is the primary factor explaining the development of oil consumption over time. Between 64 and 109 million metric tons of oil equivalent, they both perform similarly. With the decline in consumption and IPE, technological advancement took on a supporting role in the context of petroleum consumption, followed by the rise in the price of petroleum and the rise in the price of its alternatives.

When looking at absolute average errors (AAE), the translog model came out on top. This model adequately captures petroleum use because it factors in not only business activity but also petroleum costs, replacements, and technological progress.

Awodumi and Olusegun (2020) observe that there is a policy paradox between fostering economic growth and reducing pollution because the use of nonrenewable energy sources is both a necessary and significant contributor to carbon emissions. Therefore, this research looks into how the use of fossil fuels affected economic growth rate and carbon dioxide emissions in the top African oil-producing economies from 1980 to 2015. The paper used the “non-linear autoregressive distributed lag” (NARDL) method after recognizing the need to account for nonlinearity and structural break in the unit root and cointegration analysis. All of the examined nations, with the exception of Algeria, provide evidence of an asymmetric influence of per capita spending of natural gas and petroleum utilization on growth in the economy and per capita carbon emission. Positive shifts in Nigeria's utilization of nonrenewable energy sources slow economic growth but cut emissions. On the other hand, an increase in Gabon's usage of these biofuels has positive effects on the economy and the environment. Despite contributing to Egypt's economic progress, pollution from the use of these energy sources is minimal. Growth in the Angolan economy is correlated with increases in the use of nonrenewable energy sources, however the impact on carbon emissions varies with time and energy source. Furthermore, the impact of the reverse trend in natural gas and petroleum consumption is comparable to that of the positive trend in Nigeria and Egypt. Policymakers in oil-producing economies (in Africa) must therefore investigate and pursue opportunities to invest in and promote carbon-reducing techniques in production processes if they must keep increasing usage of their abundant resources, petroleum and natural gas, in order to achieve economic growth. This research looks at the leading oil-producing countries in Africa from 1980 to 2015 to determine how their citizens' consumption of natural gas and petroleum affected their GDP and individual carbon footprints. For this paper's comparative analysis of these countries (Egypt, Gabon, Angola, Algeria, and Nigeria), the authors selected for the NARDL method, which takes into account non-linearity and structural discontinuity in unit as well as cointegration analysis. While both petroleum and natural gas usage are found to have an unbalanced impact on economic development and carbon emission per capita, the study does not find any clear pattern.

There is a policy paradox between fostering economic growth and reducing pollution because the use of nonrenewable energy sources is both a necessary and significant contributor to carbon emissions. Compliance with environmental standards can be encouraged through the use of incentive and punishment systems.

According to Alarcon et al. (2021), energy usage and environmental implications arising from the extraction of these fuels need to be rapid and dependable if a country is to meet the fundamental need of satisfying the valuable energy demand in order to advance economically. The objective of this research is to contribute to the estimation of energy usage and air emissions of certain pollutant organisms stated by Pemex Refinacion in various scenarios of projection. The forecast estimate model is used to evaluate the potential outputs of four gasoline demand scenarios, three crude oil types, and eight processes used in refineries to meet fuel consumption demands. Emission factors are applied to estimate emissions from both the direct heating operations used to generate vapor using fossil fuels and from the usage of electric energy. Sophisticated refineries (full conversion) use more equivalent energy to complete their processes than do simpler ones; yet, because of their higher conversion efficiency, they use less crude to meet fuel demand while emitting fewer greenhouse gases. Potential Mexican refineries must be flexible enough to adjust to a wide range of operating conditions, including shifts in crude output, product quality, and price. Therefore, in settings where there is constant change, it is essential to create and implement viewpoints that enhance productivity and limit energy use, thereby minimizing air emissions. The question then becomes whether it is more important to minimize emissions to the environment or to reduce the expenses of operating the refinery, both of which would have positive social and economic effects. The amount of crude needed to meet gasoline demand in 2030 (2 million gallons per day) may seem minimal, given that it is the same as the amount produced to date over the past few years. However, one must take into account that highly sophisticated and thus highly efficient refineries would be used. In contrast, it stands to reason that when less crude is refined, fewer emissions will result. Energy consumption is somewhat higher while processing extremely heavy oils in the most complicated refineries (R4). It is certain that such refineries will be built, as the trend in the near future is to extract such crudes in Mexico, as they are the most abundant.

While they will still contribute to pollution in the environment, their higher conversion efficiency and reduced crude use to meet demand may mitigate this drawback. According to Bagher et al. (2003) proposition, a robust economy improves the purchasing power of the populace, which in turn increases the number of automobiles on the road. As a result, these processes need to find a middle ground to settle into. Liquid gas might be the most cost-effective choice among the several energy sources used in refineries to heat various operations. However, its NOx and PM emission factors are higher than those of other energy sources, with the exception of natural gas (NG). In this case, the challenge would be deciding whether it is more important to minimize emissions into the environment or to reduce the operating costs of refining. Additionally assumed is the accessibility of a sufficient energy source, given that the optimal choice isn't always accessible, or is only accessible at a premium. One last cost-benefit analysis is the result. If this is the case, it is crucial to identify the specific pollutant whose exposure needs to be decreased. Refinery gas (RG) is the optimal solution if sulfur oxides (SOx) are the issue. It might be possible to use fuel oil or refinery gas if total particles (PM) are being measured. The concept that "the ideal source of energy is that which causes the least pollution" has to be expanded upon. Consequently, one must weigh the pros and cons of each option in light of how much pollution they contribute to the air. Emissions from running pumps, compressors, and supporting machinery on electricity (EL) are quite high. This may happen if it is generated by thermoelectric or carbo-electric means and then transported to a refinery rather than using some other method. The reason for the latter is that PEMEX has not provided any data. However, when comparing pollutant volume to used energy factors, electricity has a weak correlation. Due to their high energy requirements relative to the other processes consider, vacuum distillation and air distillation units deserve special mention. It also means that their business model has significant ramifications for product profits and running costs. It is crucial to consider energy consumption and air emissions while evaluating the intricacy of refineries in terms of a greater yield of gasoline production. Mexico's potential refineries need to be flexible enough to adjust to a wide range of operational conditions, including shifts in crude yield, product quality, and pricing. In circumstances where change is continual, it is crucial to create and implement strategies that increase productivity while minimizing energy usage.

With the recent energy reform in Mexico and the stance of the newly elected President (Andrés López) of constructing new oil refineries, this report may help inform the officials of the oil and gas sector to strategize for a higher yield in the gasoline production and to meet the possible demand for the future years while minimizing atmospheric emissions. Lastly, the arrival of electric or hybrid vehicles has the potential to significantly alter future gasoline consumption; as a result, it is crucial to conduct studies that factor in this potential shift in fuel demand. Kahsai, et al. (2011) in their analysis of 40 countries in SSA examine the Granger causation among GDP, inflation, and energy use. They find no significant short-run relationship between energy use and economic growth for a sample of 40 SSA and low-income nations. For all SSA countries, the data show that GDP has a short-run transitory association with prices. Moreover, the findings show that there is a persistent and long-term connection between economic output and energy consumption, as well as a two-way causal relationship between the two variables. Although there is some support for short-run and high causation in the panel estimation, there is no evidence for a long-run correlation between GDP growth and energy use for middle income nations. However, a unidirectional Granger causation runs from CPI to GDP, and a bidirectional one from GDP to energy usage, as shown by the strong causality test. However, a unidirectional Granger causation runs from CPI to GDP, and a bidirectional one from GDP to energy usage, as shown by the strong causality test. They observe that CPI is an exogenous variable in terms of energy use and GDP development, with the sole exception of medium income nations. For the full sample of 40 SSA countries and the subgroup of developing and underdeveloped countries, they establish unidirectional Granger causation from CPI to GDP. For the sample of 40 SSA and low-income countries, there is a robust unidirectional Granger causation between prices and energy usage. This shows that, particularly for countries in SSA that are oil importers, high price levels, which are often tied to high energy prices, may inhibit development aspirations. Overall, the disparate findings for middle and low-income SSA countries lend credence to the idea that income plays a role in the causal association between energy use and economic growth, and they also propose that growth in GDP and energy usage are inextricably linked to one another during the development process. This correlation makes sense given the current level of advancement in SSA countries. Energy poverty cannot be effectively addressed by regional policy strategies that

disregard this reality. The significance of energy supply to the development process is shown in the low levels of growth for most of SSA. In order to ensure sustainable development, SSA nations should aim for increased regional energy self-sufficiency as part of their energy plans. In addition to proven gas and oil reserves, they offer large solar, wind, hydro-electric, and geothermal prospects that might be used to provide stable energy for the region and boost the reliability of the energy system as a whole. If countries execute energy policy on their own, they may run into trouble due to insufficient physical, financial, and human resources. However, things might look up if SSA countries coordinated their energy policy as part of a regional economic integration framework. There is an expectation that Africa's regional economic societies would help advance economic cooperation, sustainable development, competitive spirit, and the continent's overall integration into the global economy. All nations in SSA belong to the African Union, the “Common Market for East and Southern Africa” (COMESA), the “Southern African Development Community” (SADC), the East African Community (EAC), and the “Economic Community of West African States” (ECOWAS). Organizations like this can serve as platforms for discussing and organizing measures to promote long-term economic growth and energy security in a certain area.

Only a handful of research have been conducted to determine the relationship between petroleum energy and the growth of different economies. Dantama, Abdullahi, and Inuwa (2012), reviewed the link between energy consumption and the growth in economy in Nigeria from the ear 1980 to the year 2010. They used variables, coal consumption, real GDP, electricity consumption and petroleum consumption. Their results showed that there is a long-run relationship between the consumption of energy and variables related to economic growth. The findings revealed that petroleum and electricity usage have a significant positive linkage to economic growth while the coefficient for consumption of coal which is positive but not significant.

Others who made an effort to fill the gap the in literature of environment and energy, are Nasreen, Mounir and Atiqur (2020), by examining the causal linkage between the quality of the environment, consumption of energy in the transport sector and growth of the Asian economies between the year 1980 to the year 2017. By utilizing secondary data obtained from the British Petroleum statistical review of world Energy, they are of the opinion that Asian economies need to enhance domestic regulations that have

adverse environmental impacts. Moreover, they have to alter existing failures in the market using mechanisms in the economy and not fully rely on mechanisms instead of depending on globalization of trade and integration of the economy.

In addition to this, Aqeel and Mohammad (2011) wanted to establish the linkage between the consumption of energy and employment with growth in the Pakistan economy. By applying the Hsiao granger test & co-integration mechanisms, results revealed that the growth in economy leads to total energy consumption. An increase in the economy causes an increase consumption of petroleum, but neither economic growth nor consumption of gas have any impact on one another. However, in the power sector, they observe that usage of electricity leads to growth in economy but there is no feedback. The conclusion is that energy-conservation guidelines with reference to petroleum consumption don't cause any detrimental impact on the growth of the economy in Pakistan. Furthermore, Siddiqui (2004) look into the linkage between energy usage and growth in the economy. He concludes that, by expanding energy a country's economic growth would increase and by shrinking energy then the growth of the economy would decrease. He went ahead to opine that the increase of energy sources has different impacts on the economies. Electricity and petroleum factors have huge significant reaction on the growth of an economy. All in all, the reverse linkage is critical for the components in the petroleum industry.

In developing the hypothesis for this section.

H_0; There is a statistically significant relationship between petroleum energy consumption and economic growth in Kenya.

H_1; There is no statistically significant relationship between petroleum energy consumption and economic growth in Kenya.

Electricity Energy Consumption and Economic Growth

Stoffel (2015) states that electric energy consumption is the form of energy consumption that uses electric energy. Electric energy consumption is the actual energy demand made on existing electricity supply. The total consumption of electric energy can be divided into several categories, such as driving (electric motors), lighting, heating, communication, information, and others.

Fereidouni and Lee (2014) investigate the impact of renewable and nonrenewable electricity usage on economic expansion in 18 Latin American nations. The purpose of

this research is to build a panel model of GDP that would account for the years 1980-2010. Power from renewable sources, power from conventional sources, labor, fixed capital formation, and trade balance are all found to be cointegrated in a set of data analyzed by the Pedroni cointegration test. The panel “Dynamic Ordinary Least Squares” (DOLS) test findings also showed that all of the aforementioned variables have a favorable effect on GDP growth in the countries under study over the long term. An example of feedback causality between the variables is found in the results of the “Vector Error-Correction (VEC) Granger causality” model. The study found that in both the long and medium term, countries that increased their use of renewable electricity saw more economic growth than those that increased their consumption of nonrenewable electricity. Following the findings of this research, it is suggested that the countries under scrutiny increase their spending on renewable energy initiatives in order to boost the share of electricity consumption attributable to such sources. Moreover, these nations must increase their resource efficiency and execute energy saving programs in order to decrease their use of nonrenewable electrical sources. These countries might improve their energy security and do their part to slow global warming if they adopted these policies.

Liu et al. (2015) contend that nearly half of the United States' annual freshwater withdrawal is used to produce energy. Meeting future water and energy demands is a major socio-economic problem because of factors such as rising electrical consumption, a changing climate, and restricted water resources in many water-scarce states. To better understand the key determinants governing energy-water interactions and the impact of national policy, an integrated modelling method is needed that incorporates this interplay at regional or national dimensions. To model the electrical and water systems at the state level in the United States, this research expanded the Global Change Assessment Model (GCAM), a technologically enhanced model of the economy, energy, agricultural and land use, water, and climate systems. Future electricity production and consumption at the state level, as well as water withdrawals and consumption, are estimated using GCAM-USA under seven scenarios that varied the feasible energy portfolio, thermal technology mix, and water use intensities in granular detail. Future water requirements in the US electric-sector are studied using seven different scenarios to determine the effects of socioeconomic growth and rising electricity expectations, cooling system progressions,

adaptation of water-saving systems, climate mitigation legislation, and electricity transmission options. Our research shows that: 1) The shift from open- to closed-loop coolers reduces water usage while increasing water consumption; 2) variable water-use patterns in the energy sector, each leading to a unique set of options for achieving the mitigation objective; 3) the unrestricted trading of power has benefited states with low energy production and high demand; 4) In the case of some drivers (such those related to climate change adaptation and water conservation technology), there is consistency from state to state, while in the case of others, there is a more nuanced pattern (e.g., electricity trade); 5) there is an undeniable cost-benefit analysis between water use and withdrawal in the United States' power industry. This research examines the contribution of water-saving systems and the existing national policies and laws that favour reducing withdrawals (and boosting consumptive use. Water consumption consequences are also shown to be less favourable for climate mitigation plans that prioritize CCS and nuclear energy compared to those that prioritize renewable energy sources and water-saving techniques. This study's high level of geographic and technological detail provides a solid foundation for tackling pressing and novel problems at the water-energy linkage in the United States.

Foley et al. (2010) describe models of electrical systems as system software used for managing power demand and electricity networks, trading electricity, and planning expansion of generation. In order to provide governments and industries with the most cost-effective environmental and economic approach to the supply of electricity, while ensuring a stable supply of reasonable quality electricity, researchers model a number of portfolios and scenarios to evaluate the outcomes of making decisions in policy and on entrepreneurial development projects in electricity systems. Even though the difficulties and restrictions in liberalized markets are more complicated, the modelling tools established to investigate highly profitable state monopolies are increasingly being applied there. This study provides a strategic overview of the evolving role of power system modelling by examining the modelling response to important changes such as the shift from monopoly to liberalized market systems and the growing complexity caused by policy objectives for sustainable energy and emissions. The paper introduces the reader to electricity systems modelling techniques, reviews several important proprietary energy systems models utilized in the United States and Europe, and serves as a resource for

the electricity analyst lacking in the existing literature on how to decide which model to use to probe various aspects of the power grid. Typically, stochastic (random) programming is used to model electricity systems, with the aim of minimizing an objective function given the estimated price of electricity dispatch while satisfying a number of other constraints, such as the accessibility and functional capabilities of generating plants, applying environmental limits, energy cost contractual arrangements, controller and transmission constraints, and so on. In order to find optimal solutions to situations with unknown outcomes, stochastic programming is employed. The two primary strategies are the Dynamic Programming (DP) and the Stochastic Optimisation (SO) approaches. DP is a technique for breaking down large tasks into manageable chunks (e.g., shortest path). It can also involve top-down or bottom-up DP approaches are also possible. Typically, DP algorithms are implemented in one-of-a-kind programs. Finding the lowest-cost growth strategy is often related with GEP DP in the long run. Algorithms used in SO include random parameters and random decisions, either as part of the objective function plus constraints or as part of the method itself. Under the umbrella of SO are the subfields of Linear Programming (LP), Integer Linear Programming (ILP), Nonlinear Programming (NP), and Mixed Objective Linear Programming (MOLP) and Mixed Integer Linear Programming (MILP). In most cases, a solution and some codes are needed for this kind of optimization. The concept of artificial intelligence is used in several methods. However, these are mostly employed in power management, distribution planning, and load control. Various more methods exist, such as Fuzzy Set Theory, Game Theory, Genetic Algorithms, and Network Flow Theory. Stochastic methods are used to model the unpredictability of wind power output. The model includes a Monte Carlo-based stochastic modelling engine. Almost every model parameter has a distribution and set of parameters that allow us to treat it as a random variable. Power costs and trading support, full analysis of resource and contract portfolios, optimized long-term generation expansion planning (GEP), power market prices (including zonal and nodal), Firm Transmission Rights (FTR), Congestion Transmission Rights (CRR), and LMP, resource, contract, and portfolio value, risk and or Scenario Analysis (SRA), and emissions-related studies are all possible thanks to this tool.

Zachariadis and Pashourtidou (2006) conduct a review of electricity usage in Cyprus. In this work, researchers provide the first empirical assessment of the island nation of Cyprus's electrical consumption patterns. They analyze the relationship between income, cost, and weather in the residential and services sectors, the island's two fastest-growing power consumers, using annual time series data from 1960 to 2004. Time series analysis methods including unit root tests, cointegration tests, Vector Error Correction models, impulse response functions, and Granger causality tests are used in the analysis. The results demonstrate that electricity consumption has a long-term income elasticity greater than one and a price elasticity of the range of -0.3 to -0.4. Most short-term changes in electricity use are due to meteorological conditions. Granger causality studies verify the two-way causation between home electricity use and personal income, as well as the exogeneity of electricity pricing. Businesses tend to return to equilibrium more quickly and with less elasticity than households. Even though this study only employed a limited sample size, the findings are sufficiently robust to be used in future projections and policy assessments.

Bianco et al. (2010) studies and analyses Romania’s commercial and industrial power use. They find that planning a country's energy infrastructure relies heavily on predictions of electricity use. This research examines the commercial and industrial power usage in Romania and presents two models to predict future trends. The study begins with a discussion of methods for calculating GDP and consumer pricing elasticities. They find the long-term GDP and price elasticities for non-residential properties to be 0.496 and -0.274, while the short-run values are 0.136 and 0.0752. The second section of the research projects industrial and commercial electricity use out to the year 2020. The researchers use a Holt-Winters exponential smoothing technique and a “trigonometric grey model with a rolling mechanism” (TGMRM) to predict future consumption. On average, there is less than a five percent difference in the results predicted by the two models. Taking into account the time frame used in this analysis, this kind of variation is regarded to be within acceptable limits. The historical data shows that following the revolution in 1989, electricity consumption dropped dramatically. Heavy manufacturing like the iron industry is typical of Romania's economy before 1989, and so the country's industry is dependent on a substantial supply of electricity.

There was a time of instability following the revolution that lasted into the late 1990s. Companies from Western Europe that are involved in less energy-intensive industries eventually set up shop in Romania. Moreover, it's worth noting that the growth of the service sector contributes to an increase in GDP. When compared to heavy industry, the service sector uses a comparatively small amount of electricity yet produces a disproportionately large amount of value. All of these factors account for the entire lack of responsiveness of Romania's non-residential electricity usage to changes in GDP. In terms of price elasticity of demand, it is true that since the retail market was liberalized in July 2005, any industrial consumers have been granted the right to switch suppliers, and the market has been entirely open since July 1, 2007. If the amendment is successful, increased competition from the liberalized market will be reflected in greater price elasticity. The reform has lately been operational in Romania. Therefore, the effects have not yet been seen. There is a correlation between the growth in GDP and the rate of inflation. As such, while prices rose by 73% during the 1995 to 2007 period, GDP grew by 78%. There are not many ways to counteract this price hike. Furthermore, as noted, switching from electricity to alternative energy sources (such as natural gas) can be challenging due to the substantial investment required. These factors seem to account for the relatively low-price elasticity of energy consumption observed in Romania's commercial and industrial sectors. However, after the market accepts the electrical reform, researchers anticipate a rise in the consumer price elasticity.

Al-Bajjali (2018) estimates the determinants of Jordan’s electricity consumption from1986–2015. Future electricity demand in Jordan is predicted to outstrip current electricity production levels. The analysis used six predictor variables: GDP, urbanization, economic structure, electricity prices, population, and total water usage. To analyse how each independent variable impacts power use over a year, a multidimensional model is developed utilizing data collected over a year. When investigating the model's long-term relationships via the Johansen Cointegration test, the Vector Error Correction Model (VECM) is used. According to the results of the VECM regression, the gross domestic product, urbanization, economic structure, and cumulative water consumption are all significantly and positively correlated to electricity usage. In contrast, electricity costs are significantly and negatively correlated to electricity usage. In the short term, a rise in population is associated with a rise in electricity use. More money should be put into

renewable energy projects, the import of energy-wasting appliances should be outlawed, and the current policy on how to treat refugees should be evaluated, according to VECM's findings. The rate at which people move into cities will be a major factor in elevating the nation's overall demand for power. To support a 10% increase in Jordan's urban population, the country's government should think about raising electricity capacity for power generation by around 10.5 GWh. People in cities have a large impact on the nation's electricity usage because of their reliance on electrically powered appliances. The import of inefficient electrical appliances that use too much power should be banned, and taxes and tariffs should be lowered for those that help the environment. As GDP and electricity price are also major factors in Jordan's electricity consumption, the government is prompted to take the following steps: first, First, invest money into renewable energy sources like solar and wind since their low upfront and ongoing costs will allow the country to provide inexpensive electricity to various activities in crucial economic sectors like the water sector, which uses a lot of power to pump water. Second, with the power firms freed up, power grid losses may decrease, and supply efficiency can be increased. Although Jordan's agricultural and industrial sectors are relatively minor, their impact on the country's total electricity usage cannot be ignored. An additional 64 GWh of electricity would be needed to support a 200,000 JD growth in industrial value added. An additional 56 GWh of power may be used to supply a rise in water use of 200,000 m^3. There will be a significant increase in electricity demand, and policymakers should be cognizant of this while deciding how to incentivize agricultural programs and attract additional industrial operations to Jordan.

Altinay and Karagol (2005) investigate the relationship between power usage and economic growth in Turkey. The authors of this study analyse data from between 1950 and 2000 from Turkey to see whether there is a correlation between the country's electricity usage and its real GDP. Zivot and Andrew's testing demonstrated that both series are stationary processes centre on a structural rupture. For this reason, the Granger non-causality has been tested in two ways: (1) the Dolado-Lu tkepohl test with VARs in levels and (2) the canonical Granger causality test utilizing detrended data. Both analyses found substantial support for a direct link between one's household's power use and annual income. In light of this, it is clear that ensuring sufficient electricity is available to fulfil rising electrical demand is crucial to ensuring that Turkey's economic growth is not

impeded. Using the Granger causality definition, the research makes sense of the outcomes of the non-causality tests. Since using electricity typically leads to higher incomes, it follows that Turkey's economy expanded because of increased energy use. Given that they are likely both influenced by some other causes, the two variables cannot be intrinsically linked. Increasing demand for power can be seen as an early indicator of a flourishing economy. In consideration of this, it is clear that ensuring sufficient electricity is available to fulfil rising electrical demand is crucial to ensuring that Turkey's economic growth is not stunted. Altinay and Karagol (2005) discovered no causation when using aggregated primary energy consumption; however, when considering electricity usage alone, there is a significant causality flowing from electricity usage to the GDP growth in Turkey.

Mohamed and Bodger (2003) predict electricity consumption using demographic and economic variables in New Zealand. In this study, researchers examine how a subset of economic and demographic factors affects New Zealand's annual power usage. During the time frame of 1965–1999, the study looks at New Zealand's GDP, the average price of energy, and the population. To create these models, multiple linear regression model is employed. Power usage is found to be highly associated with every single factor. The models' predictions are measured against official national predictions. Also, the predictions are compared to those of a previously built Logistic model. New Zealand's electricity usage is predicted using multivariate linear regression and economic factors for both the residential and commercial sectors. The statistical assessments showed that the models worked well, indicating their importance in predicting electricity usage given the explanatory variables taken into account. Total electricity usage models have been compared with New Zealand's national forecasts available. The forecasts from the regression analysis are quite similar to the national forecasts. The reliability of these models' predictions is highly dependent on the reliability of their predictions for the explanatory variables. The variables are modelled using simple regression for this paper. There is active research on other approaches to forecasting these parameters.

Gurgul and Lukasz (2011) investigate the causal relationship between power consumption and GDP in Poland. Their study covered both residential and commercial electricity use, as well as electricity use in manufacturing. The studies are conducted in a three-dimensional framework wherein employment is selected as a further variable to

accurately capture the correlation between GDP and power consumption. For this study, researchers examine dependable quarterly data from Q1 2000 to Q4 2009. Both a whole sample and a pre-crisis (i.e. Q1 2000-Q3 2008) subsample are investigated to ensure the causalities are consistent. They used both time-honoured techniques and cutting-edge econometrics. The researchers discover a feedback loop whereby overall power consumption affected both GDP and employment levels. Not only do researchers discover no explicit causal relationship between industrial power consumption and GDP, but they also discovered a unidirectional causality extending from industrial power consumption to employment. The 2008 economic and financial crisis also have little to no discernible effect on any of these results. However, after the financial crisis of 2008, the correlation between industrial electricity usage and employment becomes much stronger. Overall, the study found rather solid evidence to support the hypothesis that there is a positive feedback loop between the two time periods' total electricity use and GDP, in addition to between total power consumption and employment. This might be viewed as proof that the structure of causal dependencies between variables is robust and so it is not severely shaken by the crisis of 2008. The fact that these findings are generally supported by two independent econometric approaches is equally noteworthy, since it speaks volumes about the validity and reliability of the empirical results. To some extent, the fact that cointegration assessment could not be performed in a three-dimensional framework explains why researchers did not uncover as strong causal links with other parameters for industrial power usage in both time periods as they did for overall electricity consumption. However, the numbers and calculations offered proof that industrial electricity use has a direct and major impact on the job market during the 2008 recession.

Hoshimov et al. (2019) in their study aim to develop a method for standardizing electricity consumption. In this paper, researchers discuss the methodology behind determining certain indicators of electricity usage during the manufacturing of technological process support components. The authors' findings inform a method for computing energy standardization in the devoid of input sources. Furthermore, the method enables the determination of energy consumption guidelines given the discrepancy between actual and theoretical values. Similarly, Ho and Siu (2006) develop an empirical analysis of the dynamic equilibrium between electricity use and GDP in Hong

Kong. Most discussions of Hong Kong's power policy centre on the regime of electrical regulation, although the policy's macroeconomic impact is rarely brought up in public debates. In this work, researchers report their results using the new electricity usage dataset. They find that real GDP and power consumption settle into a long-term equilibrium relationship. Real GDP is directly correlated with the amount of power used. When the current equilibrium is disturbed, a major process of adaptation begins. Lastly, the structural link between power use and economic activity in the 1990s may have shifted. The substantial macroeconomic impact of energy consumption on real GDP recommends that the Hong Kong administration should be cognizant of the necessity of reliable supply of electricity in the present discussion of new regulatory conditions with the major Hong Kong electricity providers. The Hong Kong administration needs to find a middle ground between protecting shareholders' rights and guaranteeing a reliable electrical supply. But the shifting make-up of Hong Kong's energy usage, along with the structural shifts in economic activity, hints towards the existence of such a shift. Incorrect estimations and misguided policy suggestions may result from omitting the endogeneity in the statistical study. Future studies should consider the likelihood of structure shifts in the long-term equilibrium and its impact on the correlation between GDP and power consumption, as done in Ho and Siu (2006).

According to Niu et al. (2013), electricity consumption, as an indicator of contemporary energy, is often used as a measure of a country's progress toward economic and social development. The research by Niu et al. (2013) examines the connection between growing reliance on energy and human progress and evaluates the current state of the electricity market. In this research, panel data from 1990-2009 for 50 nations are used to build models. The countries are split into four groups based on income. Human development indicators including gross domestic product per capita, consumer spending per capita, urbanization rate per capita, infant mortality rate per capita, and adult literacy rate are used. The findings demonstrate a long-term, two-way causal relationship between five variables and electrical energy use. The human development and electricity use of a country rise in unison with its GDP. In addition, there is a large disparity between the variables of the four income brackets. Specifically, when wealth rises, electricity consumption contributes more to GDP and consumer spending, while urbanization, birth rates, and adult literacy rates show a declining tendency.

This is primarily due to the fact that convergence is occurring in the later variables in high-income nations. Including electricity in the building of basic public services is important for human development because it increases the likelihood that low-income individuals will have access to electricity. Electrical equipment is necessary for the utilization of electricity. In addition to paying for the cost of power itself, people must also invest in electrical appliances, the cost of which is frequently higher than the cost of the electricity itself. So, electricity is likewise a form of expensive energy. Although low-income households would like to use more electricity, they often lack the resources to do so. As a result, they must take measures to reduce their electricity consumption.

While more reliable access to electricity would be welcome, raising living standards would have a greater impact on human progress. It's important to keep in mind that the HDI of a country is the sum total of a number of different criteria. Among these elements is the use of electricity. The authors of this study found that there exists a long-run causation association between one's electricity usage and five different HDIs. Even if more electricity is used, that does not mean that human development indexes are automatically improved. Researchers also discover that (a) a country's geographic location, energy structure, and other factors all have an impact on electricity consumption, (b) countries located at higher latitudes use more electricity than countries located at lower latitudes, and (c) countries that rely more on non-renewable energy sources use less electricity. Since the scope of this study is so narrow, researchers are not be able to address the aforementioned concerns. It is reasonable to assume that low-and middle-income countries will eventually reach the same level of electricity use and human development as upper-middle and high-income nations. Lessons can be taken from the successes and failures of higher-income nations by those with lower-income nations or areas. Electricity development can be planned to meet the needs of society as it evolves. Consequently, they can determine targets for human progress in light of the available electrical power. This paper's findings demonstrate a positive interaction association between countries' levels of electricity usage and human development across the 50 countries analysed. As a result, four policy implications have been identified; In order to increase the accessibility and availability of electricity, low and middle-income countries should consider power supply a fundamental public service in modernization. They need to cultivate and employ multiple energy sources in order to construct a reliable electricity

infrastructure. In particular, electrical engineering can create the circumstances for human progress in underserved rural areas. Countries should also encourage technical and economic collaboration between themselves in order to enhance the electric power-supplying capabilities of recipient regions in the South through international aid and cooperation. They need to work toward developing new cleaner, renewable, and low-cost energy in order to mitigate the environmental damage caused by rising electricity usage. This provision should be strictly enforced for any cutting-edge technology used to generate electricity through the use of renewable sources like hydropower, solar and wind energy, nuclear power, or biomass. Affordable energy-saving technology that can increase the efficiency of common household products like light bulbs, air conditioners, freezers, and televisions should also be encouraged. If energy-efficient light bulbs are used instead of traditional incandescent lights in urban households, people could save an estimated 50.9% on their annual electricity consumption. Furthermore, in China, if household appliance efficiency is substantially enhanced, urban households might lower their electricity use by 28% by the year 2020. While expanding access to electricity is critical to further human progress, it isn't the sole option. Accelerating electrification construction is only one part of the puzzle; low-income countries also need to work to end poverty, ensure that all children have access to quality education, and enhance their healthcare systems to foster development. Across China's vast territory, from west to east and from urban to rural areas, there is a wide gap in the level of human development. Similar to how there are four distinct socioeconomic classes, regions can be divided in this manner. Building a power grid more quickly would help middle- and low-income areas develop their populations. Concurrently, people need to work toward a rural electrical grid and price that is comparable to urban areas. Moreover, "bringing household appliances to the country" is a good idea that should keep going. The electricity costs of farmers may be decreased if they implement these techniques.

Manca and Nardini (2009) examine electricity consumption and forecast, using linear regression models, the future energy consumption in Italy. In order to create a sustainable consumption forecasting model, researchers have looked into how demographic and economic factors affect annual power usage in Italy. In analysing the past, they focus on the years 1970 through 2007. Multiple regression models are built by analysing past data on power use, GDP per capita, GDP, and population.

Domestic and commercial electricity consumption elasticities are estimated along with price, GDP, and GDP per capita in the first section of the study. It is determined that the short-run price elasticities of both the local and international markets are approximately -0.06, whereas the long-run price elasticities are -0.24 and -0.09, respectively. On the other hand, higher values are shown by the elasticities of GDP per capita and GDP. Several regression models for stationary or co-integrated data are described in the paper's second section. Various statistical analyses are used to verify the accuracy of the suggested models. By contrasting the produced regressions with national estimates based on complicated econometric models like Markal-Time, researchers find that they are consistent with the formal projections, with differences of -1% at best and -11% at worst. These variations should be seen as tolerable given the time frame considered. Creating tariffs with varying pricing during the day and night, or during working days and weekends, is another typical proposal to boost price elasticity customers outside the home who are able to shift production schedules and stockpile raw materials, like fresh food supplied during the week and processed on the weekend, stand to benefit from these levies. Additionally, it's important to weigh the potential savings in electricity against the potential gain in pay from working extra hours on the weekend or at night. Substituting natural gas, which is widely available throughout Italy, for electricity is another possibility, although this strategy too presents challenges. In reality, as was previously said, replacing electrical engines with ones that run on alternative fuels takes substantial financial investment, and the price of natural gas is extremely volatile. The liberalization of the Italian electricity market, which began in 1999 and was finalized in 2007, has opened up new possibilities by fostering healthy competition among generators, which should improve efficiency while also lowering the price paid by consumers. The current market structure is characterized by a lack of competition and a concentration of power among a small number of firms.

Buechler et al. (2022) investigate the global changes in electricity consumption following the eruption COVID-19 pandemic. To better prepare for future disasters and other extreme events, knowing how the COVID-19 epidemic has changed electricity demand is important. In this study, researchers quantify the changes in energy consumption in 58 regions worldwide from January to October 2020 and investigate the relationships between these changes and policy limits, mortality rates, GDP, mobility

measures, and electricity sector features. They aggregate the timeseries of power usage changes to identify effect categories that reflect systematic differences in onset, onset depth, and recovery rate. The results demonstrate that during the early stages of a pandemic, electricity consumption drops most precipitously in areas with the strictest government restrictions and the largest losses in mobility (especially retail and entertainment). Their findings point toward a new line of research, suggesting that pre-pandemic responsiveness to holidays may be linked to observed declines in power use.

Few studies have been conducted with regards to linking the consumption of electricity to the growth of the economy of various countries. Apergis & Nicholas (2011) explore the linkage of non-renewable and renewable energy consumption as well as the rise in the economy for eighty states in the period 1990 to 2007. They discovered that there is a link which is bi-directional in both the short-term and long-term between both renewable & non-renewable utilization of energy and the growth in the economy. Further, there is a short-term bidirectional linkage between renewable and non-renewable consumptions of energy meaning that these two energy sources are substitutable. Similarly, Sriyana (2019) look into how changing the effects of consumption of energy has on increasing the economy of a developing country. By using, investments, consumption of renewable energy & electric power, supply of money, government expenditure and labor participation proportion he established that consumption of electric power and participation of labor impact the economy in a positive direction. Consuming electrical and renewable energies are seen to have asymmetrical impacts in both the long and short runs. They opine that labor force and energy consumption are the primary sources of economic growth in the Country-Indonesia. These findings are in line with the neoclassical theory.

Squalli (2006) applied the bound tests for all the member states in the Organization of the Petroleum Exporting Countries notes that there is a long-run linkage between consumption of electricity and growth in the economies of all the OPEC countries. Additionally, an autoregressive Distributed Lag model is applied by Ozturk and Acaravci (2011) to analyze the causation for both the long and short runs between consumption of electricity consumption and the rise of economies for eleven Middle East and North Africa (MENA) economies. For Saudi Arabia, they note the existence of a unidirectional linkage from the consumption of electricity to real gross domestic product. Therefore, concluding

that policies aiming at conserving electricity may have detrimental effects on economic growth.

Other researchers have obtained findings that are varied such as Kojo, Yemane, Payne, and Apergis (2010) considered the link between; the consumption of renewable energy, carbon dioxide discharges, and consumption of nuclear energy on the growth of economies for a class of nineteen developing and developed countries from the year 1984 to the year 2007. The error correction model revealed that the estimates in the long-term, imply that a positive significant link exists between consumption of renewable energy and carbon dioxide discharges while a negative significant link between CO_2 discharges and consumption of nuclear power. They opine that the consumption of renewable energy does not reduce discharges of carbon dioxide although consuming nuclear energy is a vital component in ensuring that carbon dioxide discharges are lowered in the short run.

By implementing the bootstrap tests and techniques, Arouri et al. (2012) delve into the linkage between consumption of energy, discharges of carbon dioxide, and the gross domestic product for twelve Middle East and North African countries (MENA) from 1981 to 2005. They conclude that the EKC hypothesis holds at a regional level but not at a country level. In the same breath, Bildirici (2013) delves into the relationship between consumption of electricity and growth in the economies from the year 1970 to 2010 for different African countries including Kenya, Ethiopia, Togo, Congo, Cameroon, Ghana, Senegal, Gabon, Guatemala, Zambia and Cote D'Ivoire. By applying the autoregressive distributed lag model, ten out of the 11 countries in the sample showed that there is a linkage between economic growth and consumption of electricity. For Guatemala and Gabon, it is established that electricity consumption falls under leisure goods. For Senegal, electricity consumption falls under Engel goods and for Zambia it is an inferior good. Growth hypothesis is found for The Republic of Congo, Kenya, Mozambique, Cameroon and Ethiopia. The conservation hypothesis is upheld in Zambia and Senegal. Bi-directional causation is found for Guatemala, Ghana and Gabon between consumption of electricity and the advancement of the economies. As well, Bildrici, Bakirtas and Kayikci (2012) estimated the causation relationship between consumption of electricity and growth in economy. The research made use of income and price elasticities of aggregate industrial, and electricity demands for both developing and developed economies, including China, Italy, United States, India, Brazil, Canada, United Kingdom, South Africa,

Japan, France and Turkey. The growth hypothesis is upheld for countries, Brazil, Canada, China and United States, China, Canada and Brazil. The conservation hypothesis is reinforced for Japan, United Kingdom, India, Turkey, Italy, France and South Africa.

By utilizing the Error Correction Model and Ordinary Least Square methods, Aljebrin (2014) examines the relationship between prices of electricity, consumption of electricity and GDP for Saudi Arabia. He observes that the prices of electricity and consumption of electricity have a negative linkage in both the long and short terms. Whilst consumption of electricity has a positive link with GDP for the long term but is immaterial for the short run. Alkhathlan and Javid, (2013) explore at both disaggregated and aggregated levels, the linkages between carbon discharges, consumption of energy, and economic growth in Saudi Arabia. They observe that in the long run, there are positive relationships between carbon dioxide discharges & electricity consumption and GDP in per capita & carbon discharges. Nonetheless, there is no causation recognized between the consumption of electricity per capita and GDP per capita.

In developing the hypothesis for this section.

H_0; There is a statistically significant relationship between electricity energy consumption and economic growth in Kenya.

H_1; There is no statistically significant relationship between electricity energy consumption and economic growth in Kenya.

Renewable Energy Consumption and Economic Growth

Asantewaa and Asumadu (2016) define renewable energies as forms of energy that can replenish themselves indefinitely without depleting the earth's resources. Renewable sources of energy include geothermal, wind, solar, bio, ocean power, as well as hydropower. In the middle of the 1800s, the Industrial Revolution began, and ever since then, humanity has had access to resources that were previously unavailable (Chu and Arun, 2012). The introduction of steam-powered locomotives and ships, followed by internal combustion engines, revolutionized global transportation and industrial production. The 19th and 20th centuries saw the continuation of the revolution through the use of electricity and related technologies. An increasing number of people now take measures to ensure their houses are comfortable year-round, regardless of the season. They drive over hundred-horsepower automobiles to the markets and fly over continents in a hundred thousand-horsepower wide-body airplanes.

The ability to harness fossil fuels is crucial to the source of this strength. The switch from human as well as horsepower to horsepower, however, has posed enormous climate-change threats due to the carbon emissions from the equivalent of nearly a billion horses operating continually. 700 million people lived on Earth during the start of the industrial revolution. There are currently 7 billion people in the world, but that number is expected to rise to nine billion and to around ten billion by 2100. The majority of this increase will occur in Africa and Asia where developing economies will increase the need for more power. According to projections made by the Paris-based International Energy Agency (IEA) (2008) global energy demand will rise from its 2009 level of around 12 billion tonne oil equivalents (t.o.e.) to either 18 or 17 billion t.o.e. by 2035, depending on whether "current policies" or "new policies" are implemented respectively. Under existing regulations, carbon dioxide emissions are at 29 Gt yr-1, but under the current policies and new policies, they are projected to rise to either 43 Gt yr-1 or 37 Gt yr-1. The real course will be determined by how well people utilize both traditional and alternative energy sources. There is a need for a new industrial revolution wherein energy became widely available, cheap, and secure. Decarbonizing existing energy sources and increasing efficiency are critical components of this transformation. The inability to discover affordable supplies of fossil fuels will not be the driving factor in lowering carbon dioxide emissions on the timeframe needed to prevent the worst dangers of climate change. Soberingly, the fraction of non-carbon-emitting energy sources has stayed stable over the past two decades, despite the enormous expansion in the usage of renewable energy. It is possible to classify energy systems as either portable or fixed. While each system's supply, demand, and distribution infrastructures are closely connected, they operate in isolation from one another at the present time. The Reviews in this Insight go at narrower topics within the broader fields of biofuels, solar power production, and electricity production from salt gradient and wastewater. Most of the discussed systems are still in the early stages of development, and they are not yet competitive with established energy technologies. However, one should always be on the lookout for fresh ideas that might either vastly improve upon the status quo or provide an altogether new method. This Perspective examines portable and fixed power systems and provides indications of how the themes covered in the reports fit into the overall energy landscape in order to provide context for the Reviews.

Hayat, Chaudhry, and Raza (2009) examine the technologies in renewable energy in Pakistan while outlining the prospects, challenges, and applications of solar energy. Solar power can be used in a variety of settings. This technology is not only cheap and easy to use, but also harmless to humans and the planet. A few examples of this are solar ovens, solar water heaters, solar space conditioners, solar steam generators, solar food dryers, and solar dehydrators. Biogas—an agricultural variant that Pakistan has been blessed with by God—is another wonderful advantage the country enjoys. Every household in local communities owns a few animals, so there is always plenty of animal waste for biogas production. Animal manure is commonly used as a fuel source for home activities like cooking and heating in rural areas. Biogas could be generated from this garbage on a small scale. As a result, there is a great potential for utilizing biogas to construct modest household biogas plants throughout the country's outlying regions. In 1974, the Pakistani government (now PCRET) launched a biogas initiative. By 1987, 4137 biogas plants have been constructed across the country's rural areas. The biogas produced by these plants is between 3,000 and 5,000 cubic feet per day and can be used for both domestic and commercial applications. There are three distinct rollouts for this program. Wind is yet another source of renewable power that might be used to help Pakistan with its current energy problems. Unfortunately, there is currently no accessible wind data in our nation. That means it’s impossible to get an accurate picture of wind energy availability. Great efforts are required to effectively examine wind data at various mountain altitudes, especially at the most promising places along the coast. Despite the fact that the average wind speed at some strategically chosen locations isn't high enough to make wind power generation viable, that doesn't mean it can't be used to power wind turbines to pump water to areas where it's available at shallow depths of up to 100 feet. Pakistan's southern coastline, which is around a thousand kilometres long, and certain mountains in the country's northern region both have good resources producing wind energy. Unfortunately, there is currently a lack of both technical skills and appropriate wind data in Pakistan, making it impossible to erect wind turbines. However, scientists at Karachi University have been working on wind data collection and have attempted to set up wind turbines to generate electricity. Some estimates put the number of windmills used to pump water at around 30. Currently, only one company in the area, Merin LTD., produces windmills for use in pumping water. This business markets their mills both

domestically and internationally. In addition, in August of 2007, COMSATS Institute of Information Technology (CIIT) installs a windmill that it has built for educational purposes under the guidance of engineers from the United Kingdom. Planet Energy (Pvt) Pakistan's Executive Director, Mr. Khurram Sayeed, emails the company's shareholders and potential investors that the company has signed a memorandum of understanding (MOU) with one of China's biggest and world's top 10 wind turbine manufacturers to procure windmills for its intended 50MW, well with option to increase it to 150 MW. Hydropower is another essential element of renewable energy. Pakistan's hydroelectric resources are particularly abundant in the north. People still rely primarily on hydropower for our energy needs. They rely on it for 90% of their power. There are roughly 12 major hydropower facilities (each producing about 1 MW). Many locations in the mountainous terrain have waterfalls that are both naturally occurring and amenable to human manipulation. The population is spread out in a thin cluster in an area with limited access to basic services. The use of these energy sources can provide tremendous benefits to these communities. About 19,547 MW of power may be generated in Pakistan. Also, hydroelectric resources presently contribute 6,600 MW. The country has been estimated to have a hydropower potential of over 41,722MW. Up to 100 kilowatts (kW) of micro-hydropower (MHP) can be generated from perpetual waterfalls in northern Pakistan. In addition, many canals in Punjab have both a low head and a high discharge of water, making them prime candidates for exploitation as part of the canal network system. In 1910, Sir Ganga Ram set up a power plant along the BRB Canal. Kinetic energy is transformed into electrical energy in this system. In contrast to hydra power, which turns potential energy into electrical energy, this system is based on a different principle. But Pakistan does not have any such infrastructure in place. This technique is adaptable, so it may be applied on other canals to generate power for the towns below. About 228 "run of river type" plants of 3MW capacity have been installed in the Northwestern region by the "Pakistan Council for Appropriate Technology" (PCAT), currently known as PCRET. Beneficiaries must construct the transmission lines, generation facilities, transmission poles, and distribution networks themselves. Contrarily, the PCRET supplies some apparatus and skilled technical oversight. Electricity generated by these mini-hydroelectric plants is used both in homes and by local small businesses, like mills for making flour and gins for processing cotton. Waste from cities and towns across the

country is collected daily, and one environmentally beneficial option for getting rid of all of that trash is to use biomass. To people's dismay, though, not much has been initiated in this decade.

The fuel cell technology can also be applied. A fuel cell is an electrochemical device that directly transforms the chemical energy of a fuel (hydrogen) into electricity. It works in a similar fashion to a battery, which combines hydrogen from a variety of different sources with oxygen (from the air) to generate thermal energy, chemical reactions, and liquid water. A fuel cell consists of a cathode and an anode, separating the two parts by an electrolyte (which can be either liquid or solid). In most cases, hydrogen or other chemicals and oxygen are distributed across the electrodes via permeable or channelled structures. Catalysts, often platinum, are used in combination with the electrodes. DC power energy and ions with positive charges are generated when hydrogen ions enter the fuel cell there at the anode, and electrons are eliminated (protons). An inverter is a device that changes direct current to alternating current. The anode and the cathode are two ends of an external circuit through which the electrons travel. Electric motors, lighting systems, and other electrical components are perfectly acceptable for inclusion in the external circuit. Through the electrolyte, hydrogen ions make their way to the cathode, where they re-join with oxygen electrons to generate water and heat. Hydrogen ions move from the anode to cathode via the electrolyte, where they re-join the electron and oxygen to generate water and heat. For various uses, such as transportation, decentralized power generation, and battery-operated gadgets, fuel cells are considered a practical power source. In Pakistan, this form of alternative energy has not received much attention. Two small groups in Pakistan are currently attempting to break into this new area of study; one is located at the “Pakistan Atomic Energy Commission,” and the other is housed at the “COMSATS Institute of Information Technology in Lahore.”

Rennkamp et al. (2017) investigate the political climate surrounding renewable and carbon fuels in South Africa, Mexico, and Thailand. Despite having cheap local fossil fuel resources and no international backing, this research examines the reasons why middle-income countries are encouraging renewable energy. In this study, researchers compare the renewable energy policy environments of South Africa, Mexico, and Thailand. The energy resources of all three nations, both fossil fuel and renewable, are extensive. Researchers contend that alliances of powerful political players make renewable energy

initiatives a viable policy alternative in fossil fuel energy-rich middle-income nations. From a discourse network viewpoint, this research examines the domestic coalitions for and against renewable energy policy. The discourse network represents the various actors and the arguments they use to further or impede the policy-making process. The research uses a database of 560 classified statements in favor or against renewable energy gleaned from the media, policy papers, and interviews. The results suggest that the architecture of competing coalitions is very similar across all three nations and that there are strong links between economic and environmental concerns in the discourse across all three countries.

Abbas, Razzaq, Bashir, Alemzero, Sun, Iram and Iqbal (2020) state that wind energy is continuing to have a huge impact in the continent of Africa because of its decreasing cost and improvement in technology over the years. Many countries in the continent of Africa are Most African countries are trying to plan, exsiccate and connect the renewable energy projects within their national grid systems whilst giving higher priority to security of energy, consumption of energy that is sustainable and little emissions of carbon. Many policy frameworks have been established in these countries for promoting the upscaling of wind energy as well as renewable energy all over the World. But these policies have have mixed reactions on distribution of wind energy. The scholars utilized the fixed effects methodology and panel data for this purpose, current study used panel data and fixed effects model for seventeen countries in the continent. After carrying out the research on the macro-economic variables including energy usage, gross domestic product & carbon dioxide discharge and the variables on energy security including import of energy & electricity consumption have a major impact in the determination of levelling up wind energy in the continent. The study added to the main drivers of the deployment of wind energy, adding to the many studies already done for the African continent. The findings show that wind energy is at its infancy in the continent whilst it is increasing at a very fast pave in many developed countries as well as Europe. Wind power would assist the continent to have the capacity to meet the needs of its speedily increasing population and urbanization, as well as aid to meet the Paris Accord for stopping World-wide temperatures not to go beyond one point five degrees in the pre-industrial levels. Enhancement of wind energy would make the countries in the continent be able to distribute energy that is environment-friendly, clean and cheap

compared to the other forms of energy. This would also ensure that there is security/assurance in energy, there is no energy poverty and there is creation of an energy economy. Many of the countries in the continent are facing the challenge of the growth in the demand of energy, increases in oil prices, volatiles in the oil market, carbon dioxide discharges, political risks because of over-consumption of fossil fuels. In spite of all these fascinating reasons the give Africa a reason to upgrade wind energy in the different countries, the capacity of installed wind power is so minimal amounting to five thousand four hundred and sixty-four Mega Watts in the year two thousand and eighteen. Currently, the continent shares only one percent of the world installation of wind capacity. Nonetheless, commitments from the political leaders who are the presidents of the different countries have been made to upscale the level of sources of renewable energy in the countries. The Africa Renewable Energy Initiative has just been formed with the aim of upscaling renewable energy capacity so as to attain the SDGs (Sustainable Development Goals), by plunging the continent into low-carbon economies which in turn accelerate the growth of the economy.

According to Boehlert and Gill (2010), authors of “Environmental and Ecological Effects of ocean renewable energy development,” marine renewable energy has made a commitment to manage carbon emissions across the globe. However, this comes with numerous uncertainties about possible effects on the environment. The potential impacts on the environment have not been adequately studied and the devices to be used are yet to be evaluated and tested. Boehlert and Gill (2010) explore the current state of knowledge or uncertainty on the potential environmental and ecological effects of the development of several sources of marine renewable energy. These include marine wind, tidal, estuary, ocean currents, and thermal variation. The additional structures raise concerns for entanglement, habitat alteration, and community change, all of which are typical of other types of development in the maritime environment and hence are not unique to this type of development. Other consequences are more particular to maritime energy conversion, such as the type of energy being harnessed, the type of device being used, or the amount of energy being lost in marine systems. While most of the expected impacts are inevitable and difficult to manage, a number of them are measurable and can be minimized. Several ways to minimize these effects include proper selection of the devices being used and careful choice of the site.

However, the authors put out the disclaimer that the scale of development may lead to additional impacts that need to be evaded to avoid environmental pollution. Achieving clean renewable energy should be a common goal for all stakeholders comprising engineers, regulators, scientists and ocean developers. Similarly, Hussaina, Arif and Muhammad (2017), in their study, discuss the five most emerging renewable energy sources. These alternative energy sources are either novel developments or variations on more established renewables including solar, wind, geothermal, biofuels, biogas, and hydropower. the authors continue to discuss the five emerging renewable technologies comprising Marine energy, concentrated solar photovoltaic (CSP), enhanced geothermal energy (EGE), cellulosic ethanol, and artificial photosynthesis. Ocean thermal energy conversion, salinity gradient energy, wave energy, and tidal energy are the various forms of marine energy. Various concentrated solar power (CSP) technologies are classified as either parabolic troughs, linear Fresnel reflectors, parabolic dishes, or solar towers. In addition, the procedure for creating EGE reservoirs is described in depth. As if that is not enough, the authors go ahead to describe the cellulolytic and gasification steps in the extraction of energy from cellulosic ethanol. They describe the artificial photosynthesis process works paying attention to semiconductor particles, electrolysers, synthetic leaves and solar cells synthesized from dye. Each renewable source is discussed alongside its market shares, obstacles, and effects for higher adoption as well as prospects. The authors provide a systematic review of recent advances in the world of renewable energy. These include new prompts such as solar power, geothermal energy, artificial photosynthesis, and cellulosic technology. The researchers conclude that renewable energy sources collectively contributed around 22% of the total energy consumed in the US in 2014. The rate of increase in greenhouse gas emissions is very concerning.

According to the IEA, if existing policies continue to be implemented, atmospheric CO2 concentrations will more than double by the year 2050. This study has included a dire analysis of the history and potential of CO2 mitigation strategies for greener, more sustainable growth. The authors of this report feel they have a better understanding of where the top five renewable and sustainable energy sources stand right now. It also covers the stalemates and difficulties researchers have encountered in each of the five technologies and offers some possible answers to these issues. Each of the five technologies has the individual power to sustainably meet the energy needs of human

beings. It is important to note that these technologies are wide, diverse and enormous and have different sub-technologies within them. In a world where everything is technologically driven, the new innovative renewable energy sources are gaining much traffic in the marketplace. These technologies, which are now competing with traditional power sources, have great positive impacts in sustainability. Besides, it is a plus that they are constantly improving with time. Although some of them face technical issues, research shows that proceedings to overcome these challenges are on the rise. In other words, these technologically driven renewable energy sources are quickly replacing the environmental harmful energy methods. One example of the former is the concept of smart cities which has been of great benefit to these renewables by promoting clean and friendly environments. Therefore, there is a need to strongly support these technologies in an attempt to make the world a cleaner place to live in. this support could be in terms of creating public awareness, aiding in overcoming the technological obstacles and supporting subsidization and environmental-friendly mandates by the government. Table 8 summarizes the five emerging renewable energy sources.

Demirbaş (2006), in his article, proves that renewable energy sources provide more than 14% of the total energy in the world. These sources, comprising hydropower, geothermal, solar, wind, and marine energies are clean and inexhaustible. In 1995, biomass accounted for a percentage share of 62.1% of the total amount of renewable energy sources. Twenty percent of the world's electricity comes from hydropower generated at large scales. Wind energy in coastal areas and other areas prone to wind also holds a lot of potential. Four researchers named Bain, Amos, Downing, and Perlack (2003) argue that Biopower is currently the largest source of non-hydro renewable electricity with approximately 11 GW of installed capacity. This makes biopower the most viable alternative to hydroelectric power in the United States. This 11 GW of capacity includes approximately 7.5 GW of capacity from the residues of forest products and agricultural industries, approximately 3.0 GW of capacity from the generation of electricity based on municipal solid waste, and approximately 0.5 GW of capacity from other sources, such as production based on landfill gas.

Research reveals that electricity production from biomass is being used and is expected to continue to be used as base load power in the existing electrical distribution system. The author proceeds to provide an overview of sector barriers to biopower

technology development. There is also a discussion of technology barriers that must be overcome to achieve successful technology pathways leading to the commercialization of biomass conversion and feedstock technologies. In addition, there is an examination of institutional barriers which encompasses the underlying policies, regulations, market development, and education needed to ensure the success of biopower. The study further includes a summary of biomass feedstock resources, features, accessibility, costs and the prerequisites for production. Demirbaş (2006) addresses the three conversion routes for CHP application of biomass comprising combustion, gasification and cofiring. These are catered on technology characterizations developed by NREL and EPRI. The author assesses various actors comprising the size of the plants, cost of feeds, electricity and steam which are calculated using discounted cash flows. Citing several schools of economic thought helps to justify cost estimates. The topic of conversation now shifts to environmental issues. It is possible that the biomass industry will be presented with major prospects as a result of global warming and the execution of Phase II of Title IV of the Clean Air Act Amendment of 1990. (CAAA). The use of biomass technology has a number of benefits, one of which is the favourable effect it has on the surrounding ecosystem. In recent years, there has been a growing understanding, in the general public, of the urgency of addressing global warming. This has been the case in both developed and developing countries. When used as a fuel source, biomass has the potential to drastically reduce emissions of dangerous greenhouse gases as well as the effects those gases have on the atmosphere. The utilization of combined biomass gasification cycle systems in conjunction with cofiring, which is the process of burning fossil fuels and biomass together, can be a successful method for electric utilities. This is because these processes help in cutting emissions of dangerous gases.

It has been demonstrated in a research project carried out by Wieliczko and Stetson (2020) that hydrogen is a flexible energy storage medium with tremendous potential for incorporation into the upgraded grid. Adsorbents, metal hydrides, and chemical carriers are examples of some of the cutting-edge materials that are being developed for use in hydrogen energy storage technologies. These materials play an important part in making the ultimate use of hydrogen. The Hydrogen and Fuel Cell Technologies Office of the United States Department of Energy is in charge of research and development conducted on hydrogen and other fuel cells.

These activities, which include hydrogen energy storage, are designed to promote tenacity and the optimal use of a variety of domestic energy resources. Hydrogen technologies provide a wide range of options for producing and storing energy sustainably and efficiently, which is a rapidly developing field. This page provides a summary of the work being done by the Hydrogen and Fuel Cell Technology Office of the U.S. Department of Energy to advance hydrogen storage technologies (DOE). The Office of Energy Efficiency and Renewable Energy is responsible for these initiatives. This article discusses the highlighted R&D needs and obstacles, with a particular emphasis on how these pursuits apply to the evolving energy storage requirements of a modernized grid. Advanced research continues to be conducted through such programs as the DOE's H2 Scale initiative which aims to alleviate the challenges faced in energy storage. The initiative is focused on designing innovations that will generate cost-competitive hydrogen as an energy carrier. The idea is to combine hydrogen processing with renewables including nuclear, fossil fuels, and grids. This combination will help to cut down costs of power plants thereby promoting tenancy. Researchers see a great future in the continued growth and use of domestic and global policy stakeholders and partnerships.

In their article, Rehman and Mujahid (2017) discuss the importance of ensuring a reliable supply of electrical power in Pakistan. They also present an outline of the country's current energy use while considering several perspectives on the power industry. These include the supply-and-demand gap, the depletion of energy supplies, the threat to energy security, and the rising cost of power. The authors also explore the current state of energy and the promising future of renewable energy as a sustainable alternative. The part that various industries can play in spreading awareness and fostering innovation in renewable energy sources has also been explored. Reports reveal that Pakistan's overall renewable energy potential is approximately 167.7 GW. This is overall higher than the total energy required in covering the country's total electricity demand; hence the country's future prospects in renewable energy are bright. This enormous untapped potential of renewable energy sources may be leveraged to address the energy constraint. However, it has not been used efficiently due to a lack of legislation and proper infrastructure. There is a dire need for careful consideration of the diverse factors including the diversification of pre-existing energy sources as well as exploring new ones. The goal of the country should be to achieve sustainable power development.

There are many obstacles to expanding solar power in Pakistan, including the high cost of initial investments, inadequate institutions, poor management, and inadequate government regulations. While there are many obstacles highlighted by the researchers, these are the main ones. Therefore, to realize the long-term environmental and socioeconomic benefits of solar technologies, a legislative framework is needed to promote their use not only in residential but also in commercial settings. In recent years, policymakers have come to appreciate solar power's potential for boosting the economy and reducing pollution. The authors make other recommendations including the need to incorporate solar energy technologies into a comprehensive national energy policy. Renewal technology can also be promoted by the allocation of adequate funds to enable the transition of laboratory-size models to commercial viability. The third recommendation is to create incentives for business owners to put money into the spread of renewable energy sources. Fourth, the distribution of grants and low-interest loans to consumers as well as giving people access to in-the-field demonstrations, lessons, and instruction. Public spaces like parks, streets, and schools can all benefit from having solar-powered lights and other appliances installed. There is also a dire need for sufficient funding from the national budget for renewable energy organizations. Lastly is the spreading of awareness of the benefits of using solar energy in public spaces, including the illumination of stadiums with PV systems for important sporting events.

Tester et. al. (2006) believes that the future of geothermal energy from EGS is an accurate replacement that has minimal effects on the environment. It is a significant, indigenous resource that can deliver base-load electric power and heat at a level that can have a substantial influence in the United States. With a fair investment in R&D, EGS might produce cost-competitive generating capacity in the next 50 years. Besides, EGS is proven to be a reliable source of power because it will not be affected by fuel price variations or supply outages. It is the ultimate secure long-term solution to the problem that has existed for many years. Currently, there are major proceedings to implement EGS in the country in a cost-effective way. Within a 10- to 15-year-old period, assessments and verifications will be made to ensure that the performance is as expected. The federal government ought to make a commitment to assisting in the characterization and evaluation of EGS resources. This will require a national program that is vigorous, adequately supported, multiyear, and includes participation from the

USGS and DOE in addition to that of other agencies. In addition, there should be adequate EGS resources that are of high quality to ensure that they supersede the pre-existing hydrothermal systems. This is particularly for areas with high temperatures such as oil fields as well as areas with above-average temperature gradients. Similarly, areas where the development and demonstration costs are anticipated to be lower should be selected in the beginning. These include representative sites in high-grade areas that will prove that the EGS technology will work commercially. The authors propose that several sites in different areas of the country be under development within the first 15 years. Another requirement is the proof of repeatability and universality of the technology. This can be assessed by applying the technology in various geographical environments thereby controlling risks and uncertainties which ultimately cuts down the development costs. As though that is not enough, there is need for supportive polices powered by both state and federal levels. This is because ESG is just like any other energy supply technology. Through state and federal support, ESG will be able to enter and compete in the developing power markets in the United States. These policies need to be analogous to those that oil and gas and other mineral-extraction operations have received in the past. This includes provisions for incredibly rapid licensing and certification, concessional loans, drawdown allowances, and sped up write downs. Additionally, these policies need to be analogous to those that are associated with cleaner and more renewable energies, such as power generation tax breaks, renewable credits, and asset allocation standards, among others. Tester et. al. (2006) proceeds to ascertain that if the strategy is implemented well, it will continue to grow. He therefore urges that the United States aggressively participate in ongoing international field initiatives like the European Union project due to the huge leverage of supporting research that will occur. EGS should be included in the NEMS' portfolio of developing energy options. In addition, there should be a commitment to updating economic estimates as the technology develops through field testing.

Dickson and Fanelli (2004) contend that ancestors must have deduced that the interior of the Earth is heated because of the abundance of hot springs, volcanoes, as well as other thermal phenomena. However, it isn't until somewhere in the 1600s and 1700s, when the very first mines are dug down a few hundred meters, that people figured out that the Earth got hotter the deeper they went. Newer estimates, based on a larger

number of data points, place the overall heat flux from the Earth at a number roughly 6% higher than the one used by Stacey and Loper (1988). However, cooling is still proceeding at a glacial pace. In 3 billion years, the mantle's basic temperature has remained at around 4000 °C, changing by just over 300 to 350 °C. At a surface temperature of 15 degrees Celsius, Armstead (1983) calculate that the Earth's total heat content is on the order of 12.6 × 1024 MJ, while the crust's heat content is 5.4 x 1021 MJ. Thus, the Earth's thermal energy is tremendous, but only a small portion is accessible to human use. Geothermal resources exist because of the ability of carriers (fluid in the liquid state or steam) to "transport" the warmth from deep hot areas to or close to the surface. New approaches may provide exciting new opportunities in this field in the near future. If properly developed, geothermal energy has the potential to significantly contribute to the energy security of certain nations. Small-scale geothermal resources can improve the quality of life for rural populations by providing solutions to a wide range of issues. Fridleifsson (2001) provides some context for the importance of geothermal energy within the perspective of other renewable energy sources, noting that in 1998, out of a total of 2826 TWh produced from renewables, hydro power, biomass, geothermal, wind, solar, and tidal account for 92%, 5.5%, 1.6%, 0.6%, 0.05%, and 0.02% respectively. Direct heat produced from renewable sources accounts for 93% of the total, with biomass, geothermal, and solar each contributing 5% and 2%, respectively.

Barbier (2002) defines geothermal energy as the heat energy stored deep within the Earth. The internal composition of the Earth and the mechanisms by which heat is transferred between the mantle and the crust are described in this overview. It also reveals where on Earth geothermal fields are concentrated. Definitions are provided for geothermal energy's geology setting, the various types of geothermal fields, exploration techniques (such as drilling and resource assessment), and the Earth's flow of heat and geothermal gradient. In the form of hot and steaming water, geothermal energy has been used for decades to power the grid, heat homes, and run factories. Globally, geothermal power plants have an installed capacity of 7974 MWe (2000) and generate 49.3 billion kWh annually. This accounts for 0.3% of the globe's total electrical energy consumption of 15,342 billion kWh in the same year. Geothermal energy may play a huge role in developing countries where total electrical power is still low (21% of electricity in the Philippines originates from geothermal steam, El Salvador accounts for 20%, Nicaragua

account for 17%, Costa Rica account for 10%, and 8% Kenya). Production efficiency for electricity is between 10 and 17 percent. In the range of 2-10 US cents per kwh, geothermal kWh prices are competitive with those of more traditional energy sources, and the global geothermal electrical capacity added in 1998 is only about one-fifth of that from biomass but on par with that from wind. Greenhouses, fisheries, district heating, and industrial activities utilize a portion of the 15,14 MWt available for non-electrical purposes (year 2000). Over the years 1973–1992, it is estimated that roughly US$22,000 million is invested globally in geothermal non-electrical and electrical uses. Modern technology allows for mitigating geothermal extraction's harmful environmental effects. A carbon tax might serve as the basis for a policy that promotes the expansion of geothermal energy production and reduces carbon dioxide emissions. The utilization of hot wet rock/hot dry rock networks, magma bodies, and geopressured reservoirs are some of the cutting-edge technologies that could harness geothermal energy in the future. While the hot, dry rock technique is viable, the other two components still require further investigation and development. The review is wrapped up with a short discussion of specialist training, geothermal literature, online resources, and geothermal organizations.

Commercial production of geothermal energy for power generation dates back to 1913 and has continued at scales of hundreds of MW over the past four decades (Fridleifsson, 2001). Over the past three decades, usage has skyrocketed. Over eighty countries' worth of geothermal resources are mapped out by the year 2000, and 58 of those countries have quantifiable records of geothermal utilization. Geothermal energy is used to generate 48 TWh/a of electricity as well as 53 TWh/a of direct consumption around the world. Twenty-one countries across all seven continents use geothermal steam to generate electricity. Between 10% and 22% of the electricity in five countries comes from geothermal. To date, only a small percentage of the geothermal capacity has been utilized, leaving plenty of room for increased usage of geothermal energy in the generation of power and in direct applications. Electrical energy costs range from 2.10 to 10.10 U.S. per kilowatt-hour (kWh) for geothermal and hydro, from 5.13 to 10.10 USD per kWh for wind, from 5.15 to 25 USD per kWh for biomass, from 25 to 125 USD per kWh for solar photovoltaic, and from 12.10 to 18.10 USD per kWh for solar thermal. In 1998, renewable energy sources generated a total of 2,826 TWh of electricity; 92% originated from hydropower, 0.6% from wind, 1.6% from geothermal, and 5.5% from biomass. In

terms of power production, solar provided 0.05% and tidal 0.02%. Geothermal, although having just 42% of the total capacity installed among the four "new" renewable energy sources (wind, solar, and tidal), accounts for 70% of the power generated by the four. Although wind power only accounts for 27 percent of the electricity generated, it accounts for 52% of the total installed capacity. Only 2% of the nation's electricity comes from solar power, while 1% comes from tidal energy. In terms of renewable energy sources, biomass accounts for 93% of direct heat generation, geothermal for 5%, and solar for 2%. Currently, the price per kilowatt-hour (kWh) for solar heating is between $3 and $20, while the price for geothermal heating is between $0.50 and $5, and biomass is $1 and $5. Production costs for renewable heat sources are comparable to those of traditional fuels. Huttrer (2001) estimated a 43% increase in global electrical installed capacity by 2005, based on nation data presented at the World Geothermal Congress 2000. If the average rate of development from 1980 to 2000 is maintained, the world's electrical output might reach between 80 to 120 TWh by 2010. The direct use energy production might be around 100 TWh in 2010 and 200 TWh in 2020, if the worldwide direct consumption increases of 44% during 1995-2000 indicated by Lund and Freeston (2001). New innovations in the usage of ground-source heat pumps provide a new avenue for harvesting the earth's heat. Heat pumps are adaptable to a wide variety of settings. This indicates that the pace of increase of direct usage will be rather high. With its tried-and-true technology and sufficient resources, geothermal energy has the potential to make a sizable dent in the global output of greenhouse gases. Governments must provide a regulatory and policy environment where geothermal resources may be economically viable alternatives to traditional energy sources. Energy experts throughout the world agree that renewables will account for a much larger percentage of the global energy mix in the 21st century (between 30 and 80 percent by 2100). Whether geothermal energy becomes a significant part of the global energy mix by the turn of the next century will rely in great part on the efforts of the geothermal industry and the nations that are now at the forefront of geothermal development.

As more and more dry weather patterns are seen and different regional energy-production possibilities are analyzed, there has been a resurgence of interest in the electric power industry's water consumption. Nonetheless, information on upstream water parameters is scarce, and there are variations in data from various sources. Fthenakis and ChulKim (2010) looked at the literature on electricity's water footprint and utilized complete life cycle accounting to compare renewable and conventional power plants' water withdrawal and consumption demands. After doing some analysis, they determined that the most effective method of water conservation would be to adopt renewable energy sources like solar and wind power. Furthermore, they stress the significance of using a fair and open methodology to account for water use across the whole life cycle.

Policymakers have recently prioritized energy autonomy and climate change, both of which boost the use of renewable energy sources like bioenergy. Over the past two decades, scientists, manufacturers, and consumers have dedicated a great deal of time and effort to biofuels in all its many forms (liquid, solid, and gaseous). Guo and Song (2015) provide a comprehensive overview of the development, present state, and anticipated future trajectory of biofuels and bioenergy across the world. Since prehistoric times, people have relied on bioenergy for basic needs including food preparation, home heating, and illumination. The yearly biomass production of land plants stores enough energy to meet world energy needs for three to four years. Solid biofuels are things like wood chips, wood pellets, firewood, and wood charcoal. While demand for firewood and charcoal has been holding steady across the world, the usage of wood pellets and wood chips for electricity (biopower) generation and domestic heating has doubled in the previous decade and is expected to continue rising gradually. Pyrolysis bio-oil, drop-in transport fuels, and liquid biofuels like ethanol and diesel are included in this category. Bioethanol made using lignocellulosic materials just begun commercial production, adding to the yearly production of 22 billion gallons, most of which are made from food crops. Biodiesel production from oil seeds has reached 5670 million gallons per year, with potential for additional expansion as new feedstocks are developed. Cost-effective transformation and upgrading issues persist as drop-in and bio-oil biofuels go through the research and development phase. Biogas and syngas fall under the category of gaseous biofuels. The use of anaerobic digestion to produce biogas from organic residues is on the rise in both Europe and China, where it has the potential to replace 25% of the region's

current natural gas usage. In contrast, syngas generation from combustion of woody biomass isn't really commercially viable and is only used in niche applications. Globally, the lignocellulosic bioethanol, biopower, and biogas industries will lead the way in expanding the use of bioenergy and biofuels. By 2050, bioenergy is projected to supply 30% of the world's energy needs.

Mundaca and Richter (2015) analyze the US renewable energy stimulus projects as a case study for evaluating 'green energy economy' plans. This report presents an in-depth empirical evaluation of the effectiveness of American stimulus programs supporting renewable energy technology. They examine and analyze the increasing yet dispersed literature and use an indicator-based methodology to measure progress with regard to energy, ecological, and socio-economic concerns as a result of renewable energy stimulus projects associated to the “American Recovery and Reinvestment Act.” Their findings suggest that the renewable energy industry has benefited from the government's stimulus efforts. Although a 'cap-and-trade' system for greenhouse gases is intended to be introduced simultaneously with them, it has not happened. Their method is labor- and time-intensive, and it reveals several problems, especially about causation and complementarity. Despite these drawbacks, this study helps us better understand the far-reaching implications and repercussions of renewable energy stimulus initiatives. It's clear that the world's energy infrastructure is undergoing a major overhaul. As a result of their low costs, wind and solar photovoltaics have recently accounted for 75 percent of all of the world's net new energy-generating capacity additions. Over the next several decades, solar and wind will be able to largely replace fossil fuels because of the widespread use of electric vehicles, heating systems, and manufacturing. Lohani and Blakers (2021) provide evidence that by the middle of the twenty-first century, Nepal will have achieved energy independence. The wind and fossil energy potential of Nepal are both quite little, while the solar potential is rather large. A 100% solar energy system may provide all of Nepal's population with a per-person energy consumption on par with wealthy countries, without the usage of fossil fuels or the environmental destruction caused by flooding Nepal's Himalayan rivers. There is no need for on-river hydro storage or massive batteries because of Nepal's immense, inexpensive off-river pumped hydro-energy-storage potential.

Renewable electricity and the fast expansion of Nepal's energy system are most likely to take place along the solar, hydro, and battery storage triad water for later use. In a well-established, competitive market, solar PV easily outperforms fossil and hydro power in terms of cost. However, solar PV's fast expansion might be slowed by a number of problems. Until a critical mass of qualified individuals and distribution networks is reached, the price of solar energy is rather high. However, once this threshold is reached, the price of solar energy will drop fast, becoming competitive with other energy sources. Unnecessary regulatory limits, frequently based on false and utterly outmoded technological reasoning, can be another significant hurdle for private persons and corporations sending solar power into the grid. Nepal’s government can unleash solar PV's full potential by subsidizing tens of thousands of residential rooftop systems and many large-scale solar farms producing 100 MW or more. Favourable feed-in tariffs are one sort of assistance that may be used to attract private investment. According to global evidence, solar energy costs rapidly decline when a private market has been effectively established. The government's key continuous duty is to ensure sufficient storage and transmission capacity is made available. The private industry could fund this infrastructure if it is guaranteed a reasonable rate of return on its investment. Having reliable access to energy is crucial to maintaining a high standard of living and supporting the rest of the economy. Clean, plentiful energy from sources like the sun, wind, the soil, and plants is a goal of renewable energy research and development. Almost everywhere in the US and the rest of the world has access to some form of renewable energy. About 10% of the energy used in the US now comes from renewable sources, mostly hydropower and traditional biomass (Bull, 2001).

Alternative energy sources including biomass, solar, wind, and geothermal are becoming increasingly competitive with traditional energy sources in a variety of industries. It is important to note that the various renewable energy technologies are not all at the same point in their development, commercialization, or cost, and that they also vary in terms of their existing industrial infrastructure, the resources they can access, and the emissions of greenhouse gases they could potentially reduce. Implications for wider use of renewable energy sources can be discussed alongside their current technological state, cost, and practical uses. For grid-off and remote applications, small-scale hydropower is a viable solution for producing and supplying electricity with minimal

environmental impact. The high annual rainfall total that falls over Malaysia provides an abundance of sources of water that may be used to produce electricity.

Oumer and Sahat (2017) discuss the current state of small-scale hydropower in Malaysia, focusing on its application in low-head settings and for the purpose of bringing electricity to rural areas. Additionally, the literature on small scale hydroelectric technology and the difficulties encountered by tiny renewable energy generation in Malaysia are discussed. Hydropower reserves in Malaysia are projected as being 29,000 MW, with 500 MW coming from mini hydropower, according to a survey of published publications. This has led to the identification of 149 locations around the nation with minor hydropower potential, with a projected 490 MW available by 2020. Despite the fact that hydro-power technologies are the most viable options for Malaysia's power production, they have not yet been completely explored due to a variety of obstacles on the technical, economic, and institutional fronts. Because of this, the article can serve as a resource for researchers interested in learning more about how to use small-scale hydropower to bring electricity to rural areas in Malaysia. Barriers in the technological, economic, and institutional realms are some of the most significant in preventing the widespread adoption of renewable energy.

In the technical aspect, the infrastructure for renewable energy technology is still developing. When compared to traditional methods, some renewable ones are still in the research phase. With so much unknown, it's safer to stick with the status quo of technology than to take the plunge and switch to renewable energy sources. Inadequate education, training, and quality assurance are also a problem for the widespread use of renewable energy. In addition, because to the challenging terrain and short operational season, tiny hydropower has a prolonged gestation period compared to alternative renewable sources. An additional challenge is that there is insufficient precipitation information on which to base an analysis of the station's dependability. There is also a problem with the transmission of power because of insufficient inter-grid connectivity. In the economic aspect, there is always a degree of risk involved when implementing novel technologies like green technology because of questions about how well they will work. Most of the initiatives that get funded this way involve some sort of preliminary study or experimentation. Consequently, the cost of renewable energy will be greater than that of conventional energy sources. The Ministry of Energy in Malaysia has recently established

a comprehensive renewable energy strategy that is related to the National Green Technology policy. The goals of this strategy are to level the playing field for renewable energy technologies, eliminate market failures, reduce prices, and make them a more viable part of the nation's energy mix.

Finally, in the institutional realm, the prosperity of minor hydro projects can also be affected by government policies. The government and other organizations in Malaysia are less interested in building new hydropower plants than they are in improving and expanding the country's current ones. Further, dealing with Tenaga Nasional Berhad (TNB) transactions can be a hassle, especially for smaller projects. While the larger projects are effectively excluded, they are responsible for settling the interconnection costs and negotiating. For instance, the Ministry of Energy in Malaysia has its own “Special Committee on Renewable Energy (SCORE)”. The committee's approval is required for all small-scale renewable energy projects. There are just two annual meetings of the committees.

Since researchers don’t get to present those initiatives during the meeting, participants have to wait another six months. Those involved in the initiatives lose enthusiasm if they have to wait so long. Since the inception of pumped hydro energy storage (PHES) in the 1890s, it has shown to be a reliable and financially viable method for storing electricity at utility scale. Its adaptability and storage capability make hydropower a viable option for improving grid stability and bolstering the adoption of other transitory renewable energy sources like wind and solar. This has resulted in growing attention in PHES and a call for the refurbishment of aging small hydro power facilities throughout the world. New tactics for improving storage space and for optimizing plant viability in the unregulated energy market are necessary for PHES, as are advancements in turbine design to improve plant efficiency and flexibility (Rehman, Luai & Alam, 2015). Reviving in the mid-2000s, the technology is now a viable alternative for reducing peak loads and storing renewable energy sources like wind and solar for reliable power supply. Additionally, renewable energy sources, because of their unpredictability, need large-scale electrical storage in order to sustain or regulate continuous flow of power.

This research is conducted with the intent of analysing and suggesting the most effective worldwide PHES capabilities, technical advancements, and hybrid systems (solar pv-hydro, wind-hydro, and wind-hydro). Rehman, Luai and Alam (2015) find that

PHES seems to be the best option for large-scale energy storage and tiny, self-sustaining island grids, with actual efficiencies ranging from 70% to 80% and theoretical maximums of 87%. The average size of a PHES is between 1000 and 1500 MW, with some as enormous as 2000 to 3000 MW. However, solar based pressurized storage systems have only been implemented on a microscale (load of a few buildings).

Hydroelectricity is used to describe electricity created through the usage of hydropower, which is the generation of electrical power by harnessing the gravitational effect of flowing or running water. It is the most popular renewable energy source, responsible for 16 percent of worldwide power output in 2010 (3,427 terawatt-hours) and predicted to grow by around 3.1 percent year over the next 25 years (Askari, Abadi and Mohsen, 2015). There are 150 nations that produce hydropower, with 32% of the world's hydropower coming from the Asia-Pacific area in 2010. China's hydroelectric output of 721 TWh in 2010 accounted for around 17% of the country's total power consumption, making it the world leader in this sector. There are presently four hydroelectricity stations with generating capacities more than 10 GW; they are Brazil's Itaipu Dam, China's Xiluodu and Three Gorges Dam, and Venezuela's Guri Dam. In terms of renewable energy sources, hydroelectricity is one of the most cost-effective. Power from a hydro plant more than 10 MW typically costs between 3 and 5 cents per kilowatt hour in the United States. Additionally, the station's output can be rapidly ramped up or down to meet fluctuating energy demands, making it a very adaptable electricity source. Building huge dams and reservoirs typically necessitates relocating people and species, and disrupts the natural flow of rivers, both of which can be harmful to local ecosystems. After a hydroelectric complex has been built, it generates no waste and emits far less CO2 than power plants that use fossil fuels.

Wongwises and Somchai (2015) observe that the generation of electricity all around the world relies heavily on hydropower, which is why it is the leading renewable energy source today. Thailand's abundance of water sources makes it a prime location for hydroelectric power plants. Wongwises and Somchai (2015) recommend that future work in Thailand should focus on hydropower development that makes good use of the country's water resources. This research is conducted to assess the state of and future prospects for hydropower in Thailand. Strategies for further advancing hydropower's use in the future have also been introduced. The research observes that Thailand’s

hydropower reached 3,497 MW on the grid at the end of September 2013, accounting for nearly 11% of the country's total productivity system. At the time, Thailand's hydropower potential is 15,155 MW, or almost four times the capacity. Furthermore, the country's 25 river regions have the potential to host small-scale hydropower projects with a combined output of at least 1500 MW. The Department of Energy forecasts that Thailand will boost its use of renewable and alternative energy sources to generate 9201 MW of electricity in 2021, with hydropower accounting for 1608 MW of that total. Furthermore, Sipahutar et.al (2013) find that the vertical gradient (Tidal Barrages) and the kinetic energy of the water in motion (Tidal Current) might be used to generate electricity. However, according to the research, there are certain drawbacks to tidal barrages. These include negative effects on the ecology and a lack of suitable commercial areas. Environmentally, technologically, and practically, tidal current appears to offer several benefits. In light of growing international concerns about environmental repercussions and rising energy demands, this article explores the likely rise in small hydroelectric energy producing systems in the future decades.

Saidur, Islam and Solangi (2010) argue that the diminishing supply of fossil fuel and the worsening environmental impacts of fossil fuel burning have prompted many nations to explore and adopt renewable energy sources as a means of meeting their growing energy needs. Energy strategy is crucial in reducing the effects of climate change and the energy supply dilemma. Saidur, Islam and Solangi (2010) examine the wind energy market through the lens of wind energy policy. It has been observed that energy policy has the potential to increase wind power output and stimulate the energy sector. It might be argued that a country cannot address pressing issues like lowering GHG emissions, addressing energy shortages, etc. without a comprehensive energy strategy. In this article, researchers look at the energy strategies that have proven beneficial in a small number of nations. Many nations throughout the globe employ RPS, FIT, incentives, pricing regulations, and the Quota system because these are the most effective energy policies based on research. Then, the researchers look at Malaysia's wind energy policy and compare it to those of a few other countries. Forests, crops, diverse residual streams, and specialized woody or herbaceous crops are good sources of biomass for bioenergy and bioproducts (Keoleian and Volk, 2004). In comparison to agricultural resources, there are a number of benefits to developing and using woody biomass resources. Consumers

are not reliant on a single supply of woody biomass because it is readily available all year long from a variety of different locations.

Bioenergy and bioproducts derive from woody biomass have substantial, positive net energy ratios, which means that far more energy is generated by these systems than is consumed by burning fossil fuels to create the biomass and the electricity and perhaps other finished goods. In certain parts of the United States, the potential from resources of woody biomass that can be generated responsibly is larger than the capacity from other sources. High yields in a few years, an easy vegetative propagation, a large genetic basis, a quick breeding cycle, and the capacity to resprout after many harvests are just a few of the reasons why willow shrubs are so well-suited to short-rotation woody crops (SRWC) systems. The cultivation of willows for several uses, including medicine, construction materials, and erosion control, has taken use of many of these traits for ages. The estimated 450 varieties of willow found around the globe ranging in size from rostrate, tiny species to trees reaching heights of more than 40 m. Due to its complete carbon cycle, willow biomass production significantly reduces emissions of greenhouse gases to the level of 40-50g C_O2/KWHelec. When compared to the current U.S. grid, this would result in a reduction of greenhouse gas emissions of 95 percent. There is a similar decline in emissions of nitrogen oxides (NOx), sulphur oxides (SOx), and particulate.

Bridgwater (2003) believes that bioenergy might ultimately supply the bulk of the future's anticipated renewable energy sources. Chemical reactors of various configurations and designs are used in the three primary methods for producing these biofuels: physical conversion, biological conversion, and thermal conversion. The focus of this article is on thermal conversion processes, and more specifically, the reactors that have been designed to offer the conditions required for optimal performance. Solid, gas, and liquid fuels, electricity, and a wide variety of chemicals are only some of the by-products that can be produced. The primary technical and non-technical impediments to implementation are highlighted, and a summary of the fundamental conversion processes and their outputs is provided.

According to Field, Campbell, and Lobell (2008), in theory, increased biomass production for energy may significantly reduce the need for fossil fuels. It might, however, endanger protected areas, contaminate water supplies, and reduce food supplies. Depending on the complexity, biomass energy agriculture might either cool or warm the

environment. This is contingent upon the biomass crop, the technology for turning biomass into usable energy, and the disparity between the existing vegetation and the biomass crop in terms of carbon stocks and reflection of solar radiation. Land that was once farmed or pastured but has not been transformed to woodland or urban areas has the best potential for producing biomass energy that minimizes net warming and does not compete with food production. The aboveground crop yield that may occur on these uncultivated lands has a global energy content equal to 5% of the world's primary energy demand in 2006. Although the worldwide capacity for biomass energy generation is substantial in absolute terms, it is not sufficient to substitute more than a small fraction of the world's present use of fossil fuels. Beyond this point, increasing biomass energy output is likely to decrease food security and increase climate change forcing. Previous research has indicated that the amount of unused agricultural land might increase substantially in the near future, or that tropical grasses could give harvests many times beyond native NPP.

Field, Campbell and Lobell (2008) see sufficient evidence to conclude that both of these hypotheses are too optimistic. In the foreseeable future, agricultural and grazing land needs will remain high. Over the past few decades, the energy problem has become a major threat to sustainability, especially in developing nations and communities (Mekhilef et al., 2011). While global energy consumption rose by 11% between 1990 and 2000, consumption in emerging Asia and the Pacific regions grew by 27%. As a result, the need for more energy is anticipated to continue growing. Since the dawn of technology, humanity has relied mostly on fossil fuels to power their activities. However, as these fuels are used up and their environmental repercussions become more severe, governments and authorities have begun to prioritize renewable energy sources. Increases in both population and GDP have contributed to a rise in recent years in the demand for fuels generated from petroleum. The energy consumption behaviour shifts that accompany rising energy needs in a growing economy are affected by several factors, including the cost of acquiring that energy, the efficiency of its conversion and usage, and the overall effectiveness of that energy. Malaysia has managed to keep its energy consumption in check despite its abundance of fossil and renewable sources of energy. The country has an abundance of readily available renewable energy sources.

Even though renewable energy is widely used in Malaysia, there is still a long way to go until it is fully exploited.

According to Berndesa, Hoogwijkb, and Broekc (2003), the role of biomass can play in the world's future energy supply. The conversation is grounded in a meta-analysis of 17 primary research papers. Depending on the study, estimates for biomass's potential contribution to the world's energy supply in 2050 range from far below 100 exajoules per year to well beyond 400 exajoules per year. The main reason for these differences is that the two most important characteristics, availability of land and yield patterns in energy crop production, are very unclear and subject to widely divergent opinions (e.g., the anticipated 2050 plantation capacity varies from below 50 EJ yr1 to approximately 240 EJ yr1). However, there is a wide range of estimates for the future supply of forest timber and agricultural and forestry leftovers. Interactions between the growing bioenergy sector and other land uses including production of food, biodiversity, soil and environment protection, and carbon sequestration have been studied extensively. As a result, it is not easy to determine if bioenergy is a viable choice for combating climate change within the energy industry. In order to better understand the potential for large-scale bioenergy and the future of land use and biomass management, it is necessary to model interactions between different uses and food, bioenergy, and materials production. These interactions include competition for resources and synergies between different uses.

Ravindranath and Hall (1995) in their book explain that modern bioenergy solutions have been shown in case studies to be capable of meeting the energy demands of India's rural population. Reduced reliance on foreign oil and more sustainable development would result from this measure's impact on the nation's forest cover and power system. The study's overarching goal is to provide strategies for supplying high-quality fuels to fulfill the demand for energy services necessary to improve rural residents' standard of living. The findings of this study are applicable to the vast majority of the world's least developed nations. As an example, if India, a huge, populous nation with limited biomass resources, can implement viable bioenergy solutions, then technically many developing countries should be able to do the same. For instance, take a close look at the use of biofuels in India. They assess the existing state of affairs, evaluate bioenergy in relation to other development-promoting strategies, investigate bioenergy's potential, evaluate its social, economic, and environmental implications, and recommend the policy choices and

guidelines needed to advance bioenergy solutions. Each of the 12 chapters examines a different aspect of bioenergy production and utilization, from its origins through its ultimate consumers. It then offers solutions for overcoming obstacles including monetary and legislative constraints and increasing community engagement in biomass production systems. They demonstrate that a lack of land is not a barrier to growing woody biomass in highly populated areas like India and that nations devoted to equitable and sustainable development can benefit from the widespread adoption of bioenergy through the implementation of sound financial and institutional policies.

Irfan et al. (2020) observe that Pakistan's energy demands have skyrocketed in recent years attributable to the country's rising standard of living, expanding population, and thriving economy. Biomass energy offers great potential to meet the country's energy needs and has recently emerged as a viable renewable energy source. The purpose of this article is to evaluate biomass energy resources and their potential for use in the future of power generation. To do this, they combed through a plethora of literature, including scholarly articles, energy studies, government statistics, and policy documents. The rich biofuels of the nation are found to consist of fuelwood, agricultural wastes, animal manure, and solid waste from municipalities. Fuelwood supplies 48% of the nation's residential energy needs, with agricultural and animal wastes accounting for 32%. The country's 85 sugar mills create enough bagasse to power 5800 gigawatt hours (GWh) of electricity. The most common agricultural residues and their relative yields are corn stalk (with 6.43 Mt), sugarcane trash (with 8.94 Mt), rice straw (with 17.86 Mt), wheat straw (with 35.6 Mt), and cotton stalks (with 50.6 Mt). There is a possibility for 4800-5600 MW of electricity to be generated from animal manure. It has been estimated that 220 kWh/t and 560 kWh/t of electricity may be generated from solid waste from municipalities by biochemical and thermochemical conversion, respectively. Biomass energy holds promising chances of helping Pakistan meet its 2030 goal of increasing the number of renewables in the country's total energy mix from 1.1% to 5%.

Latief and Lefen (2019) in their article “Tomorrow’s Impact of renewable energy on the world” note that prior to a century ago, human beings relied on hydro, sun, wind, and geothermal energy for very small portions of their energy needs, while animal and human muscle and wood are the primary sources of energy. Fossil fuels, which include oil, natural gas, and electricity generated by coal at centralized power plants, quickly

surpassed other energy options in the US and elsewhere in the world. They pose several questions like; could the world be on the brink of yet another energy revolution? Is it possible to supply a substantial fraction of today's society's significantly larger energy demands by utilizing the renewable energy sources that supported early civilization at an affordable price and with sufficient efficiency and availability? There is always uncertainty when making forecasts, but the intersection of several current patterns does point to some exciting prospects. The convergence of current developments in renewable energy includes, in essence, recent scientific breakthroughs and engineering advancements; transformation of the electrical industry's economic framework; shifts toward modularity and decentralization; rapid technological and informational progress; market globalization; consistent, all-encompassing backing for green energy; diminishing prospects for cheap fossil fuels.

Boqiang et al. (2019) investigate the factors affecting China's reliance on renewable power to generate energy. Energy from renewable sources is crucial to China's efforts to move toward a low-carbon economic growth path. In this study, Boqiang et al. (2019) look at what influences China's growing desire for renewable power. Using data from 1980–2011 and utilizing the Johansen cointegration approach and VECM, this study examines the factors that affect the proportion of renewable power in China's total electricity consumption. The analysis' findings demonstrate a correlation between renewable power consumption and several macroeconomic variables, including per capita GDP, FDI, financial development, trade openness, and the proportion of energy generated from fossil fuels. Increasing economic and financial growth boosts renewable power consumption, but FDI, trade openness, and conventional energy lobbying work against China's efforts to increase the percentage of renewables in overall power consumption. The "lobby effect" is explosively persistent whereas the influence of disruptions to the other parameters seem to fade with time. The findings also indicate the existence of a unidirectional short-run causation connecting trade openness and renewable power usage. The Chinese government ought to implement measures that raise both the overall quantity of power consumed and the proportion of that total that comes from renewable sources. The following policy recommendations are made in light of the study's findings; to achieve a low-carbon and sustainable growth development in China, the nation's leadership must, first and foremost, prioritize renewable power.

To make room for renewable energy consumption along with a more sustainable model, China's existing economic development model, which is destructive to the environment, should be efficiently transformed. In order to do this, it may be necessary to redirect funds from broader economic growth to the expansion of renewable energy sources. Second, while promoting trade liberalization and FDI, the Chinese government should actively push for the development and adoption of renewable power among international investors and Chinese export producers. Third, the government needs to fortify and assist the financial sector to increase its capacity to fund investments in sustainable energy technologies. For example, the government might back renewable energy expansion initiatives with guarantees. Fourth, the government has to take firm action against the fossil fuel industry's lobbying efforts to hinder the growth of renewable energy in the country. As a result, efforts should be made to drastically cut back on the use of fossil fuels. One way to do this would be to impose an environmental tax on fossil fuel usage in order to recover some of the monetary and ecological costs associated with using these fuels. The findings of this research have implications for strategies that aim to increase not just the total amount of renewable power generated but also the proportion of renewable electricity used overall. However, this report is limited in scope because it only looks at China’s renewable energy as a whole. Due to disparities in resources for renewable energy allocation and economic developmental status between provinces in China, future research should try to investigate the determinants of the proportion of renewable-generated power at the sectoral and provincial level. The factors that influence the adoption of various renewable energy sources can be studied in greater depth in future research.

As one of the largest economies in Africa, Egypt plays a crucial role in the international transmission of energy. However, the country's energy industry is still struggling to keep up with domestic demand. If conventional power-generating methods fulfill Egypt's energy needs, the country's CO2 emissions will rise roughly 125% between 2012 and 2035. Since Egypt has acknowledged the need for international collaboration in combating climate change by signing the Kyoto treaty, the country should prioritize satisfying the growing energy needs with clean energy technology. Over the past decades, the absence of effective solid waste management solutions has posed serious environmental dangers and water shortage problems for Egypt. There is concern that the

nation's reserves of crude oil will run dry within the coming decade. Current and future energy frameworks in Egypt should place a strong emphasis on the development and implementation of renewable energy systems in order to effectively meet these challenges and strengthen Egypt's contribution to international energy transit. (Salah, Eltaweel, Abeykoon, 2022) provides an overview of Egypt's current energy situation and an analysis of the country's prospect to utilize energy from renewable resources. The renewable energy sector in Egypt has a lot of untapped potential due to the country's rich diversity of resources. In the end, two alternatives are recommended to ponder about in order to reach the country's 2035 energy goal, which is to produce 42% of the nation's energy need from renewable sources. This research should serve as a guidepost for Egypt as well as other countries as they work toward the NET ZERO goal that the entire world has set for itself in the coming decades.

The energy future of Southeast Asia is uncertain, given the region's governments are primarily dependent on fossil fuels for transportation and power. In a time of global energy revolution and economic upheaval, Asia is at the forefront of renewable energy generation, led by India and China in particular. There is a great deal of untapped potential for renewable energy in Southeast Asian countries. While they have made progress in renewable energy deployment, they have yet to perform worldwide. Erdiwansyah et al. (2021) analyze the strategies of various governments to increase the implementation of renewables for electricity generation significantly. The research also suggests legislative changes that might hasten the region's transition to renewable energy without jeopardizing its environmental integrity. The ASEAN Governments should adopt aggressive actions, such as removing incentives of fossil fuels, global market integration, and speedy execution of the current project, to meet the ambitious objective of 23% renewable power in the main energy mix before 2025. Each of these plans of action will require political will, long-term commitment from leaders, and action from stakeholders, including greater regional collaboration.

Abdmouleh, Alammari and Gastli (2015) analyze the factors that have led to the widespread adoption of renewable energy legislation and makes that data available to policymakers and those working on renewable energy projects. Their research uses case studies and cross-country research to focus on the numerous strategies available for establishing a supportive regulatory environment for renewable energies. They look at

both successful and unsuccessful cases. This statistical review looks at the various renewable electricity sources and technologies to see what variables contributed to their effective deployment. Abdmouleh, Alammari and Gastli (2015) aim to facilitate knowledge sharing among policy implementers and to aid in achieving realistic renewable energy targets. Their approach is to compile all the methods used to assist in deploying renewable energy projects by researching and analyzing study examples from various relevant experiences. The data is then organized and examined from multiple perspectives—including financial, economic, legislative, political, technological, and environmental—to provide a framework for future research on renewable energy policy.

Almost every problem with a country's long-term economic and social health can be traced back to its energy infrastructure. Saudi Arabia intends to use renewable energy sources as part of a strategy to broaden its economy. Barhoumi et al. (2019) try to assess the human resource capabilities of Saudi Arabia in relation to the country's renewable energy resources. According to research, solar, wind, and geothermal energy, among other forms of renewable electricity, are abundant in the nation. However, the large amount of fuel generated means that gasoline is the primary source of Saudi Arabia’s electrical energy. There are several benefits to using renewable energy sources beyond the financial ones. True, another goal of such a strategy is safeguarding the Earth and its natural resources. The future of energy in Saudi Arabia will be greatly aided by solar and wind energy. In reality, a target of producing over 40 GW of power from renewable energy sources by 2030 is created through a clear policy set in place by the senior authority of the Ministry of Energy. R&D, industrial manufacture of equipment, and higher learning to produce qualified human resources will form part of the production of renewable energy chain. Therefore, there should be a rise in the number of engineering departments at universities that provide degrees in renewable energy, so that these institutions may produce graduates who can effectively oversee such projects. In this work, researchers discuss ways in which renewable energy may be improved in education and scientific study as a whole.

Following the outbreak of COVID-19 epidemic, worldwide energy consumption has changed significantly, especially with regards to investments in projects for renewable energy. As a result of mandatory lockdown regulations implemented in March 2020, private and public sector investments in India's planned renewable energy projects have

undergone significant revision. Shekhar et al. (2021) draw attention to changes in energy usage and the amount of renewable energy capacity that is built in India around the time that lockdown directives were issued. They review current legislative actions and increases in deployed renewable energy production capacity and provide significant policy considerations that may assist the industry in adopting a growth path similar to one recorded before to the pandemic. There are four key sections in this study. In the first part, researchers highlight India's renewable energy policy, with a focus on the country's most recent initiatives and campaigns aim at attaining rapid expansion in the field. In order to accomplish these goals, the researcher briefly outlines why strong public-private partnerships are essential. The second section provides a quantitative description of the expansion of renewable energy in India. Researchers provide a synopsis of the many programs and initiatives that the government has developed in keeping with its policy to reduce the negative effects of India's energy mix on the environment. Third, they examine the drop in energy use in India between 24 March and 30 June of 2020, the time span during which the government issued lockdown directives. For further demonstration of the pandemic's causal influence on the expansion of renewables, the researcher additionally characterizes variations in deployed renewable energy capacity from March 2016 to December 2020. Here, they also collect and examine information on stressed assets among renewable energy providers on a state level. Lastly, this study offers policy ideas that may aid the industry in the short-term in overcoming logistical and financial barriers. Their goal is to provide a blueprint for the actions that policymakers might take to ensure the continued success of the pre-COVID industry. Three types of policy instruments are addressed in our suggestions: capital incentives, operational incentives, and advice for DISCOMs. Financial support in the form of direct capital investments has been granted on a per-kilowatt-hour basis relative to the total investment expenses of the project. Additionally, low-cost funding is available for renewable energy projects through the “Indian Renewable Energy Agency (IREDA),” India's monetary institution devoted to green energy. Furthermore, the “Central Public Sector Undertaking (CPSU) Scheme Phase-II” is recently launched by the Ministry of Renewable and New Energy to assist the development of 12,000 MW of grid-connected PV plants. Public-private partnership projects seeking this grant money do so because they hope to profit eventually. There is a hard limit of 20% of the overall project cost for VGF funding. Another 20% of the overall

project cost can be funded by grants from the public or government organization that controls the project (Shekhar et al. 2021). As a result of this clause, public-private partnerships are encouraged to engage in the nation’s expansion of its renewable energy potential. The promotion of VGF funding should extend beyond just solar installations to include all renewable energy-producing technologies, even those with significant initial investment requirements. Government entities like the “Solar Energy Corporation of India (SECI)” reportedly have underutilization of funding since the start of the pandemic. Therefore, they may use this money to develop additional capacity in collaboration with private groups. The initial equity expenditure by the developer for solar projects is found to decrease to 15% (from 30%) thanks to VGF funding. Residential solar panels, as well as other renewable energy sources, such as wind energy, may benefit from such capital incentives in the future.

Countries like Pakistan and Turkey have to rely heavily on foreign fossil fuel imports to satisfy their energy needs. Pakistan is making a rational choice by prioritizing renewable energy sources in its existing infrastructure to solve the country's energy crisis. Several projects (including solar PV and wind power technologies) are already up and running or in the works, and their goal is to alleviate Pakistan's energy problems. By 2030, the new Pakistani government hopes to have 30% of all electricity generated from renewable sources. However, Turkey has more renewable energy resources than Pakistan has. The country is home to 186 wind energy generating facilities, whereas Pakistan only has 14. Solar energy is also used, mostly in homes around Turkey. The Vision 2023 energy plan for Turkey calls for meeting 30 percent of the country's electricity needs using new renewable energy sources. Turkey has adopted renewable energy systems for heating, cooling, and electricity generation, including photovoltaics (PV), wind power stations, solar buildings, geothermal power reserves, and biomass technologies.

At now, hydropower accounts for 16% of Turkey's energy supply, while fossil fuels make up 56%. According to publicly available information, the Ministry of Energy in Pakistan has consistently ignored the country's abundant geothermal energy resources, in stark contrast to Turkey, where this type of energy is effectively used for heating and cooling. Taking into account all the data, Uddin et al. (2021) conduct comparison studies that show that the two nations' generation of power from geothermal power solutions falls short of the vast potential. They find that powering rural regions as well as the national

grid with renewable energy sources might help decentralize energy production. The researchers determined that there is significant potential in renewable power sources in both nations after comparing energy generation and examining the existing level of the usage of renewable energies in both countries. Power storage techniques may be incorporated into energy production in order to boost the dependability and sustainability of renewable energy sources. Additionally, both nations should boost their R&D collaboration with the rest of the developed world. This suggestions for energy policy should be incorporated into both Pakistan's energy strategy and vision for the year 2030, as well as Turkey's vision for the year 2023.

Furthermore, Gozen (2014) observes that in 2005, the Grand National Assembly of Turkey approved a legislation encouraging the use of renewable energy and setting up a system of feed-in tariffs for power generated using such methods. However, because of the little feed-in tariffs provided by this regulation, investors are not charmed by it. Then, in 2011, an embedded day-ahead market assistance plan is created, and the promotional law is revised. Gozen (2014) aims to describe the new support system, evaluate it from a monetary standpoint, and talk about the associated important concerns and challenges. In addition, certain recommendations are made to policymakers to further enhance the assistance system. The liberalization of Turkey's power market is still in the works. The main problem is ensuring a reliable and constant supply of power while decreasing the country's reliance on foreign sources of energy. One way that the government can reach its market goal is by relying on renewable energy. To be competitive with traditional energy sources like natural gas and coal, electricity output from renewable energy needs financial assistance and a purchase commitment. Turkey, like many other nations, has introduced FIT to encourage the use of renewable energy. In 2005, Turkey implemented a uniform FIT into all renewables as part of its efforts to execute this strategy. However, it is later determined that this method is undesirable to investors, given the FIT's low level compared to spot market pricing. Then in 2011, a brand-new aid program built around the day-ahead market is unveiled. TEIAS, as part of all market-active providers, has implemented a brand-new method for selling power generated from renewable sources in the day-ahead market. While it is too soon to assess the effectiveness of the new support program, the support mechanism appears to be competitive with spot market rates for renewable energy facilities such as those that run on solar, biogas, and

geothermal. However, it does not affect renewable energy sources like wind and hydro. Installations of hydraulic and wind power plants that use entirely domestic equipment are liable for a rebate for domestic equipment utilization. Because the aggregate support price is more significant than spot market rates, power stations in this segment would benefit from participating in the support mechanism. In Turkey, FIT is not defined by law. Realistically, the aid implies that FIT will be higher than spot market pricing. If not, the investor will likely opt to sell the output on the open market instead. The current FIT under Law No. 5346 is unfavorable to all market participants; a modified FIT formula centered on addition of a specified premium to spot prices, essentially a day-ahead price, would be preferable. In either case (a set FIT or perhaps a support price model that factors in spot market pricing), the goal is to ensure that the renewable energy generation can recoup his expenses of operation and make a fair profit. Then it would be prudent to revise the current FIT in order to boost investment in renewables. However, the clean energy promotion law is missing a crucial part of the support system: a way to track progress and adjust as necessary. It is crucial to check the mechanism's progress regularly to see if it is moving in the correct direction in accordance with the state's renewable energy strategy. Effective monitoring and evaluation of the system will allow legislators and regulators to anticipate problems and take preventative measures.

Hess and Gentry (2019) conduct interviews and a poll with society organizations advocates and public officials in regions of the United States that have pledged to switch to renewable electricity for the entire community in order to assess the level of progress achieved towards green energy. Based on the survey questions, it appears that the cities share traits common to those described in the literature on the issue of legislative reform for sustainable urban development and greenhouse gas efforts. Most localities in the sample have liberal political cultures and express local concern for environmental and fossil-fuel emissions and climate-related danger. Environmental non-profits and municipal governments provided the “entrepreneurs” who shaped policy, and they frequently collaborated with a wide range of community members. When considering factors other than GHG emissions, local job development is the most cited reason for support, while cost is the most frequently cited reason for doubt or resistance. Advocates' recommendations and political approaches are explored, and a review of implementation tactics is offered. Some initiatives consider affordability and equity for household

customers' energy requirements. Many cities and towns around the United States participate in 100% renewable energy programs. Cities like Los Angeles, Chicago and Atlanta are increasingly participating in a trend first seen in smaller communities. Universities, industries, and other significant energy consumers are setting similar targets, and even state governments are beginning to show interest in transitioning to renewable energy sources. There have been many attempts on the municipal level to authorize and implement such programs. Hess and Gentry (2019) help to bridge that gap with the scholarly literature on the prerequisites necessary for rural sustainability efforts. First, they give an overview that should be useful for specialists, legislators, and activists who are either trying to obtain political backing for such initiatives and policies or are already in the implementation stage. Second, the research adds to understanding the variables influencing the acceptance and execution of renewable power liberalization and climate mitigation programs. These insights expand on and enhance the existing literature. In a society where certain countries and political groups are still dedicated to further exploitation of fossil fuels, these projects represent encouraging indicators.

Global warming projections still need to be slowed to within the safe zone of 1.5 degrees Celsius, and this will need major action from national governments and big utilities in nations with high GHG like the United States. Local and private efforts may have a cumulative impact on the environment, but their larger value may lie in raising awareness of the need for and potential of more sustainable policymaking. Significant action by national governments and big utilities is still needed in nations with high greenhouse-gas emissions, like the United States, to bend the curve of anticipated global warming to a goal of a 1.5 degrees Celsius warming limit. The environmental impact of many small-scale governmental and private efforts may be substantial. Still, their actual value may lie in raising awareness of the need for and potential for such policies. There is reason to believe that the expanding movement for 100% renewable energy targets and implementation plans will influence federal policy and the strategies of major investor-owned utilities. These regulations can potentially sway public opinion in favor of taking action to decrease emissions of greenhouse gases through energy transitions, which is feasible and necessary.

Renewable Energy Consumption and Economic Growth

All factors including the economic complexities, renewable and non-renewable consumptions of energy consumption have a positive association showing higher rates of economic growth according to Gozgor, Marco, and Zhou (2018) who introduced a growth model that took into consideration the indicator of economic intricacies to measure how possible it is to export delicate or intricate products. They researched on twenty-nine OECD countries from the year 1990 to the year 2013. Moreover, Shahbaz, Zeshan, and Afza (2012) explore linkages between both renewable and non-renewable energy consumption to economic growth for the country Pakistan ranging from 1972 to 2011. They worked with various variables, labor, real output, domestic output, energy, and capital. Findings indicated that there is a co-integration running between non-renewable & renewable consumption of energy, labor, capital, and economic growth in Pakistan. Findings proved that both non-renewable and renewable energy consumption support growth in the economy. Labor and capital are also seen as vital elements in economic growth. The vector error correction model validated the presence of the feedback hypotheses for all the variables in the study.

Furthermore, Fatemeh, Bahareh, Behname, Salari, and Seyed (2020) explore the linkage between different kinds of renewable energy such as nuclear energy, hydropower, solar, wind, and waste combustible energy with the value of the stock market and economic growth for Iran from 1990 to 2014. In the long run, the value of the stock market has an impact on both types of renewable energy. The rate of economic growth for both the long and short term, greatly impacts nuclear energy, solar energy, wind energy, and hydropower. For waste energy and combustible renewable energy, the rate of economic growth is substantial in the short run only. Neither kind of renewable energy consumption has an impact on the growth of the economy in both the long term and short term.

In addition, it is confirmed that there is a long-run relationship between traditional energy-related inputs and economic growth. For fifty-seven percent of the sampled economies, there is a significant and positive long-run linkage between the consumption of renewable energy and the output of their economies. They further suggested that global corporations, Governments, planners in the energy sector, and other institutions

should work together to increase investments in renewable energy in order to lower the carbon discharges in these countries. Also, Sudharshan, Bhattacharya, Ozturk and Sankar (2015) investigated how the consumption of renewable energy affects the growing economies for the dominant renewable energy-consuming economies globally. They utilized the Renewable Energy Country Attractiveness Index created by EY Global and sampled thirty-eight of the top renewable energy-consuming economies from the year 1991 to the year 2012 utilizing Panel estimation methods and suggested that global agencies, those in charge of energy administration and Governments ought to come together to increase the investments in renewable energies in order to have lower carbon emissions in these countries.

Likewise, Boluk and Mert (2014) investigated the environmental Kuznets to test the linkage between income, carbon discharges, and energy consumption for sixteen European Union economies from the year 1990 to the year 2008. Renewable energy consumption contributes around 1/2 less per unit of energy consumed than fossil energy consumption in terms of GHG (greenhouse gas) emissions in EU countries implying that a shift in energy consumption mix towards alternative renewable energy technologies might decrease the GHG emissions. Some studies have produced mixed results like Maamar (2014) who aims to quantitatively integrate empirical literature in this subject matter while using meta-analysis techniques for investigating sources of differences in the direction of the relationships between renewable energy consumption and growth in the economies. His results revealed that the disparities in supporting the hypotheses are because of a number of factors such as the level of development of a country, the characteristics of data collected, tests & techniques for analyzing the data, and the specification of the models. Others such as Kouton and Sulpice (2019) investigated the effects of the consumption of renewable energy on economic growth in Côte d'Ivoire from the year 1991 to the year 2015 and suggested that in the short run, the consumption of renewable energy has mixed effects on economic growth and for the long run, the effect isn't material. They also note that the change-over to nonrenewable and renewable energy transition has not been embraced fully in the country. Pinar, Thanasis, and Mehmet (2020) studied the linkage between the use of renewable energy and the growth of the economy of one hundred and three countries from 1995 to 2015. They opine that a given minimum threshold of energy consumption must be surpassed in order for

developing economies to enjoy positive growth in their economies related to the investments made. Dinc and Ece (2019) aim to interrogate linkages in Turkey, amongst the gross consumption of energy, growth in the economy, and production of energy from 1980 to 2016 both for the short-run and long-run and using the time-series tests of Granger causality. They note that there is a bi-directional linkage between economic growth and renewable energy in both the short-term and long-term which upholds the feedback hypothesis.

They further report linkage running from consumption of energy to economic growth for both the long term and short term hence supporting the growth hypothesis. Anyhow, the findings from the growth in the economy to the consumption of energy for the short term are inconsistent. They conclude that for Turkey to continue developing, then the production of renewable energy must be boosted while consumption of energy should be reduced. Le, Hong, and Vo (2019) tested this common hypothesis utilizing the environmental Kuznets curve (EKC) and taking into consideration five countries in the Association of Southeast Asian Nations (ASEAN) which included the Philippines, Malaysia, Indonesia, Thailand, and Myanmar from the year 1971 to the year 2014. They conclude that there is no long-run linkage between the variables for two countries-Thailand and the Philippines. There is however a link for Malaysia, Indonesia, and Myanmar. Malaysia and Indonesia did not uphold the Environmental Kuznets curve, but it is supported by Myanmar. There are a lot of variations in the causal relationships of the variables for the various sampled countries. For the Philippines, Thailand and Malaysia, there are no linkages amongst variables, consumption of renewable energy, carbon discharges and consumption of energy. For, Indonesia there is a unidirectional relationship moving from economic growth to renewable energy consumption for both the long and the short run, as well as from economic growth to carbon discharges and consumption of energy. On an interesting point, the only country with a unidirectional impact from economic growth, population and consumption of energy is Myanmar.

In contrast, using the bootstrap panel causality test, Ozturk and Ozcana (2019) who analyze the linkage of renewable energy consumption to economic growth for seventeen emerging economies, ranging from 1990 to 2016, opposed the neutrality hypothesis for all the economies with the exception of Poland that upheld the growth hypothesis. They conclude that since there is no causal relationship between the demand

of renewable energy and the growth in the economy then strategies for saving energy would not have adverse effect for the rates of growth for the sixteen emerging countries with the exception of Poland where actions for conserving energy may be harmful to the performance level of the economy.

Additionally, Ocal and Alper (2013) examine the economic growth-renewable energy consumption link for Turkey using variables; GDP measured in billions, fixed capital formation measured in billions, total labor force measured in millions, waste and combustible renewables as a percentage of total energy measured in thousands of metric tons. They opine that the consumption of renewable energy has an unfavorable effect on the growth of the economy. However, causality measured by Toda–Yamamoto tests showed a unidirectional link from the growth in the economy to the consumption of renewable energy.

Bisselink et.al (2011) summarized findings from a Joint Research Centre with regards to renewable energy in the African continent. With regards to renewable resources, the geographical data that is gathered concerns patterns of wind, radiation of solar, resources of biomass from forests & residues, and resources on water data. They assessed the prevailing consumption of energy and the portion of renewables for the countries in Africa. The major findings included; there is need to have more accurate data on energy and more so the prices of energy at the moment which must be consistent all through, having more harmonized data across; need to have a hybrid system which will take into account both solar and wind power/energy; the need to have more organized biomass resource evaluation that looks into the yields, fiber, feed and human capacity; The impact of climate change on the rural areas which should incorporate the effects of droughts, floods and radiations; The need to have more research on the estimated growth rate of urban areas and rural areas in terms of population. The forum notes that when renewable energy is decentralized, there is the possibility of limited growth. This move would be useful in the mega-cities. Renewable Energy in the continent of Africa offers a great potential by allowing the standards of living to be upgraded in a big part of both existing and the future population. The forum noted that most of the knowledge gathered, should be transferred to researchers, scholars, and partners in the technology field in the continent. This will ensure that the research gaps are done by Africans themselves in

terms of developing prototypes, demonstrations, and massive deployments, hence the acceleration of the receiving and acceptance of the projects.

Gajdzik et al. (2023) undertook a comprehensive study investigating the factors influencing the development of renewable energy sources (RESs) within the European Union (EU). The research focused on four primary categories of barriers: political, administrative, grid infrastructural, and socioeconomic. Utilizing publicly available data from sources such as European Union reports, Eurostat, and the Eclareon RES Policy Monitoring Database, the study encompassed all 27 EU member states. Its objective is to assess the impact of various factors, including socioeconomic ones, on RES development across these countries. One key finding of the analysis challenges the notion of uniformity in RES advancement and barriers across the EU. The research identified a significant correlation between the level of societal development and the integration of renewable energy sources. In less affluent EU nations, economic growth emerged as a critical driver for RES development. Administrative barriers are highlighted as influential, particularly in less prosperous EU countries, while grid-related obstacles are more prevalent in Southern–Central Europe. Moreover, regions with a substantial share of renewable energy sources in electricity consumption faced challenges associated with excess capacity in the renewable energy market, which impeded further growth. Overall, the study provides valuable insights into the complex dynamics shaping RES development within the EU, emphasizing the multifaceted nature of barriers and the need for tailored strategies to overcome them effectively.

Yolcan (2023) conducted an assessment of the global energy landscape and the progress of renewable energy development within the timeframe of 2012 to 2021. The study focused on evaluating the contribution of renewable energy to electricity production and primary energy consumption, analyzing its growth trajectory over the specified period. The findings indicate a consistent rise in interest and utilization of renewable energy resources over the years. Analysis of global energy data reveals a significant increase in both installed capacity and consumption of renewable energy during the study period. While renewable energy is recognized as crucial for sustainable development, fossil fuels continue to dominate primary energy consumption worldwide. Despite this dominance, there is a notable upward trend in the use and consumption of renewable energy on a global scale. For instance, in 2012, renewable sources accounted for 0.24 gigatons of oil

equivalent (Gtoe) of the world's primary energy consumption, which surged to 0.95 Gtoe by 2021. Moreover, the proportion of electricity generated from renewable sources increased from approximately 7.4% in 2016 to 12.8% in 2021 on a global scale. Although renewable energy usage is more pronounced in European Union (EU) countries compared to other regions, the study highlights a growing adoption of renewable energy across various parts of the world. This suggests a broader acceptance and integration of renewable energy solutions in diverse geographical contexts.

Hassan et al. (2023) discuss the challenges faced by the Middle East despite its abundant fossil fuel resources, highlighting vulnerabilities to fluctuations in oil and gas prices, which can strain national budgets. Additionally, while some Middle Eastern countries benefit from cheaper energy costs due to energy imports, others grapple with war, social unrest, and political instability, complicating the region's energy landscape. Water scarcity is another pressing issue in the Middle East, exacerbated by its arid climate. Effective management of water resources has become increasingly crucial as shortages intensify. To tackle the current energy crisis and bolster energy security, Middle Eastern governments have initiated commendable renewable energy projects. However, there remains a significant gap between the potential of renewable energy and actual production, driven by rising demand and population growth. The study provides an overview of Middle Eastern energy consumption and assesses the feasibility of tapping into renewable energy sources. Technical predictions reveal the region's ample potential for solar and wind energy, with regional transmission systems emerging as a viable option to harness these resources, despite their intermittent nature. In conclusion, the study emphasizes the importance of exploring and implementing various policy options to meet renewable energy goals, especially in a region heavily reliant on fossil fuels for its economic output. By diversifying energy sources and promoting renewable energy initiatives, the Middle East can mitigate risks associated with fossil fuel dependency while enhancing its energy security and sustainability.

Simionescu, Rădulescu, and Cifuentes-Faura (2023) address the pivotal role of renewable energy consumption in advancing sustainable development, stressing the necessity of a sectoral approach to tailor recommendations for each sector effectively. Against this backdrop, the primary aim of this paper is to evaluate the impact of renewable energy usage on economic growth across 23 European Union (EU) member states during

the period from 1990 to 2020. The study examines various utilizations of renewable energy, including its applications in industry, transportation, commercial and public services, as well as residential purposes. The methodological framework is constructed around panel data models, starting from a Cobb-Douglas function. Renewable energy consumption is regarded as a crucial factor expected to stimulate economic growth. The panel data approach, incorporating causality analysis and estimators such as Augmented Mean Group and Common Correlated Effects Mean Group, suggests several key findings; Renewable energy usage in the industrial sector does not directly drive economic growth. Instead, economic development acts as a catalyst for increased utilization of renewable energy in industry. Conversely, higher levels of renewable energy consumption in the transportation sector are associated with enhanced economic growth. A heightened level of economic development can foster greater consumption of renewable energies within industrial sectors. This phenomenon enables industrial firms to allocate more financial resources to research in renewable energy fields and facilitates their adoption of renewable energy sources. The study highlights the potential of investments in biofuels to contribute to achieving sustainable transportation goals within the EU. Overall, the findings underscore the complex interplay between renewable energy consumption, economic growth, and sectoral dynamics, emphasizing the need for nuanced policy interventions tailored to specific sectors to promote sustainable development effectively.

Ojekemi, Ağa, and Magazzino (2023) conducted a study focusing on the examination of renewable energy consumption, economic risk, and financial risk's influence on the load capacity factor (LF) within the BRICS countries, spanning from 1990 to 2019. The empirical analysis employed the Method of Moments Quantile Regression (MMQR) alongside long-run estimators including Fixed Effects Ordinary Least Squares (FE-OLS), Dynamic Ordinary Least Squares (DOLS), and Fully Modified Ordinary Least Squares (FMOLS). The findings reveal the presence of a cointegrating relationship among the variables under investigation. Notably, the study indicates that fossil fuels and economic growth contribute to a decrease in LF, whereas economic risk and renewable energy usage are associated with an increase in LF depth. Moreover, the results obtained through the MMQR method are validated by estimates derived from DOLS, FMOLS, and FE-OLS techniques. Causality analysis suggests that these factors can serve as

predictors of ecological quality, highlighting the potential impact of policies related to renewable energy consumption, financial risk management, renewable energy utilization, and economic growth on LF levels. In light of these findings, the study underscores the importance for policymakers to promote investments in environmentally friendly technologies and prioritize economic and financial stability. Doing so can enhance energy efficiency and facilitate the widespread adoption of energy-saving products, ultimately contributing to sustainable energy practices and environmental conservation efforts.

In developing the hypothesis for this section.

H_0; There is a statistically significant relationship between renewable energy consumption and economic growth in Kenya.

H_1; There is no statistically significant relationship between renewable energy consumption and economic growth in Kenya.

Foreign Direct Investments (FDI) and Background of FDI in Kenya

As per Moosa (2002), FDI is the process where inhabitants of a source country get the ownership of assets of a host country to control the production of, distribution of, and other activities of a company. The International Monetary Fund (IMF) defines FDI as an investment that aims to obtain a long-lasting interest in a company in an economy that is different from the investors. UNCTAD (1999), states that FDI is an investment that involves a long-term affiliation with a continuing control and interest of a resident company in one country other than the country of the investing company.

Duce and España (2003) investigate the methodological aspect of FDI in relation to International Investment Position (IIP) and the Balance of Payments (BoP). The financial system is a focal point because of its importance both as a sender (domestic perspective) and a receiver (host perspective) of direct foreign investment. The paper defines terms like "direct investor" and "direct investment enterprise" (associate, subsidiary, and branch), as well as describing the various sector divisions available and their implications for FDI in the financial sector. In this report, researchers take a look back at the primary data points they have on FDI, and they highlight the disparities between the estimates of how much FDI is flowing into emerging markets and how much is sitting in stock in industrialized nations. The gaps appear to be significantly wider for stocks, especially those of developing nations. Using this information, researchers deduce some broad patterns: First, although FDI into emerging economies

has increased, the vast majority of FDI still goes to developed nations. Secondly, while the UNCTAD figures show a drastic drop in FDI inflows to emerging economies in 2001, the IMF figures and stock data paint a considerably more detailed overview. It appears that total stocks and FDI obtained by industrial countries have levelled off, at least according to IMF statistics, although this is not the case according to UNCTAD data. There is a lack of internationally comparable and trustworthy data on the sector split, especially FDI in the banking industry. FDI outflows from the financial sector might not be accurately reflected even by sector breakdown in national data, especially if the investment is made by holding firms. Recalculating the outbound FDI flows of Spain's banking industry, which now includes transactions conducted by resident holding firms, suggests a rise of more than 50% for the years 1997–2001.

Hassen and Anis (2012) observe that the world economy has become extremely complex during the past few decades. Given the free trade, free circulation of goods and capital mechanism, the investment landscape has become increasingly complex, and it is imperative that emerging countries attract foreign investment. Specifically for the case of Tunisia, it is important to investigate how FDI affects the development of the country's economy with the help of modern time series analysis methods applied to data from 1975-2009. Therefore, their empirical findings imply that FDI may assist long-term economic growth. The relevance of the residue retrieved in the estimation is explained by the findings of this empirical investigation, which demonstrated that the real GDP of Tunisia is in dynamic balance with long-term FDI. As a result, FDI has been crucial to Tunisia's economic development. In addition, the researchers demonstrated the validity of the error correction mechanism by showing that the long-run equilibrium may be improved by the use of short-term relationships between model parameters and error correction. In conclusion, FDI is a vital driver for development and an essential component of an open and efficient international economic system. Its advantages, however, do not materialize without effort and are not equally shared throughout nations, industries, or neighbourhoods. FDI competition among developing nations has been going on for two decades. FDI is rising in developing nations for a number of reasons. These include the creation of jobs, the accumulation of capital, the promotion of exports, the prospect of technical diffusion in business, etc. Although FDI has a beneficial effect on some growth-driving variables, their model suggests that financial development and human capital are

the most important. The model of annual data for Tunisia from 1975 to 2009 is used for the empirical analysis. Results from our model indicate that FDI has a strong positive effect on a subset of growth-promoting factors, particularly human capital and financial development. The empirical study presented here is divided into three sections.

The first step is to ensure that the variables under investigation are truly stationary (real GDP, trade openness, FDI, financial development, and human capital). All variables are found to be non-stationary in level, suggesting that a rerun of this test using first-difference values would be necessary to draw any firm conclusions. The second step is to check for evidence of co-integration between the relevant variables; this analysis revealed the existence of a single co-integrating relationship, which is characterized by long-term coefficients between FDI, trade openness, financial development, human capital, and real GDP in the Tunisian economy. In Tunisia, researchers discover a positive correlation between independent and explanatory variables. The third stage involves analysing model errors and correcting them. Adjustments that bring about long-term equilibrium can be modelled using this framework. The regression results suggest that there may be some short-term rationale for the correlation they find between real GDP and FDI after accounting for other explanatory variables, thus they suggest that the error correction hypothesis is adequate.

Evans, Frank, and Rebecca (2017) investigate the implications of FDI for economic development in Ghana. Ghana's economy has benefited greatly from FDI, which has helped to spur expansion by bringing in the money, technology, and management expertise that the country lacked. Time series data is used in this analysis of foreign direct investment's impact on GDP growth in Ghana from 1980 to 2012. Periodic records for real GDP increase and FDI net inflows expressed as a percentage of GDP (FDI ratio) are the primary data utilized in this analysis, with additional data from a secondary source providing context. These statistics are drawn from the World Bank's Development Indices database. In order to determine the impact of FDI on real GDP, the linear regression method is used to analyse the annual data. The study concludes that FDI, together with the other two control factors considered, has a substantial effect on Ghana's economic growth. According to the findings, the rising tide of FDI has propelled the nation's GDP to new heights. Capital formation is facilitated, and the quality of Ghana's capital stock is improved thanks to FDI inflows, making FDI a crucial factor in the country's economic

growth and development. Investing in new resources and expanding existing ones are essential to any nation's economic development and growth. According to the study's findings, an upward trend in FDI also boosts a country's GDP and contributes to its growth. It is also determined that FDI is a key factor in driving economic development in emerging markets like Ghana. Host countries benefit from FDI in a number of ways, including the transfer of technology, the improvement of human capital formation, the stimulation of domestic investment, and the expansion of access to global markets. Therefore, FDI makes a considerable difference to GDP growth since it is less volatile than other sources of capital inflow. Overseas direct investment (FDI) is thought to promote the host country's integration into the world economy and boost growth by giving local enterprises access to overseas markets, introducing new technologies, and generally boosting capacity. Foreign direct investment (FDI) is essential to a flourishing economy since it not only increases the rate of capital production but also improves the standard of capital.

Denisia (2010) notices that there is a significant increase in FDI's relevance in the global economy following the Second World War. Understanding the economic process and the actions of economic agents, on both the micro and macro levels, has been made possible by theoretical research into FDI, which in turn has opened up new fields of study in economics. The fundamental reasons why a company would choose to invest abroad as opposed to exporting its goods or outsourcing to domestic enterprises are the starting point for any analysis of FDI. The goal of this research is to track and identify the most prominent currents in FDI concept and shed light on their historical development as well as the impetus for new methods that have been put forth to enliven the economic principles of FDI. Researchers have put out various hypotheses to explain FDI, but no single explanation has gained widespread acceptance. All the data show that there is no single, cohesive hypothesis to explain FDI, and it looks highly improbable that such a theory would ever emerge. Multinational corporations (MNCs) could not be explained by neoclassical trade theory. Portfolio investments might be explicable by differences in return rates between countries, but FDI is a bit more elusive. FDI acquired a major role in the international economy following World War II, but no satisfactory explanation is available until Hymer presented his study, in 1960, of FDI and MNCs. After numerous attempts to explain FDI and Hymer's (1976) ground-breaking work, the conceptual

framework presented by Dunning (1977), dubbed OLI paradigm, is used until quite recently.

In the research by Adams (2009), he finds that over the past two decades, FDI flows have increased dramatically all over the globe. This is due to the fact that FDI is regarded as crucial by many nations, especially emerging ones, as a means to accelerate economic growth. This study surveys the research on the effects of FDI on economic growth with a focus on Sub-Saharan Africa and other developing nations. The study presents two major findings; first, FDI is essential to host countries in the following ways. The first major finding is that there is an increase in domestic capital and efficiency as a result of the sharing of cutting-edge technological know-how, marketing and management expertise, innovations, and best practices. The first major finding is that there is an increase in domestic capital and efficiency as a result of the sharing of cutting-edge technological know-how, marketing and management expertise, innovations, and best practices. Second, FDI has pros and cons, and the extent to which each is felt depends on factors such as the policy environment in a given country and the extent to which that country is capable of diversifying the level of workability, the targeting of FDI, as well as the prospects for connections between domestic investment and FDI. The research concludes that FDI is important for economic growth but that it is not adequate on its own. Review findings indicate that SSA nations have been successful in attracting more FDI in recent years; nevertheless, this trend has not been accompanied by any discernible improvement in the region's economic standing.

The findings from the papers analysed point to four primary implications for diversification, boosting the absorptive ability of local enterprises, giving chances for links between domestic and international investors, and taking a tailored approach to FDI. Although new oil mining and exploration activities have attracted the bulk of FDI in Africa, diversity from primary to services and manufacturing has been cited as a key strategy for fostering economic growth (UNCTAD, 2008). Furthermore, because the equipment used is capital-intensive rather than labour-intensive, there are little spillover effects during mineral extraction. Because of this, the FDI impact in Africa has varied depending on how the money has been spent. Foreign direct investment has the potential to boost economic growth in the region, but this could be hampered by widespread corruption at the governmental level. The UNCTAD review (2007) suggests that encouraging FDI into

more varied and high-value sectors is one way to address this issue. Here, investing in infrastructure, human capital, and productive capacity is key to attracting foreign direct investment and ensuring its success. For Africa, the issue lies in luring FDI into industries and goods with higher income demand elasticity. The ability to employ FDI, or absorptive capacity (AC), is largely dependent on the host country's human capital and infrastructure, both of which must be developed.

Absorptive capacity refers to one's propensity for taking in, processing, and making use of information presented by others (Habiyaremye and Ziesemer, 2006). As Ayanwale (2007) points out, for instance, the lack of a significant effect of FDI on Nigeria’s economic growth may be traced back to the country's low level of education. The government's strategy should encourage FDI that enhances domestic capacity or investment if the AC is to be built. Keshava (2008) has proven that public investment is more efficient than FDI in generating growth, and this is true for China as well as other Asian nations where FDI has been thought to be more effective. Although economic growth slowed throughout the 1990s, it is interesting to note that Lesotho is the largest beneficiary of FDI within SSA in terms of overall GDP (22%) during that decade. In addition, Botswana's economy grew despite a fall in foreign direct investment (Ajayi, 2006).

Not that foreign direct investment (FDI) isn't needed in the sub-Saharan African region; rather, FDI can only boost growth by doing so if it also boosts the domestic capability of the population of the host country (De Mello, 1999). In a similar vein, Pigato (2000) argues that in the majority of African countries, the competency structures that boost investment performance include those that offer extensive expertise, a supplier connectivity that allows specialized knowledge and competitive costs, and an appropriate physical, systematic, and institutional infrastructure. Lastly, governments' potential to advance domestic capacity-building programs suggests they should try to attract the kinds of FDI that can provide beneficial economic spillovers. Here, rather than trying to attract FDI in general, it is more useful to direct promotional efforts at luring a specific category of FDI flows. According to Mwilima (2003), the monitoring of funding requests and the granting of disparity incentives to various companies and even prohibition of FDI have made Asia (particularly China, South Korea, and Taiwan) more successful at attracting foreign direct investment than other developing countries.

Iqbal et al. (2014) in their study try to verify the relationship between FDI and GDP. In recent years, both industrialized and developing nations have paid more attention to FDI due to its potential to boost economic growth. The importance of FDI in recently closed economies has grown. FDI is good for economies because it brings in new technologies, trained workers, and new ways of doing business. The cobb-Douglas output growth is used to analyse data that spans 30 years, from 1983 to 2012. Their study includes the following independent variables: “Gross Capital Formation (K), Labor (L), Health Expenditure (H), Foreign Direct Investment (FDI), and Openness to Trade in Export-Oriented Economy (OP*FDI).” For this reason, the research adopted Bhagwati's premise that FDI has a more pronounced effect on GDP in an economy that is geared toward exports. Researchers look at the descriptive statistics, correlation, and linear regression for this data. For this purpose, they use a regression model that takes into account the production function. In conclusion, the researchers find that FDI and GDP in Pakistan are positively correlated. However, throughout the previous few decades, Pakistan has not received a substantial amount of FDI. The fundamental consideration, supported by data and experience, is that FDI is more influential in free-trade regimes. It is also deduced that the effects of FDI may vary depending on factors such as location and culture. Therefore, it is impossible to estimate how much the economy will profit from FDI. FDI is crucial to every country's economic development. The impact of FDI on the GDP of the host country has been determined to be substantial and beneficial during the previous few decades. From the available literature on Pakistan, it is clear that the country's adoption of market-oriented policies has led to a modest but steady increase in foreign direct investment. The goals of this research are to (1) establish a causal link between FDI and GDP, and (2) examine the effect of trade policy on FDI's role. Furthermore, FDI encourages human resource development in the host country by way of training, education, technology transfer, additional employment, and other spillover impacts. In a nutshell, these results illustrate how the Export Promotion policy of Pakistan's government affects the country's GDP and how much foreign direct investment Pakistan is able to attract.

Islam (2014) investigates how FDI affects Bangladesh's economy by focusing on its effects on GDP, exports, and domestic investment, and then on economic expansion as a whole. In order to attract foreign investment, it is crucial for developing nations like

Bangladesh to implement effective measures to safeguard potential international investors. They ought to feel respected and valued for the part they play in Bangladesh's commercial world. In this regard, it is important to guarantee business-friendly rules, to streamline regulatory practices, to incentivize investment, and to do away with unnecessary bureaucratic red tape. While Bangladesh is making efforts to be as welcoming to foreign direct investment as possible, she is still encountering roadblocks. FDI is very much encouraged in Bangladesh as a result of the government's openness to foreign investment and the country's warm reception of visitors. However, it is disappointing that fewer projects have been formally listed as having received FDI in the country than have really been implemented. There are 365 FDI ventures registered between 1996 and 1998, but only 72 are actually in production by the end of 1999, with another 27 in the implementation phase. The other 266 projects remained dormant, existing simply as file-cases. The following are some of the issues that have hampered the country's ability to attract FDI: “Bureaucratic interference; Irregularities in processing papers; Overlapping administrative procedures; Absence of a transparent system of formalities; Continuity and prevent timely implementation of strategic, procedural, and even routine duties; Frequent power failures; Poor infrastructure support; Labor unrest; Political unrest; Lack of professional personnel; lack of commitment on the part of local investors; Unexpected delays in selecting projects in studying feasibility; Frequent changes in policies on import duties for raw materials, machinery, equipment etc.” A country's GDP is the total market value of every one of its final commodities and services supplied within a certain period. GDP growth can be sped up by a number of different means. It is hypothesized that FDI Inflow has an effect on GDP. The assumption will be validated if FDI Inflow, the predictor variable, has greater explanatory power than GDP, the dependent variable. Export: Many different things can influence export. Foreign direct investment is often believed to play a significant role in shaping international trade. The hypothesis will be validated if FDI inflow, the predictor variable, has a greater explanatory power than export, the response variable. It's important to note that there are a variety of domestic investment considerations. FDI is widely believed to be one of the most important variables affecting domestic investment through enhancing the country's competitiveness. The hypothesis will be validated if FDI inflow, the predictor variable, has a greater explanatory power than domestic investment (the response variable).

Using panel data covering 34 years (1980-2013) and subjecting it to dynamic GMM estimators, Zekarias (2015) examines the effect of FDI on economic growth in 14 Eastern African nations. The study also conducts model specification tests and autocorrelation. FDI has been flowing into developing countries in an effort to close resource and technology gaps as well as decrease unemployment and trade imbalances. Contrary to predictions made by traditional growth theories, however, empirical research on the impact of FDI on development has yielded mixed results. The results affirm the positive, marginally significant impact of FDI on GDP growth, economic conditional convergence rate at 5%, the lack of a significant crowding out effect when switching from FDI to domestic investment, the interconnection of trade openness and domestic investment in the sub-region, and so on. He concludes that FDI is a critical driver of economic growth and a catalyst for Eastern Africa's economic conditional convergence, and that the region needs to strengthen regional integration, improve its investment climate, develop its human capital and basic infrastructure, and encourage investment geared toward exports in order to attract more FDI.

Dabour (2000) notes that most, if not all, emerging countries during the past two decades have actively pursued FDI to supplement the level of local investment. By sharing relevant technologies, managerial know-how, facilitating entry to international markets, boosting employment, and raising living standards, they have ensured efficiency advantages for the economy as a whole. The OIC member nations wanted to increase the flow of FDI into their economies for the same reasons as other emerging countries. On the other hand, most of these nations have not seen much progress. Even though the OIC countries make up a sizable portion of the world's developing countries, they have only managed to attract a marginal portion of the total FDI pouring to developing countries so far. Dabour (2000) aims to educate readers about the importance of FDI to the economic growth and progress of OIC member countries, as well as the difficulties these nations have in luring FDI that is in line with their long-term plans for economic growth and progress. Accordingly, it is of the utmost importance to continue the upward trajectory of FDI into OIC nations. The need for FDI is clear, but that does not warrant employing any incentive device, especially one that could cause tax system fragmentation and weaken the macroeconomic policy position. The effectiveness of the many "positive" incentives and policy proposals accessible to OIC nations to increase FDI inflows can be

increased by creating a more favourable investment climate with careful macroeconomic management, fortified institutions, accelerated structural reforms, deregulated markets, and privatized economic activities.

On the other hand, Wang and Jiayu (201) draw the following conclusions evaluating China’s economic climate: (1) Energy usage and greenhouse gas emissions in Shandong Province are affected by the province's overall economic size, structure of the economy, and technical sophistication. Shandong Ministry of Industry's energy usage is significantly impacted by the size effect and the technology effect. As a means of bolstering the positive impact that FDI has on the province of Shandong's environment, provincial authorities there should prioritize the recruitment of clean, environmentally conscious firms. (2) Foreign direct investment causes a growth in the size of the economy, the volume of production, and the number of emissions of pollutants. Meanwhile, FDI also causes a shift in the composition of industries and a consequent rise in productivity and innovation. (3) Foreign direct investment has a negative impact on energy usage in Shandong province, which in turn encourages a rise in energy usage in the manufacturing industries. Combining quantitative and qualitative methods, this study demonstrates the current positive association between foreign investment and energy usage in Shandong province. Foreign direct investment can help the Shandong Province economy grow, close the economic gap, introduce cutting-edge technology, and enforce stringent environmental regulations; however, these benefits come at the expense of scale and structure increases in the industrial sector (facilitate robust development of pollution-free industries). Shandong province has been increasing its energy use.

Wahid, Sawkut and Seetanah (2009) observe that when compared to the entire amount of FDI in the world and the total amount of FDI in developing nations, the amount of money that goes into Africa is very little. Worse still, over the past three decades, Africa's proportion of FDI inflows has been steadily declining. Investment from overseas increased by 20 percent to $36 billion in 2006, more than doubling from 2004's level. The purpose of this research is to use a panel data approach to evaluate the many potential factors of FDI for a selection of African economies from 1990 to 2005. Based on the data that is made available, this study includes twenty different African countries. Utilizing a fixed effects model is suggested by the Hausman test's stipulations. The results of the econometric functions confirm the importance of all the response variables in luring FDI to

Africa. This study, which uses data from 20 different African countries between 1990 and 2005, looks into what makes FDI recipient countries more appealing.

In agreement with Kinoshita and Campos (2004) and Asiedu (2002), reports indicate that the richness of natural resources is favorable and significant (supporting the existence of resource-seeking FDI). It seems sense that an efficient environment, which comes with more trade liberalization, would entice foreign enterprises, and this effect of openness on FDI has been observed. The findings are in line with empirical research in the field, which find that the scope of the domestic market and the stock of human capital both play positive roles in FDI Inflow in the markets, whilst political instability and labor cost play negative roles.

According to Singh (2019), the Indian economy is rapidly developing into one of the most promising new markets worldwide. India is included in the fragile five until around years ago, but now it isn't. It has seen a dramatic increase in FDI since 2014, making it one of the top foreign destinations worldwide. The process of luring FDI to India began in earnest with the implementation of the New Economic Policy in 1991, but it has reached new levels in the 2000s. This article analyses FDI into India between 2000 and 2018 using a sectoral approach based on secondary data. A secondary goal of this article is to examine various aspects of the country's experience with beneficial FDI spill overs. India is now regarded as one of the world's most promising emerging markets. From between April 2000 and June 2018, the United States saw a total of USD 563320 million in FDI. This steady influx of cash has allowed the country to make strides in areas like as technological development, human resource development, job creation, infrastructural improvement, and administrative efficiency (Sharma & Khurana 2013; Teli 2014). The country's economic structure has been altered with the assistance of multinational firms based outside, which have drawn new investors and sparked growth in cutting-edge industries. It has been noted that the Government of India (GOI), particularly starting in 2014, has taken an active role in formulating policy with the goal of achieving structural transformation. As a result, numerous industries have benefited from a flood of foreign investment. Consequently, this contributes to increased productivity and supports sustainable and equitable growth. India has received the most FDI in its service industry, which includes financial and nonfinancial products, banking, insurance, offshoring, and R&D. The electronics, hardware, auto, pharma, and similar industries have received the

most FDI recently. India's appeal as a location for FDI in the services and manufacturing sectors begs the question, what makes India so special? An easy indicator would be India's level of competition in a given industry; for example, Indian manufacturing sector may not be competitive on a global scale. Industry insiders point to a wide range of explanations. Since textiles, generic pharmaceuticals, and similar products can all take advantage of India's relatively low labour costs, these are the only types of manufacturing that have found success in the country. A number of countries, including Cambodia, Brazil, Bangladesh, and Myanmar, have recently opened their economies. There is a lot of foreign investment in these countries because of things like the free trade agreement between the Cambodia and European Union. Rising labour costs in the future will have a chilling effect on the aforementioned manufacturing in India and may have far-reaching consequences for investors. There is never going to be a boom in India's heavy industry because of a shortage of skilled workers. Examples include how to progress from learning to construct bicycles and motorcycles to automobiles and ultimately jet engines and airplanes, yet this is not unfolding in India and has already taken place in China. Therefore, the industry will not expand without the development of sophisticated manufacturing, and merely attracting FDI is not going to particularly useful. The aviation industry, to give just one example, is experiencing unprecedented growth in demand, but no company is willing to make the necessary investments to meet that demand. India's industrial sector is not highly regarded because the country has been slow to adopt new technologies. Scale is a must for industries to compete with global giants, yet scale is impossible without technology. Therefore, foreign funding is hard to come by unless businesses aim for global growth. The government of India launched the "Make in India" initiative on September 25, 2014, with the goal of turning the country into a regional and eventual global powerhouse in the fields of manufacturing, R&D, and innovation. The government of India has even singled out twelve industries as having particularly promising futures. The “Make in India” program has yet to prove how big of an impact it will have.

Iddrisu, Halidu and Immurana (2015) note that while there is some consensus in theory, empirical data is mixed as to whether FDI contributes to economic growth in host economies. As a result, sectoral analysis is established to help comprehend the dissimilarity between the effects of changes in FDI inflows on the different economic

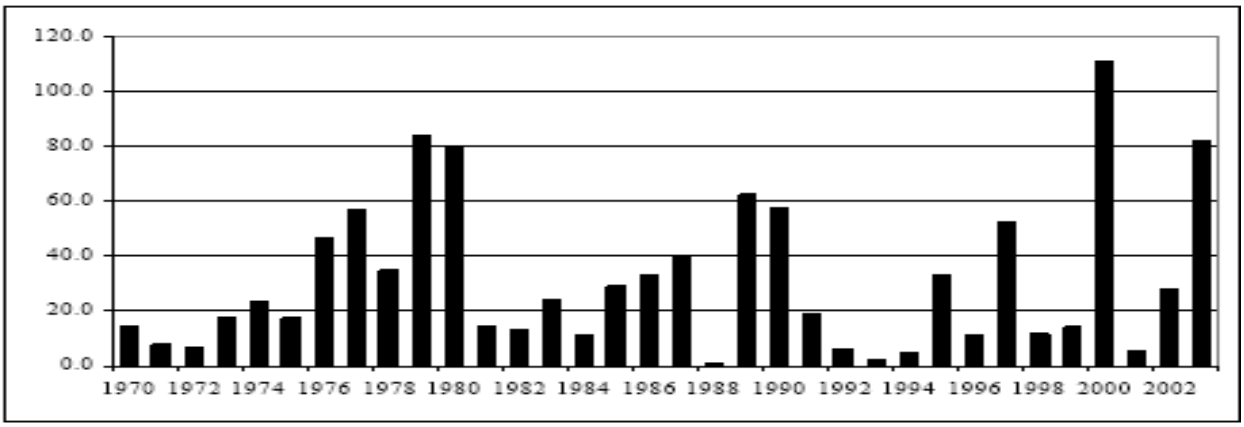
sectors and on the economy as a whole. However, the agricultural sector, which employs the vast majority of Ghana's working population and holds the key to global food security and poverty reduction, has received very little attention within the sectoral paradigm.

Iddrisu, Halidu and Immurana (2015) in their analysis, which uses the Johansen cointegration test on data from 1980-2013, focused on the effect that FDI has on the prosperity of Ghana's agricultural sector. Their research indicates that FDI has a negative long-term effect on agricultural sector production but a positive short-term effect. They also discover that the long-term expansion of the agriculture sector is hindered by the cedi's depreciation. However, agricultural production benefited greatly from trade liberalization in the long run. The researchers suggest that the government facilitates commerce, maintains a stable currency, and checks to see that foreign direct investment in agriculture and the overall economy doesn't cause harm through capital outflows and excessive profit repatriation. FDI's positive effects on economic growth have received a great deal of theoretical and empirical attention in recent years. Due to the lack of consensus in the literature on the effect of FDI on the growth of the economy in host countries, some authors have begun to consider the possibility that the influence of FDI on growth varies by industry. Very few research has examined the effects of FDI on the agricultural sector, despite the fact that it is a major part of the heterogeneity paradigm. The limited research done on Ghana's agricultural industry has casually focused on the connection between foreign direct investment and that sector. Iddrisu, Halidu and Immurana (2015) used a more thorough approach by considering both the long-term effects of FDI on agriculture and their short-term dynamics via the cointegration by Johansen (1988) and the VECM. Their time series data includes the years 1980 through 2013. Given that virtually all of the tools and resources required to increase agricultural output in Ghana must be brought in from elsewhere, this discovery should come as no surprise. Since these inputs are imported, the sector feels the effects of a depreciating cedi. In contrast, the agricultural sector benefits greatly from trade liberalization in the long run. The government should take advantage of trade policies that give Ghanaian farmers a chance to export their goods, increasing the country's farmers' market, demand, and output. Agriculture might benefit from trade policy reforms by giving farmers easier access to global markets for growth-promoting inputs and cutting-edge technologies. Moreover, the government needs to work on strengthening the country's

currency (cedi), whose devaluation has greatly increased the price of farming inputs (since they are imported). The government should take precautions to guarantee that the capital and surplus profit repatriated by FDI in agriculture and the economy as a whole do not undermine domestic economies.

Kinaro (2006) emphasized that FDIs, other than providing Africa nations with the required capital to be used for domestic investment, they also assist to transfer technology and skills from one country to another and create many employment opportunities, both of which lead to development in the economy. Acknowledging that FDI contributes so much to economic development, all the national governments in Africa, Kenya included, are aiming to attract it. And for sure, the global market for foreign investments is very competitive, Kenya would want to get as much FDI as possible in order to boost its developmental plans. At the moment, there are very with reformed guideline frameworks being common and lose of the traditional bureaucracies to attract FDI, Kenya has started being more attentive to systems that support FDIs. Therefore, the determinants of the economy remain a major factor. In the future, a distinctive advantage to Kenya would be the different locations especially in places where there are assets which can be offered to the potential investors. What is likely to be more critical in the future is the distinctive combination of locational advantages, especially, created assets that Kenya can offer potential investors. The amount of FDIs in Kenya has been stagnant and very low over the past years and way below Kenya’s ability and potential. In recent years there has been a concerning trend showing that foreign investors are avoiding Kenya and are moving to other regional countries. This is shown in the below graph.

Figure 12: FDI inflows to Kenya in Millions USD, (1970- 2003)



Note. Adapted from *Determinants of Foreign Direct Investment in Kenya* by Kinaro, 2006, p. 22.

Energy Consumption (Petroleum Energy Consumption, Electricity Energy Consumption, and Renewable Energy Consumption) and FDI.

Ting, Yin, and Yin (2011) delve into the reduction of the consumption of energy for China specifically the Jiangsu Province, they suggested that while the FDI scope is being expanded then there should be the adoption of emission-reducing and energy-saving policies and guidelines. They note that the province should expand the FDIs which are technology-intensive but at the same time utilize energy-saving technologies. Furthermore, there is a need to adjust the structure and framework in the distribution industry of FDIs in order to take advantage of the adjustments in the industrial structures. In the recent past, due to the speedy increase in economic growth, the GDP of Jiangsu's province was more than three Million Yuan in 2008. Which is 4 times higher than in 1998. During the same interval, the FDI is at 174 million Yuan which is 3 times that in 1998. The fraction of FDI to the General Fixed Direct Investment (GDI) declined from the year 2003. They note that foreign direct investments into the province played a major role in the province's growth in its economy.

However, foreign direct investments may adversely impact the industry structure in the importing province or nation by creating a spill-over effect, creating competition, and affecting the input factors. The FDIs for Jiangsu province are concentrated in the manufacturing industry. This causes an imbalance in the distribution of FDIs for the industries, hence causing negative effects. This is the reason why the negative impact on

Jiangsu province's reduction in energy consumption is stronger compared to the positive impact. On the basis of the observations, they suggested that in furthering the expansion of FDI in a country, the Government should consider improving FDI policies, as well as developing clusters for the industries. Governments should also look keenly into attracting FDs that are of better quality. An emission- reduction and energy-saving policy must be in place and be applied equally to both local and foreign-invested establishments. There is need for governments to offer guidance so that; FDIs are transferred to the technology-intensive and the capital-intensive sectors, enterprises offering FDIs adopt only progressive energy-saving technologies, and local businesses to make innovations following that basis.

Amri (2016) investigated the linkage between consumption of energy, inflows of FDI, and the growth of seventy-five nations between the years 1990 and 2010. He went ahead and distinguished the developed and developing nations assembling them from disparate geographical locations all over the globe. He concludes that there is a bidirectional relationship between output per capita and FDI, this is for both non-renewable and renewable energy in all the developed and developing countries. Additionally, the results showed that there is a bidirectional relationship linking consumption of renewable energy and FDI in developed nations. He notes that when renewable energy rate increases by one percent then FDI improves by 0.185 percent. On the same note, increasing FDI contributes in the enhancement of renewable energy by 0.292 percent. Notwithstanding, the case in all the developing countries, shows that there is a unidirectional relationship from foreign inflows to both energy types – renewable and non-renewable.

In developing the hypotheses for this section.

PEC and FDI

H_0; There is a statistically significant relationship between petroleum energy consumption and foreign direct investment in Kenya.

H_1; There is no statistically significant relationship between petroleum energy consumption and foreign direct investment in Kenya.

EEC and FDI

H_0; There is a statistically significant relationship between electricity energy consumption and foreign direct investment in Kenya.

H_1; There is no statistically significant relationship between electricity energy consumption and foreign direct investment in Kenya.

REC and FDI

H_0; There is a statistically significant relationship between renewable energy consumption and foreign direct investment in Kenya.

H_1; There is no statistically significant relationship between renewable energy consumption and foreign direct investment in Kenya.

Foreign Direct Investment and Economic Growth

According to Muhammad and Majeed (2015) who analyzed the growth in the economy, financial & commerce openness, and consumption of energy linkages in South Asia confirmed that trade, FDI, and energy have a positive impact on the growth in the economy, there is a bidirectional linkage in the long term between energy and growth and a unidirectional relationship from commerce and financial advancement to economic growth for five South Asian countries for a period between 1980 to 2010. In a similar study, He, Gao, and Chong (2012) interrogate the direction and presence of linkage between foreign direct investment, consumption of energy, and the growth in the economy in China between 1985 and 2010. They find out that there is unidirectional relationship from gross domestic product to the use of energy, and a unidirectional relationship from consumption of energy consumption to foreign direct investment. Furthermore, results revealed that increasing FDI inflows have a substantive energy-saving impact. Similarly, Lean and Shahbaz (2012), assessed the linkages between financial development, consumption of energy, urbanization, industrialization, and the growth in the economy of Tunisia starting from the year 1971 to the year 2008. Their findings confirmed the presence of a long-run relationship between financial advancement, growth in the economy, urbanization, consumption of energy, and industrialization in Tunisia.

There are bidirectional relationships in the long run between, the consumption of energy & industrialization, consumption of energy & financial advancement and financial advancement & industrialization. They therefore recommended the need for an advanced and sound financial infrastructure to attract investors, reform operations in the economy

and advance the stock markets. Furthermore, Shih-Mo and Linh1 (2015) explore the dynamic linkages amongst FDI, consumption of energy, deterioration in the environment and growth in the economy in twelve of the most populated countries in the continent of Asia They opine that there exists a causal relationship for both the short term and long term amongst the variables. More so, Kahia, Ben and Belloumi (2019) examine effects of the consumption of renewable energy consumption, inflows of FDI & trade, growth in the economy and carbon dioxide discharges and for twelve North African and Middle Eastern countries for the years 1980 to 2012. Results of analyses show that the variables are all inter-related, supporting the feedback hypothesis. Expansion of the economy causes environmental deterioration while inflows in FDI, global trade, and renewable energy, lead to a decline in carbon dioxide discharges. Also, Hammami and Abdouli (2017) delve into the nexus between foreign direct investment inflows, consumption of energy, and growth in economies for a panel of seventeen economies covering the period 1990 to 2012. Findings confirmed a causal linkage which is bidirectional between inflows of foreign direct investments and growth in the economy as well as between consumption of energy and growth in the economy.

Aside from this, a unidirectional causal link exists between the consumption of energy to inflows of foreign direct investments for the international panel, indicating that increasing consumption of energy leads to an increase in the inflows of foreign direct investments for both collective and individual economies. Zhu, Duan, and Keming (2016) highlighted the effects of consumption of energy, growth in the economy & FDI on carbon dioxide discharges for 5 countries in the Association of South East Asian Nations which included Singapore, the Philippines, Thailand, Indonesia, and Malaysia covering 1981 to 2011. They observe that for both high and low emission countries, an increased amount of trade openness can reduce carbon discharges. An example is Borensztein et al. (1998) who suggested that a strong complementary impact between human capital and foreign direct investment exists. He further observes that the contribution of foreign direct investments to the growth in economy is facilitated by interacting with the human capital in its host economy. In addition to this, the level of growth in FDI is dependent on how FDI complements and substitutes the domestic investments. Additionally, Zhang (2001) look into eleven countries using time-series and showed that there is a strong relationship between foreign direct investments and growth in gross domestic product. Latief and

Lefen (2019) highlighted the current position of PESP {Power and Energy Sector of Pakistan}and analyze the relationships empirically for foreign direct investments in the energy and power region, growth in the economy and consumption of energy for Pakistan from the year 1990 to the year 2017.

Findings uphold that there is a bidirectional linkage which is positive in the short term between growth in the economy and consumption of energy. Furthermore, findings show a long-term causation in the energy consumption equation. Moreover, Bashir and Sher (2019) researched on the factors that contribute to enhance the economic growth of Asian economies, emphasizing on the often-ignored bilateral FDI, use of energy, CO2 discharges and the role of capital role in the growth of the economy for thirty-four host economies in Asia and a hundred and fifteen source countries covering the years 2001 to 2012. It concludes that both outflows and inflows of foreign direct investments, consumption of energy, discharges of carbon dioxide and capital are vital components in the growth of the economies for the Asian countries.

Some studies produce mixed results such as Gökmenoğlu and Nigar (2015) who studied how the environmental Kuznets curve hypothesis is relevant in Turkey from 1970 to 2010. Causality from Toda–Yamamoto tests reveal that there are bidirectional relationships among, carbon discharges & foreign direct investment and consumption of energy consumption and carbon discharges. Contrarily, unidirectional causalities are found to be running from growth in the economy and consumption of energy to foreign direct investments and from growth in the economy to consumption of energy. An example of this is Chowdhury and Mavrotas (2006) who examine the causal linkage between FDI and growth in the economy applying time-series analysis from the year 1969 to the year 2000 for three developing countries: Thailand, Chile and Malaysia. They utilized the Toda -Yamamoto causality technique and found out that Gross Domestic Product causes Foreign Direct Investments for the country Chile but not vice versa. Thailand and Malaysia showed a strong bi-directional linkage between FDI and economic growth. Additionally, Hansen and Rand (2006), tested causal relationships between GDP and FDI for a sample of thirty-one countries over a range of years between 1970 and 2000 and concludes that the direction of causality varies greatly as they are dependent on the sample selection and the various techniques applied.

There are several researches that found opposite results from the other ones like Hrushikesh and Mahalik (2014) who investigated linkages between financial development, consumption of energy, and the growth in the Indian economy from the year 1971 to the year 2009. The ratio of urban to total population greatly affects the consumption of energy. However, this is greatly and negatively affected by developments in the financial sector, the ration of industrial to total output, and growth in the economy. Cointegration results went ahead to show that increasing the ratio of urban population has a negative effect on the growth of the economy while the use of energy use has a positive impact on the growth of the economy. Likewise, Hamdi and Shahbaz (2013) explore linkages between clean energy, FDI, openness in trade, carbon discharges, and the growth in the economy of the United Arab Emirates covering a period between quarter one of 1975 to quarter 4 of 011. They confirmed the presence of cointegration for the series. Trade openness, carbon discharges, and FDI lead to a decrease in the energy demand. Clean energy and growth in the economy have positive effects on the consumption of energy (De Mello, 1999). These are also dependent on country-specific issues such as the country's trade systems, political stability, rules and regulations, the rate of urbanization (Hsiao and Shen, 2003) and so forth. Carkovic and Levine (2003) also disputed that foreign direct investments lead to economic growth. Furthermore, Hanson (2001) obtained very little evidence to show that foreign direct investments bring any positive spillovers for the hosting economies.

However, Stoneman's (1975) findings verify the beneficial influence of FDI inflow and domestic savings but imply that direct investment is linked to structural consequences that slow growth. As a means of evaluating potential policy consequences, researchers have tried to interpret these findings in a broader perspective than is typically the case. For instance, Iamsiraroj (2016) argues that the relationship between FDI and economic development has been hotly contested due to contradictory empirical evidence. He contends that FDI and economic expansion may work in both directions. This research uses a simultaneous network of equations approach to analyze 124 cross-country data from 1971-2010 in order to examine FDI-economic growth correlations. The estimation results show that FDI has positive overall effects on growth, and growth in turn stimulates FDI. Other key factors of FDI include the size of the workforce, the degree to which trade

is open, and the degree to which economies are free to allocate resources as they see fit.

On the other hand, Omolola and Aziakpono (2022) using the data collected from 1970-2017 and the autoregressive distributed lag model (ARDL) limits technique compare the long- and short-term effects of various forms of international money flows on Kenya's economic performance. This occurs as the Kenyan government has prioritized luring foreign investment as a means of realizing the economic goals outlined in the country's Vision 2030 blueprint. The target is to increase the economy by 10% each year until 2030 and keep it growing at that rate. The results, which are obtained via a stringent and meticulous model selection procedure, show that the equity in a company's portfolio has a large and beneficial long-term influence on economic growth. The positive impact of portfolio equities on economic expansion is not just long-lasting, but also prominent in the short term. In contrast, Reinharta (1998) argues that there exists a negative correlation between national and foreign saving, as shown by both theory and actual data for many different countries. Yet, a common belief has developed on the basis of the 1990s' data suggesting a positive relationship between domestic and international saving in Asia and a negative relationship in Latin America. The paper contends that this common approach fails to distinguish between the cyclical element of saving, tied to capital flows, and the patterns in domestic saving (substantially different across the two regions). They show that there is no difference between the two regions in the short-term response of domestic investment to capital inflows provided trend and cyclical elements of domestic investment and capital flows are appropriately accounted for. They draw the conclusion that the key differences concern the long-run dynamics of saving rates primarily driven by population changes, per capita GDP, as well as other factors that have nothing to do with changes in capital flows.

According to Wheeler and Mody (1992), governments compete with one another for foreign investment in worldwide "location tournaments" by offering tax and other short-term incentives. If scale economies are strong enough, they can win such competitions and discourage investors from diversifying their portfolios as a risk-mitigation strategy. For this article, Wheeler and Mody (1992) zero in on the 1980s and examine the manufacturing investments made by American multinational corporations. Based on their

econometric modeling, it appears that scale economies are the most important factor in the decision-making process of investors. Surprisingly, evidence suggests that short-term incentives have little bearing on where businesses choose to locate. They draw the conclusion that countries with developed infrastructure, specialized input providers, and a growing domestic market do not need to invest in expensive tournament participation.

Odhiambo (2009) provides a new perspective on the relationship between savings and South Africa's economic growth from 1950 to 2005. The study is prompted by two factors: South Africa's low and deteriorating savings rate, on one hand, as well as the country's slowing economic growth, on the other, in the 1990s. Recognizing the limitations of the bivariate causation framework, the present research adds a third variable to the bivariate model linking savings and GDP growth in the form of foreign capital influx as a non-stationary exogenous factor. The study uses the cointegration-based error-correction mechanism and finds that, in the short term, savings and GDP growth have a bi-directional causal relationship, whereas in the long run, economic growth has a clear unidirectional causal flow towards savings. The study concludes that growth-oriented savings are more prevalent in South Africa than other types. The findings also reveal a Granger causality between the influx of foreign capital and savings, as well as a Granger causality between economic growth and foreign investment. In order to increase investor confidence and encourage foreign capital inflow, the study suggests that, in the short term, South African authorities should aim to achieve both increased savings and productivity expansion. On the other hand, in the long haul, the country's priorities should move toward attaining higher GDP growth in order to increase domestic savings and maintain a continuous influx of foreign investment capital.

Baharumshah And Thanoon (2006) quantitatively evaluate the impact of various forms of capital influx on the development of East Asian countries like China. First, using dynamic panel data for their empirical research, they discover that household saving rates are positively associated with long-term economic expansion. Second, they found evidence that FDI boosts economic growth in both the long and short-term. Additionally, FDI's impact on growth is significantly larger than that of domestic savings. Third, it seems to be susceptible to both long- and short-term capital inflows, with short-term capital inflows having a negative impact on both long- and short-term growth prospects. Fourth,

although long-term debt is beneficial to growth in the short-term, its impact gradually diminishes over time. Overall, the research supporting FDI's beneficial effect on East Asian economies' expansion is compelling. From a policy standpoint, there is strong evidence that nations that are able to attract FDI can finance larger investments and grow quicker than those unable to do so.

However, Paul and Feliciano-Cestero (2021) find that despite the importance that Multinational Enterprises (MNEs) place on FDI, no comprehensive assessment of the FDI research has been conducted. The articles that have been presented tend to narrow in on specific types of foreign direct investment. Paul and Feliciano-Cestero (2021) review analyzes 500 papers published over the past 50 years to comprehensively investigate the empirical and theoretical studies on FDI. Models and approaches of theory, historical background, and scholarly advancements are discussed. They aim to present an overview of the most important theories, paradigms, and papers, as well as point the way for future studies. From their research, they deduce that foreign direct investment (FDI) is now the most consequential sector of the global economy.

In developing the hypothesis for this section.

$H_{0:}$ There is a statistically significant relationship between foreign direct investment and economic growth.

$H_{1:}$ There is no statistically significant relationship between foreign direct investment and economic growth.

The Environment (Kuznets Curve), Energy and Economic Growth

According to Coondoo and Dinda (2002), the Environmental Kuznets Curve (EKC) is the subject of empirical research on whether there is an inverse U-shaped correlation between pollution and Income level. As is standard practice, the EKC diagram plots income on the horizontal plane and pollution on the vertical. As a result, it is assumed that pollution is a direct result of rising income rather than the other way around. That assumption is now being called into question. It is hypothesized that the direction and character of causality may differ from nation to nation. In this research, Coondoo and Dinda (2002) use a Granger causality analysis to cross-country data set on per income per capita and the matching per-capita Carbon dioxide emission data and report their

findings on the income-CO2 emission causation. In a nutshell, their findings suggest that there are three distinct sorts of causation relationships holding for various groupings of countries. This study finds a positive causal relationship between emissions and income growth in the developed nations groups of North America, Western, and Eastern Europe. The income-emissions relationship is determined for the Central and South American, Oceania, and Japanese regions. Finally, they find evidence of a two-way causal relationship between the Asia and Africa region groups of countries. Furthermore, the computed regression equations within the Granger causality analysis indicate that the increased rate of emission for the North American and Western European nation groups has become stagnant around a zero mean. There is a correlation between a sudden increase in emissions and a sudden increase in income. However, while a change in the rate of income increase is unlikely to cause a change in the emission growth rate, the opposite is true for the nation groupings of South and Central America, Japan, and Oceania. Finally, it appeared that the growth rates of both income and emissions are reinforcing each other within the Asian and African nation groups, suggesting that causality ran in both directions.

However, Beckerman (1992) notes that even though many people are calling for drastic measures to be taken immediately to mitigate the threat of global warming, this is a distraction from the much more pressing environmental issues that developing nations face. The limits to growth are not resource scarcity or climate change, both of which would have a minor impact on global output. Lack of access to clean water and sanitation, as well as urban air pollution, are major causes of decline in living standards in developing nations today and should be prioritized over concerns for future generations. In this regard, there is no way to defend the concept of "sustainable" growth ethically, because it just doesn't work. López-Menéndez, Pérez, and Moreno (2014) finds that there has been growing awareness in recent years of the environmental implications of economic development. Lowering emissions of greenhouse gases that are responsible for climate change can be an important step toward achieving both economic development and environmental protection on a global scale (World Energy Outlook, 2013). The "20-20-20" goals are intended to be attained within this framework, and they include a 20% cut in emissions of greenhouse gases from 1990 levels, a 20% increase in the percentage of EU energy usage derived from renewable resources, and a 20% increase in EU energy

conservation. In addition, the European Union has established the "Energy Roadmap 2050" as a foundation for establishing a long-term energy strategy, combating climate change via the adoption of energy efficient technologies and the emission reductions. In order to explain how rising GDP affects CO2 emissions, López-Menéndez, Pérez and Moreno (2014) estimate an EKC from panel data, focusing on the European setting. Additionally, the research offers some expansions of the EKC through integrating sources of renewable power as independent variable in the suggested models, as energy appears to lie at the core of the environmental disaster and hence should also constitute the heart of the solution. The datasets focus on the 27 member states of the EU from 1996-2010. Their empirical findings provide interesting evidence of the large effects of green technologies on CO2 emissions, which hints at the presence of an expanded EKC.

Say and Yucel (2006) provide a historical context for the energy industry in Turkey, focusing on the years 1970–2002. In order to predict future energy needs, a model is developed that takes into account both growth in the economy (routed by GNP) and population expansion in emerging countries. Total CO2 (TCO2) emissions and their correlation with the total energy consumption (TEC) are also investigated. Therefore, researchers used regression analysis to model the robust connection between TCO2 and TEC (R2=0.998). Results further demonstrated that the TEC can be predicted with high certainty (R2=0.996) using a regression model based on the population and GNP of the country of interest. The study's models are used to project TEC as a function of the desired economic progress (annual rate of growth in GNP) outlined in the “National Development Plan,” and TCO2 premised on the TEC, for the years 2011 through 2015. The TCO2 is further estimated using the IPCC method and compared to the findings obtained from the other approach. Values calculated using the IPCC technique are found to be much higher. The study's findings informed a set of suggestions for the Turkish government to consider as it develops future energy policy to implement the “Framework Convention on Climate Change,” which is signed by Turkey on 18th December 2003.

However, Bruyn (1997) argues that simple reduced-form models have been used to predict EKCs; however, these models provide little insight into the mechanisms underpinning the projected inverted U-shaped association between specific pollutants and income. Many attractive intuitive theories, such as structural shifts and environmental

policies, have been proposed, but they have rarely been scientifically tested. Decomposition analysis is preferred to augmenting the reduced-form framework with independent variables because doing so may lead to severe multicollinearity difficulties, which would make it difficult to trace the causes of the observed emissions shift. Decomposition analysis is applied, but no structural changes are found to be a significant predictor of the remarkable declines in industrialized economies' SO2 emissions throughout the 1980s. Pollution declines with income growth because of international agreements that promote environmental policy. Ambition in environmental policy appears to be explained in part by the current condition of the environment as well as the degree of affluence, but the latter is generally overlooked.

According to Roca et al. (2001), in the EKC hypothesis, there is a backwards U-shaped correlation between environmental stress and GDP per capita. This idea has been tested recently for a variety of contaminants in a variety of nations. The concept could not be extrapolated to the worldwide interaction between the economy and the environment, despite the fact that some empirical evidence reveals that some environmental factors have lessened in industrialized countries. This article adds to the conversation by studying the rising and falling rates of six air contaminants' annual emission flux in Spain. The results show there is no link between income and emissions reductions, with the possible exception of SO2, whose evolution is consistent with the EKC theory. The researchers contend that several factors influence the correlation between income and various forms of pollution. Therefore, it is incorrect to assume that rising GDP will automatically improve environmental conditions.

Twerefou, Adusah-Poku, and Bekoe (2016) find similar results. They postulate that pollutants and GDP growth have an inverse U-shaped relationship, according to the EKC hypothesis. There are few studies that either validate or refute the EKC theory in respect to CO2 emissions and the factors that influence CO2 emissions in Ghana, as is the case in many other emerging economies. The purpose of this study is to fill this information gap by applying the Auto Regressive Distributed Lag (ARDL) Limits Testing method to data from 1970 to 2010 and answering these two key issues. Instead, the data point to a U-shaped link between GDP and CO2 emissions per capita, disproving the EKC assumption for CO2 emissions in Ghana. Considering that the per capita income tipping

point happened from 1996 to 1997 at around $624 at steady 2000 prices, this means that any additional growth in GDP will only be related with growth in CO2 emissions. Their findings also show that both energy use and trade openness represent favourable long-term contributors of CO2 emissions. Thus, it is suggested that trade liberalization policies be strengthened to ensure the use of greener technology and products, and that expenditure in cleaner energy options could assist reduce CO2 emissions. They also suggest carrying out measures that combine development with climate change mitigation, such as the Low Carbon Management Strategy.

Bernaciak (2008) also argues that for a long time now, the connection between expanding economies and mounting environmental stress has been the source of many questions and debates. Growth potential in the face of dwindling natural resources is discussed in foundational economics literature such the ones by Adam Smith and others. Many economists with expertise in the environment have started focusing on these problems recently. Some highlight the environmental costs of expansion, demonstrating that it fails to bring about the desired societal outcomes (e.g., Mishan, 1967; Schumacher, 1973). Some argue that constant growth is unachievable in the long term (e.g., Meadows et al., 1972; Arrow, 1995). Others in the field of environmental economics stress the potential for balancing economic development with environmental protection measures, or even argue that sustained economic growth is essential to preserving ecological integrity (Simon and Kahn, 1984). The EKC shows the relationship between economic expansion and environmental stress. Whether or not this curve actually exists is a matter of pure speculation in the scientific community. Efforts to conduct empirical verification have yielded results that both support and disprove its existence. Nonetheless, all international studies excluded data from transition nations on the grounds that it is too anomalous and would skew the conclusions. As a result, no study has yet looked at how a country's shift from a planned to a free-market economy affects the relationship between economic development and environmental strain. The EKC shows how economic development (Y), which they simplify by equating with wellbeing, is related to environmental pressure (EP). GDP per capita can be used as a measure of economic expansion (happiness). Multiple indices of an economic system's effect on the natural environment are used to define environmental pressure. As a graphic, it can be thought of as a flipped U curve.

Hung and Shaw's (2004) analysis of panel data on Taiwan uses the EKC to determine the correlation between income and air quality. When estimating EKC, a single equation is always used in the literature. However, due to the fact that both earnings and environmental safety are endogenous variables (they influence one another), the assessment of single equation connections in situations of simultaneity will yield inaccurate and contradictory results. In this paper, researchers develop two-equations simultaneous approach for empirical investigation after first specifying the routes by which Y (income) influences P (pollution) as well as P impacts Y in a theoretical model. They use the Hausman test to check for exogeneity and the TSLS technique to calculate the simultaneity model. NO2/CO and GDP per capita in Taiwan show inverted U-shaped connections. There is an increase in NO2 and CO as income rises, followed by a decline. However, there is little evidence that suggests that air pollution has a substantial impact on household income.

Iwata, Okada, and Samreth (2010) consider the function of nuclear energy for power generation as it relates to estimating the EKC for the case of France. As their estimating strategy, researchers use the autoregressive distributed lag (ARDL) method for cointegration. They also look at Granger causality links between the system's variables and test the robustness of the predicted models. Their estimation results corroborate the EKC hypothesis, and they show that the predicted models are consistent well over sample period. The results of the causality tests corroborate the one-way flow from extra factors to CO2 emissions. That nuclear energy plays a significant role in cutting down on carbon dioxide emissions may be seen in the statistical evidence provided by the one-way causation relationship between the two.

Fotourehchi and Şahinöz (1970) in their study using skewed panel data analysis to examine, for 60 developing nations between 1995 and 2010, the effects of economic growth, demographic, social, as well as other economic forces on environmental degradation, all while assuming that economic growth can be sustained indefinitely. Their findings demonstrate that the EKC for Carbon dioxide emission is U-shaped in an anticlockwise direction, while the EKC for PM10 is U-shaped in a clockwise direction. In light of these findings, it is possible to assert that instead of standardizing environmental and energy initiatives across countries, they should be tailored to each individual

substance and country. In addition to economic growth, the impacts of demographic and social variables should also be taken into account when formulating environmental policy.

Using data from 10 MENA nations from 1980-2009, Farhani and Shahbaz (2014) attempt to delineate the dynamics between renewable and non-renewable electricity usage, output, and CO2 emissions. Panel “Dynamic Ordinary Least Squares (DOLS)” and “Fully Modified Ordinary Least Squares (FMOLS)” results confirm the EKC hypothesis, showing that both renewable and non-renewable electricity usage increase CO2 emissions. However, output (real GDP per capita) shows an inverted U-shaped correlation with CO2 emissions confirming the EKC hypothesis. The short-term dynamics reveal a direct cause-and-effect relationship between the use of renewable and non-renewable energy sources for generating power and the resulting increase in CO2 emissions. The long-term relationship across renewable and non-renewable electricity uses and carbon dioxide emissions appears to be bidirectional. The results raise the possibility that future CO2 emission reductions will slow economic development.

Day and R. Quentin Grafton (2003) investigate the links between real GDP per capita and four indices of environmental deterioration using standard reduced form concepts for Canada. Only carbon monoxide concentrations appear to decrease over time with advances in real income per capita, out of the four indices of environmental deterioration considered. Unit root tests and tests for cointegration between several indicators of environmental breakdown and per capita income are also performed on the data utilized in the reduced form concepts. Logarithmic indices of environmental damage and per capita income show non-stationarity, according to unit root tests. Conventional reduced form parameters are evaluated for Canada to investigate the links between real GDP per capita and four indicators of environmental damage, and the results are consistent with hypotheses generated via the Engle-Granger analysis and the maximum eigenvalue test. Only CO concentrations show to decrease over time with advances in real per capita income, out of the four specified indices of environmental deterioration. Cointegration and the existence of unit roots are also examined for in the data utilized for the reduced form analyses, as are the relationships between the various metrics of environmental damage and income per capita. Using logarithmic metrics of environmental deterioration and per capita income, unit root tests show that these variables are not stationary over time. The maximum eigenvalue analysis and the Engle-Granger test both

indicate that there is no long-term link between per income per capita and the indices of environmental deterioration. The results of the causality tests also show that the relationship between income and the environment is bidirectional, not simply one-way. The findings imply that Canada cannot afford to grow its way from its environmental challenges. This means that Canada needs coordinated incentives and policies to minimize pollution severity per unit of production across sectors, to switch to fewer polluting outputs, and to limit the environmental harm caused by total consumption. Only one of the four selected metrics of environmental deterioration (carbon monoxide) has been shown to ultimately drop with real income per capita using a conventional reduced form analysis of the growth-environmental connection. However, estimations using a conventional reduced form framework with a linear trend component may be inaccurate for parameters including carbon dioxide, carbon monoxide, and total suspended matter, according to a time-series examination of the connections. Further, causality tests contradict the notion that pollution has no effect on GDP per capita. In other words, rather than a unidirectional connection from wealth to the environment, the data suggests a bi-directional causality.

Environmental sustainability and energy efficiency are topics that have been widely discussed recently, and Agozie et al. (2022) research adds new evidence to the conversation by examining the cases of the economies of Russia, China, India, Brazil, and South Africa. This study uses yearly frequency data from 1990 to 2019 to examine the dynamic relationship between FDI, urbanization, natural resources, renewable energy, the Economic Complexity Index (ECI), and CO2 emissions. This analysis makes use of advanced econometric methods, such as the “Augmented Mean Group with Fully Modified-Ordinary Least Squares” estimators. The empirical results for the link between ECI and CO2 emission reveal that it may be represented by an inverted U-shaped or an N-shaped EKC. The empirical data also provide support for the Pollution Haven Hypothesis, where it proposes that increased FDI in the economies of Russia, China, India, Brazil, and South Africa contributes to environmental degradation in those countries. While urbanization and natural resources have favorable effects on the environment, renewable energy and the interplay between the ECI and urbanization have negative effects. Finally, the Dumitrecu and Hurlin causality studies show that ECI and CO2 emission are causally connected in both directions. Over the course of the study

period, researchers find that the ECI, urbanization, and CO2 emissions all have causal relationships with one another, but foreign direct investment has a causal relationship with CO2 emissions only in one direction. The results of this study should serve to persuade policymakers in the nations under study— Russia, China, India, Brazil, and South Africa—to adopt a more comprehensive energy strategy focused on renewable resources. In addition, all of the economies under scrutiny would do well to prioritize economic measures that encourage greener manufacturing practices that don't cost too much or hinder economic growth.

According to Wang, Xia and Xu (2022), now more than ever, experts and policymakers advise that rising and industrialized nations use ecologically friendly energy supplies like renewables in order to aid in environmental recovery. However, economies continue to pay less and less attention to the use of renewable energy. Accordingly, the purpose of this research is to examine the variables that affect the use of renewable energy sources in the seven developing economies from 1990 to 2021. In particular, this research looks at how the production and effectiveness of renewable power (electricity) affects renewable energy use. Variables under control include economic expansion, carbon dioxide emissions, and technological advancement. Results from many panel data methods confirmed the validity of the long term cointegration relationship as well as the existence of variation in slope coefficients and dependency across cross-sections. This research employs a unique approach using moments quantile regression to account for the asymmetry in the data distribution. The predicted results posited that the primary drivers of renewable energy consumption are the output of renewable energy sources, economic growth, carbon dioxide emissions, and energy efficiency. But advances in technology have drastically cut down on the demand for renewable energy. Bootstrap quantile regression verifies the results' reliability, and the panel Granger test of causality verifies the bidirectional causal link between renewable energy use and the aforementioned factors. Increased funding for renewable energy production, the energy efficiency industry, and ecologically relevant technology innovation is also recommended in this report in an effort to boost renewable energy usage.

Wang et al. (2022) note that until recently, assessments of the effects of sustainable energy and CO2 in European nations have neglected to take into account the implications of geographic dynamics between the two. Also, instead of breaking down

renewable energy into its individual parts, most research incorrectly employ its aggregated form. Since not all sources of renewable energy are the same, this is crucial information to have. To address these knowledge gaps, Wang et al. (2022) analyze the impact of different types of renewable energies on CO2 emissions across 36 European nations between 2000 and 2018. Using spatial econometric models, they can better comprehend the findings. The Durbin panel paradigm and the incorporation of connectivity of CO2 emissions are validated by a battery of illustrative experiments. Accordingly, the EKC theory is supported by research data. They find that GDP per capita growth, urbanization, FDI, and energy intensity all have a positive and statistically significant impact on CO2 emissions. Their research shows that increasing the use of conventional RE technologies like geothermal and hydropower helps to reduce carbon dioxide emissions. But expanding RE sources with cutting-edge technologies like wind, solar, and bioenergy either raises CO2 emissions or has no effect at all. CO2 emissions are reduced across the board when RE generation increases in the nations studied. Further, our geographical models indicate that FDI reduces local CO2 emissions whereas energy efficiency and openness to trade in surrounding nations raise local CO2 emissions. Finally, they find that the development of solar and bioenergy in neighboring countries raises local CO2 emissions, whereas the creation of geothermal energy in neighboring countries somewhat reduces local CO2 emissions.

Fang, Yang and Tian (2023) investigate how environmental taxes affect people's use of renewable energy. For this purpose, the researcher use data from 1998-2019 to construct a panel ARDL model for 15 representative nations along the Belt and Road. Environmental taxes have a negative effect on the use of renewable energy sources in these nations in the near term, as estimated by the pooled mean of group estimates. In the long term, a 1% rise in environmental tax will result in a 1.201% increase in renewable energy usage. A causality test using a Dumitrescu-Hurlin panel demonstrates that there is a two-way relationship between environmental taxes and the use of renewable energy sources. According to the standard canonical cointegration regression method, a 1% spike in environmental tax results in a 0.021% rise in the proportion of renewable energy use in final energy use. Using completely MOLS and DOLS, they examine the durability of the long-term connection. Tests for linearity show that the effect of environmental taxes

on the use of renewable energy sources is nonlinear. The potential benefits of environmental taxation to enhance environmental quality are outlined.

Dar and Asif (2023) compare the environmental effects of using renewable and nonrenewable energy sources in India using empirical data. This research looks into how rapid rise of national income and the growth of the financial sector have affected environmental quality and the viability of the "Pollution Haven Hypothesis" in India. To look into whether the variables are cointegrating, a cointegration test based on several structural breakdowns is used. To verify cointegration, a modified ARDL Bounds test is carried out. Empirical tests validated the occurrence of cointegration, revealing three distinct structural fractures. Long-term findings showed that using renewable energy does not reduce carbon footprint; but, switching from traditional to renewable energy sources might benefit the environment by reducing the harmful effects of fossil fuels. India must thus contend with the dual challenges of maximizing national production growth while also mitigating the increasing risks posed by climate change and global warming. The researchers propose that authorities adopt the appropriate measures to increase clean energy exports, including reducing subsidies for fossil fuels and offering financial and fiscal incentives for implementing renewable energy projects.

Moreover, Arrow et al. (1995) investigate the relationship between growth in GDP and environmental policy. To sum up, they find that environmental regulation is essential, and that trade liberalization as well as other policies that boost GDP development are not adequate alternatives for environmental policy. However, it's possible that stronger policy reforms should accompany them. The need for changes that would enhance the signals perceived by those who consume resources is particularly pressing. Loss of ecological systems, among other environmental problems, frequently occurs abruptly. There is usually no way to undo them. However, decision-makers in the modern world rarely have access to the kind of signal-gathering tools that would allow them to predict sudden shifts. Even when they are noticed, misinterpreted, or absent from the incentive system of societies, the signals that are present are often overlooked. This is attributed to institutional barriers, such a scarcity of properly defined property rights, and an insufficient understanding about the dynamic consequences of changes in ecological variables such as buffering capacity. Monitoring ecosystem dynamics and using reliable indicators of

change are crucial to the creation of suitable institutions. Above all, people must behave in a cautious manner to preserve the variety and adaptability of ecosystems, as there are basic uncertainties regarding the dynamic nature of the ecosystem and would face significant repercussions if guessed wrong. The expansion of the economy will not improve environmental quality on its own, and it is not even the primary problem. The resources (including natural resources) and outcomes (including waste products) matter more than the rate of growth itself (what is produced). The economic structures that humans operate under shape the nature of this material. The robustness of natural systems requires that these institutions be constructed with appropriate incentives in mind. Not only will these reforms ensure a sustainable economic activity level within the natural life-support system, but they will also encourage improved efficiency in the distribution of natural resources across income levels. Poor countries are just as invested as affluent ones in protecting natural systems' ability to maintain well-being.

Akbostanci, Turut, and Tunç (2009) look into the correlation between income and ecological sustainability in Turkey on two different scales. Using a time series model and cointegration methods, they first investigate the link between carbon dioxide emission and per capita income. In the second part, PM_{10} and SO_2 data in Turkish regions are used to examine the correlation between earnings and air pollution. Here, they employ panel data estimate strategies. Both the time series and panel data models use data from 58 provinces and span the years 1968–2003. Time series research reveals a long-term positive correlation between CO_2 and GDP that increases at a constant rate. However, an N-shaped link between PM_{10} and SO_2 emissions is revealed by panel data analysis. Thus, the Environmental Kuznets Curve hypothesis, which implies a U-shaped association between environmental deterioration and income, is not supported by the findings of their time series and panel data analyses.

Renewable energy technologies are viewed as sustainable since their optimal usage reduces negative effects on the environment, generates few by-products, and can meet both the present and the long-term demands of society economically and socially (Panwar, Kaushik and Kothari, 2015). All energy originates from the sun. Light and heat are the two basic types of solar energy. There is a plethora of methods in which heat and sunlight are absorbed and altered by the environment. Some of these changes lead to the circulation of renewable energy sources like biomass and wind power. Greenhouse

gas emission reduction and global warming may both be greatly aided by the substitution of renewable energy technology for traditional energy sources. Panwar, Kaushik and Kothari (2015) take a look at the water heater, solar stove, improved cookstoves, biofuel, dryer, and hydrogen as a means of reducing carbon dioxide emissions. Hydrogen is often regarded as the fuel of the future, with the potential to completely substitute fossil fuels. Hydrogen is being looked at more and more as a promising future energy. It is easy and clean to transform it into heat or power. Hydrogen, when combined with oxygen, produces solely water as a by-product of combustion. Hydrogen is the most abundant chemical element on Earth, yet it is never found in its pure elemental form in the wild. It must be extracted from its aforementioned chemical brethren, either by electrolysis from water or through chemical procedures from hydrocarbons and hydrogen carriers. Clean renewable sources like solar radiation, the kinetic energy of water and wind, or geothermal heat might one day supply the power needed for the electrolysis process. Hydrogen might, therefore, play a pivotal role in connecting renewable physical energy with chemical energy carriers.

Linh and Lin (2015) in their research look at the 12 most populous Asian nations to determine the dynamic causal linkages between degradation of the environment, economic development, FDI, and energy consumption. This panel data demonstrates that CO2 emissions start falling at a per capita income level of 8.9341 (in logarithms), in accordance with the EKC. Using a Granger causality test, they discover that the GDP growth, FDI, energy consumption, and CO2 emissions of the 12 most populous Asian nations are all linked to Japan's national wealth. Their projected results, however, indicate that these nations have been trading environmental destruction for the promotion of economic activity. These findings also add legitimacy to the pollution haven theory, which proposes that FDI inflows have been drawn to the host nations because of their lax environmental restrictions. But the panel sample of 12 Asian nations shows that FDI inflows have not worsened environmental deterioration.

In conclusion, since carbon emissions have risen dramatically over the past few decades, many researchers look at the causes of this trend in the energy-efficiency-environment domain. Dogan and Seker (2016) acknowledge that the use of panel estimating methodologies is a key critique of the prior research. Even though the nations in the panel are likely to be varied and cross-sectionally dependent, almost all research

utilize panel methods that overlook the problem. Furthermore, most current studies only look at total energy usage, which makes it impossible to isolate the effects of different types of energy consumption. Dogan and Seker (2016) empirical study analyses the effect of income growth, renewable energy usage, non-renewable energy usage, financial development, and trade openness on CO2 emissions in order to fill the aforementioned gaps in the literature. Using cross-sectional dependency and heterogeneous panel estimate methods, this study applies the EKC model to the top nations in the "Renewable Energy Country Attractiveness Index." Again, using CADF and CIPS unit root tests, as well as the bootstrap LM cointegration test, they find that the analysed parameters become static at their first differences and that they are cointegrated. The EKC hypothesis is validated for the leading renewable energy nations, and they show that growth in renewable energy usage, financial development, and trade openness all reduce carbon emissions while increment in non-renewable energy usage add to the level of emissions.

Chien et al. (2023) highlight the escalating concern of climate change as a global issue, emphasizing the pivotal role of sustainable energy technologies in addressing it, thus warranting increased attention from researchers. Their study focuses on assessing the impact of sustainable energy technologies, particularly renewable electricity output, on mitigating climate change, specifically carbon dioxide (CO2) emissions, within E7 countries. The study also examines the relationship between various factors—such as renewable energy (RE) consumption, overall energy use, urbanization, energy imports, and industrialization—and CO2 emissions in these E7 countries. Utilizing secondary data sourced from World Development Indicators (WDI) spanning from 2001 to 2020, the study employs the Method of Moments Quantile Regression (MMQR) to analyze the interconnections among these variables. The findings suggest a negative association between renewable electricity output and RE consumption with CO2 emissions in E7 countries. Conversely, factors like energy usage, industrialization, energy imports, and urbanization exhibit a positive correlation with CO2 emissions in these nations. The research underscores the importance of informing policymakers about the significance of sustainable energy technologies in combating climate change. By identifying these associations, policymakers can develop informed policies geared towards promoting the adoption of sustainable energy technologies as a means to curb CO2 emissions within E7 countries.

Theoretical/Conceptual Framework

The Energy Consumption Theory

Vosooghzadeh (2020) defined Energy Cost Theory which is often referred to us as Energy Consumption Theory states that cost of utilizing energy resources in operations, services and production is compensated by the long-term positive economic effect of the said engagements. These engagements or businesses could utilize the income that is generated in performing research and development (R&D) in order to ensure there is investment in combined energy-resource technologies. This will enable them to reduce hazardous emissions to the environment as well as lowering the costing of energy production. These positive economic effects are brought about by incremental innovations in those businesses and result in total improvement of the economy because of the demand which is arbitrarily induced causing a multiplier-effect on the monetary transactions. Additionally, the stated demand that is induced improves monetary transactions, therefore, boosting the economy and improving the standards of living of the population. The original decision to boost consumption of energy is part of business introductory innovations, whilst the dynamic impact which can reduce the cost of consumption of energy in the forestated businesses forms part of business far-reaching innovations.

The energy consumption theory extends the works of the current grand theories that uphold the economic effect of efficiencies in energy. In this theory, the regulatory framework of the environment on unhealthy emissions and greenhouse gases is similar to other theories, only that elements of energy efficiencies that are not linked to the environment are marginally relaxed in the introductory levels of energy consumption so that services and production are able to thrive in the operations. On the other hand, at maturity levels, the businesses enhance the non-environmental elements of energy efficiencies. This theory does not allow a business to bend the regulatory framework in which it operates.

He further went ahead to explain the importance of Air Transport as a vital element in the application and utilization of Energy Consumption Theory. There is increasing demand of air transport which is much safer and faster and therefore more flights and routes can be scheduled in different countries. Airplanes can carry less passengers for them to have more room per passenger and utilize the extra room to have Supersonic

Equipment and Fuel Emission Converting Units. Moreover, when air transport facilities are enhanced, more people will be willing to utilize air transport in terms of airplanes and other aerial devices, this will boost the tourism industry in all parts of the world and consequently have an exponential impact on the expansion of global economies. This theory does not force the utilization of any definite energy resources by a business. It in fact, encourages utilization of mixed-energy technology which in turn reduces the costing of energy consumption, to adhere to environmental regulatory frameworks, and diversification of revenues in business by adopting energy-converting-units.

Integrating electricity consumption into the Energy Consumption Theory involves considering a range of factors. Firstly, understanding the demand factors is crucial; this entails analyzing when and how electricity is used, which can vary daily, seasonally, and even hourly. These patterns are influenced by factors such as weather, economic activity, and cultural practices. Additionally, technological factors play a significant role, as the efficiency of devices and appliances impacts electricity usage. For example, newer, energy-efficient appliances consume less electricity compared to older models. The rise of smart devices also affects electricity demand and must be taken into account. Moreover, infrastructure and distribution are key considerations. The efficiency of electricity generation, transmission, and distribution infrastructure affects energy consumption, with transmission losses being a notable factor. Accessibility and availability of electricity also influence consumption patterns. Furthermore, incorporating renewable energy consumption into the theory is essential. This acknowledges the increasing importance of renewable sources like solar, wind, hydroelectric, and biomass. Government policies and incentives play a vital role in promoting renewable energy consumption, with targets, tariffs, and standards driving investment in renewable projects. The theory recognizes the environmental benefits of renewable energy, including reduced greenhouse gas emissions and improved air quality, emphasizing the importance of sustainability. It also examines how renewable energy interacts with other sources within the system and the role of complementary technologies like energy storage in enhancing integration. Petroleum energy consumption is another significant aspect considered in the Energy Consumption Theory. Petroleum, including crude oil and its derivatives, is a primary energy source for transportation, industry, and heating. Consumption patterns are influenced by economic factors such as oil prices and income levels, with fluctuations

in prices affecting consumption behavior. Energy security concerns related to petroleum dependency and strategies for diversification are also examined within the theory, considering geopolitical events and supply disruptions.

Foreign direct investment (FDI) plays a crucial role in the energy consumption theory, impacting various facets of the energy sector. FDI brings in advanced technologies and managerial practices, potentially enhancing production methods, introducing cleaner technologies, and improving energy management practices. These effects contribute to the overall efficiency of energy use within an economy, a key consideration in the energy consumption theory. Moreover, FDI influences energy consumption through its effects on economic growth and consumer behavior. Increased FDI can stimulate economic activity, leading to heightened consumption and production levels, thus driving up energy demand. Conversely, FDI can induce structural changes in the economy that decrease energy intensity or encourage energy-efficient practices, offering a balancing effect on energy consumption patterns. Additionally, FDI is intertwined with a country's energy policies and regulatory landscape. The regulatory environment can influence FDI decisions, while FDI inflows may shape energy policy choices. Energy consumption theories delve into these interactions, examining how FDI aligns with energy policy frameworks. This analysis encompasses incentives for renewable energy investment, carbon pricing mechanisms, and regulations aimed at enhancing energy efficiency. Understanding these dynamics aids policymakers in devising more impactful strategies for managing energy consumption and attracting sustainable FDI.

Kuznets Curve

Simon Kuznets expanded on the theory to support the Arthur Lewis’s theory which is known as the Kuznets’s curve. Studies confirmed that there are economic variances in the early growth stages. At the start, when workforce begins to discontinue agricultural activities to work in industries, the greatest difference is felt. But as production factors cluster in the industrial places, the differences are seen to disappear. In addition, Kuznets notes that there is a relationship which is positive between the expansion of urban population (to the total population) and the growth in the economy. Kuznets worked on income distribution and economic growth, leading him to hypothesize that developing countries experience an increment followed by a fall in the economic inequalities which

is described with an inverted U-shaped curve. His thought process is that there would be an increase in economic inequality due to migration of rural labor to urban areas, making wages go down as the workers compete for limited jobs. Notwithstanding, since Kuznets developed this theory in the 1970s, since then income inequalities have gone up in developing advanced economies while inequalities have dropped in fast-developing East Asian economies like Kenya.

Growth Hypothesis

This hypothesis posits that the consumption of energy leads to growth in the economy both an indirect and/or direct manner. The growth in the economy would be measured by the capital element used to produce goods and services as well as labor. This hypothesis is corroborated when the tests show a unidirectional link from energy consumption to GDP. Apergis and James (2010) confirmed this proposition by examining the linkage between energy consumption and economic growth for a period from 1980 to 2005 for 9 countries in South America. The finding revealed that there exists a long-run equilibrium link connecting the gross fixed capital formation, consumption of energy, real GDP and labor force. In both the long and short run there is a relationship between energy consumption and economic growth supporting the hypothesis.

Neutrality Hypothesis

This hypothesis proposes that the consumption of energy is a relative tiny element in determining real GDP therefore the energy-conservation actions that tend to minimize the consumption of energy consumption wouldn’t adversely affect GDP. This proposition is confirmed when there is no link between GDP and energy consumption. Research supporting this proposition is done by Ozcana and Ozturk (2019) who explore the linkage between growth in the economy and the consumption of renewable energy consumption for seventeen emerging economies from 1900 to 2016. They opine that the neutrality proposition is upheld for all the countries with the exception of Poland.

Feedback Hypothesis

The feedback proposition indicates that the consumption of energy and the growth in the economy are connected. This hypothesis is upheld when the results show a bidirectional causality between the consumption of energy and the growth in the economy. A study done on the G20 economies from 1990 to 2016 by Pala (2020). He used the variables; labor force in millions, annual growth in the gross domestic product, energy usage in kilograms and the capital formation which is a percentage of the gross domestic product and conclude that there is a linkage which is bidirectional relationship from GDP to energy consumption. Hence validating the feedback hypothesis. Additionally, Temiz and Ece (2019) who conducted studies in Turkey using the Vector Error correction model found out that there is causality between renewable energy and economic growth points to a bidirectional relationship both in the short and in long runs hence endorsing the feedback hypothesis.

Conservation Hypothesis

The hypothesis infers that energy conservancy approaches which curtail greenhouse discharges, lessen the wastes from energy usage and boost efficiencies in the energy sector that won't have an adverse effect on the real GDP. This proposition is reinforced by unidirectional causality from real GDP to energy consumption. Several studies have advanced this hypothesis including Lee and Chiu (2011) look into the linkages between the consumption of nuclear energy and the growth in the economy for a few industrialized economies employing the Toda–Yamamoto tests, upheld the conservation proposition for Japan. Sweden and Canada supported the conservation hypotheses from the studies of Wolde-Rufael and Menyah (2010) who tested the linkage between consumption of nuclear energy and the growth in the economy for 9 developed countries. Yoo and Ku (2005) proved that the conservation proposition applies for two countries - Pakistan and France.

Summary

The hypothesis of this study is based on the feedback hypothesis which postulates that energy consumption and economic growth have a bidirectional linkage and are connected from either side. All the Kenyan studies in this paper (Esso, (2010), Jacques, (2010) and Gachunga (2010) conclude that FDI causes economic growth and economic growth causes FDI in Kenya. The energy consumption theory states encourage the utilization of mixed technologies to ensure that most energy efficient modes are used in businesses which will in turn grow the economy. Kuznet's curve is also be tested since FDIs encourage industrialization and encourage rural-urban migration as people shift to urban centers to look for employment opportunities in the industries.

Chapter 3: Research Methods and Data Collection

Introduction

This chapter restates the research problem and purpose. It also explains the research approach and design and the data collection tools, it gives the population and the sample that is used in the research study. The chapter goes ahead to broaden on the data collection process, how data is imported into the data analyzing software and how the data is analyzed.

Mixed findings have resulted in these research studies from various researchers who conclude varying results. Researchers Awodumia and Adewuyi (2017) analyze 136 journals which studied how consumption of energy relates to consumption of energy in 3 decades. Almost half of them authenticated the existence of a feedback effect; almost a third of the studies showed that there is growth hypothesis; a quarter of the studies approved the conservation hypothesis and only a tenth backed the neutrality hypothesis. Limited research has been done which delve into how foreign direct investments impact the relationship between the consumption of energy and the economic growth of a country. This especially in the African context. A few studies have been done for South African and west African countries. A wholesome study has not been conducted for the East Africa region and more specifically Kenya. This research introduces the moderating variable being the foreign direct investment and how it impacts the relationship between energy consumption and GDP in a developing economy like Kenya.

Research Approach and Design

According to Creswell (2005), researchers utilize either quantitative or qualitative or quantitative research methodologies. Qualitative methodologies rely on the perspectives of study participants to establish the themes. Quantitative methodologies are focused on correlation relationships, descriptive and scientific analyses. The general problem of this research is how FDI impacts the relationship between energy consumption and the gross domestic product in Kenya. The research investigated how injecting foreign direct investments impacts on how different forms of energy consumption affects the economic growth in Kenya. In accordance with Creswell (2005) quantitative methodologies use numeric measures to give an expansive prediction or explanation amongst various variables. Creswell, 2005 observe that quantitative methods target to

explain information while qualitative methods seek to explore information. Therefore, quantitative methods are more applicable than qualitative methods.

As per Creswell (2005) quantitative research designs are divided into three-correlation, survey and experimental. The research questions for the topic under study are focusing on how the various variables relate to each other. The experimental research design is not suitable as it aims to show if doing a certain activity, has an impact in the results. Creswell, 2005 opine that the experimental research design is appropriate for that research which aims to find out whether putting an intervention impacts the results of a group. The survey research shows trends by applying survey questions to a few individuals/participants. This study does not make use of primary data but used secondary data. The correlation research design investigates the inter-relationships amongst variables.

The role of Foreign Direct Investment (FDI) on the relationship between energy consumption and Gross Domestic Product (GDP) in Kenya, delve into these variables to assess if they have a relationship which can predict each other. To answer the research questions in this study then a correlation design is most suitable to explain these relationships (Creswell, 2005). This research utilized explanatory, non-experimental quantitative correlation design. The methodology preferred analyses how foreign direct investments have a statistical relationship between energy consumption and GDP in Kenya so as to demonstrate associations and patterns amongst the variables. Creswell, (2005) state that “in correlation research designs, investigators use the correlation statistical test to describe and measure the degree of association between two or more variables”.

This research employed pre-existing data over the last 20 years to determine whether there is a relationship between the dependent variable and the independent variables. Kahia, Jebli and Belloumi, 2019 investigate the effect of renewable consumption of energy, growth in the economy and FDI inflows & trade on carbon emissions for twelve MENA (Middle East and North Africa) economies for twenty-two years. They used quantitative research design (specifically the panel VAM) and secondary data obtained from the World Bank online database and the United States Energy Information Administration. A causality design methodology gives the scholar an opportunity to explore how independent variables impact the dependent variable. Leedy

and Ormrod (2001) witnessed how it is important for a scholar to take into account the extent of correlations amongst different characteristics depending on how accurately these characteristics are computed.

Population and Sample of the Research Study

The population chosen for this study is the country, Kenya. The study utilized a desktop approach review since data is secondary statistical data from different organizations which are publicly available. Data comprised of gross domestic product (GDP) and foreign direct investments, from the Kenya National Bureau of statistics (KNBS) and energy consumption data from EPRA (Energy and Petroleum Regulatory Authority) website. The Population Kenya is appropriate as the study is about energy and foreign direct investment which are public commodities and affect all the citizens in the country. The population responded adequately to the study problem in looking at how these variables affect each other. The period of study is from the year 2002 to the year 2021. Hertzog (2008) in her study of determining a sample size for various pilot research observes that, the standard error of a proportion differs from that of a mean, as it relies on the proportion itself, peaking when the proportion reaches .50. This means that more extreme values are estimated with greater accuracy given a specific sample size. Table 1 demonstrates confidence intervals for various sample sizes, considering two proportion values: .15, typical for estimating attrition, and .30, a plausible figure for survey non-response. For instance, if a pilot study with 20 participants shows a 15% attrition rate, we can be 68% confident that our estimate is within 8 percentage points of accuracy. Doubling the sample size to 40 decreases the estimation error to 6 percentage points, while doubling it again to 80 results in a slightly smaller reduction to 5 points. Whether adding more participants to achieve this precision is warranted depends on the impact of inaccuracies. For instance, precise estimation of dropout rates may be crucial as attrition influences recruitment plans for larger studies. It's essential for the final sample size to be adequately powered, but using resources wisely means not exceeding what is necessary.

The research used judgmental sampling. Judgmental sampling technique is chosen since it uses the judgement from the researcher. This information is available on the websites which have audited numbers. According to Sukamolson (2007) reiterated that sampling tests the attributes of a population with statistical accuracy. Since this is a quantitative study, then power analysis is used to determine the sample size which is based on the size effect, level of power needed and the statistical significance. In the determination of the minimum sample size, consideration is placed on the representativeness to the population, assumptions put forth with the test statistics and the sampling error. Reddy and Kannamani (2016) explain that judgmental sampling is one of the non-probability techniques of sampling where the person conducting a study, trusts in his own discernment in determining the sample to be applied.

Data Collection Method

Data is obtained from secondary sources with information on gross domestic product, amounts of foreign direct investment and consumption of energy. The websites to retrieve the data are – Kenya National bureau of statistics (KNBS), Energy and Petroleum Regulatory Authority (EPRA) and Rural Electrification and Renewable Energy Corporation (REREC).

Data Collection Tool

The data collection tool to be used is the desktop review of secondary data. For causal research methodology, the scholar considers how the independent variable of a study, is impacted by a dependent variable in a study. It reviews the cause-effect interlinkages amongst variables.

Data Validity

Reliability and validity are vital in affecting the correlation coefficients. Bold (2001) opines that correlation methodology purposely establishes the relationship amongst variables. Creswell (2002) explained the correlation methodology as statistical testing which establishes patterns amongst variables. Cooper and Schindler (2001) showed that the statistical evaluation of a research question may be administered using a sequential or progressive analyses using a standardized test of correlation which gives a value, “r.”

For a study, the internal and external validity show how important assumptions are arrived at about data in a population. Belli (2009) emphasized that for data to be valid then it has to measure what it is intended to and represents all the quality measures. The independent variables of petroleum energy consumption, electricity energy consumption, renewable energy consumption including solar, hydro, wind, geothermal, biomass and the dependent variable of gross domestic product (GDP), as well as the moderating variable of foreign direct investment to give the desired information. This data is retrieved from financial reports which are audited by third-party external auditors authenticating their credibility. The reliability of the data is based on the assumption that the external auditors have carried out the appropriate checks and inspections to proof the compliance of data.

This research is non-experimental and utilized publicly available data, therefore other forms of internal validity threats are not applicable. Maturity, mortality, history, selection of study persons and impact of communications does not affect this research. Onwuegbuzie (2000) state that the instruments utilized for a study cannot be excluded as a source of threat since the findings would never provide scores that are perfect. Creswell (2003) observes that the instrument used to measure a study may sometimes be changed during the research and hence cause a validity threat. Onwuegbuzie (2000) also notes that a validity threat emerges when analysis of data is done, during the review of change scores, and when various classes are equated statistically.

To curb this then standardization of the processes can be done. This study utilized annual financial reports both locally from the local regulatory bodies and internationally from the World Bank reports. Population validity refers to how much the results of a certain study can be applied to the larger population. An increase in the sample size increases the population validity. Onwegbuzie (2000) further explained the ecological validity refers to how much the findings can be generalized beyond the population target, since the target population for this study is the country, Kenya then will these results be applicable to other East African countries and to the whole of Africa as a whole? The particularity of variables may cause a threat on external validity. This is because every variable is particular to a certain time, place, category, meaning and instrumentation.

Table 3. 1

Operational Definition of Variables

Variable	**Initials in the study**	**Definition**	**Measurement**	**Reference**
Foreign Direct Investments	FDI	It is the process where inhabitants of a source country get the ownership of assets of a host country in order to control the producing of distribution of and other activities of a company.	Kenya shillings (Kshs.) in Billions	Moosa (2002)
Gross Domestic Product	GDP	It is a measure of output and nationwide income for an economy at a particular period in time.	Kenya shillings (Kshs.) in Billions	OECD (2009)
Petroleum Energy Consumption	PEC	Usage of Crude oil and other liquids produced from fossil fuels are refined into petroleum products that people use for many different purposes.	Thousand Tonnes	US Energy Information Administration (2020)
Electricity Energy Consumption	EEC	It is the form of energy consumption that uses electric energy.	Kilowatt hours	Stoffel (2015)
Renewable Energy Consumption	REC	These are energy sources which restore themselves in a natural way without being diminished by earth. They include They comprise of geothermal energy, solar energy, wind energy, bioenergy, ocean (tide and wave) energy and hydropower.	Megawatts	Asantewaa and Asumadu (2016)

Proposed Software Analysis Technique

The data analysis software used is Statistical Software for Data Science (STATA) which is an interactive program that can be used for both simple and complex analyses. STATA is able to generate graphs, and charts and plot data and results. STATA provides different capabilities that are useful to this study such as visualization, exploration, manipulation, reporting, statistics and reproducibility of data. According to Burns and Grove (2005), descriptive analysis describes the basic characteristics of the data collected in the research.

Descriptive Analysis

Data is screened as a top-level examination of the ranges. This analysis of data and use of graphs enables detect outliers or any data that has not been recorded correctly and there are none noted, they are all within the range. The data in this research is also enormous and therefore requires normalization to be analysed with STATA. Having outliers that are not consistent with the rest of the data may cause significant distortions in the findings and hence indicate incorrect relationships. Steinberg et. al (2013) describes descriptive analysis as a means for describing or summarizing the data which has been obtained from the field and providing an overview of the results. This is the preliminary analysis which provides the mean, mode, median, and standard deviation of the data. Graphs are plotted for a better visual representation. Additional descriptive analyses include the maximum value, minimum value, skewness, and kurtosis of the variables. The mean, median, and mode are the measures of central tendency. The output of the mean would indicate the average value of the amounts, the output of the median analysis would show the distribution of the data while the mode indicates which amount appears multiple times. Visually, the minimum value, maximum value, skewness, and kurtosis showed the distribution with how the data is either light-tailed or heavy-tailed in comparison to a normal distribution. Due to the size of the variables being very huge such as measured in billions for the GDP and FDI, then transformation of the variables is done to normalize the data.

Descriptive analytics help to determine whether the range of the data in the variables to fit into one scale. They also check for any outliers so as to know data that is not consistent with the rest of the data may cause significant distortions in the findings and hence indicate incorrect relationships.

Correlation Analysis

Thatte and Gogtay (2017) opine that correlation analysis introduces the concept of finding relations and associations between two or more variables. They explore different possibilities in the relationships between variables and comprehended the metrics of odds ratio, relative risk, and absolute risk. Trend plots are plotted for each variable for the visual representation of the variables over the period under investigation. The correlation matrix is run to find out the strength of the relationship between the variables to each other, in the study. An analysis that gives a value greater than zero indicates that the variables have a positive relationship. An analysis that gives a value of less than zero indicates that the variables have a negative relationship. And an analysis of zero shows that the variables have no relationship between them.

Correlation analysis aids in finding out the relationships between variables, determining the strength of the relationship between the variables to each other and checking for Multicollinearity which causes severe problems in data analysis and must be remediated before data modeling.

As per Wooldridge (2009), the formula for correlation is.

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}}$$

Xi and Yi represent individual observations of variables $X$and Yrespectively.

$\bar{X}$ and $\bar{Y}$ represent the means (averages) of variables X and Y respectively.

The numerator calculates the sum of the products of the deviations of each observation from their respective means.

The denominator calculates the square root of the product of the sum of squared deviations for each variable.

Stationarity Tests

Stationarity is then assessed. In all stationarity tests, the null hypothesis (H_o) is non-stationarity while the alternative hypothesis (H_a) is for stationarity. Time series data is assumed to be non-stationary and therefore to keep off spurious regression, variables in the model are tested for stationarity by carrying out unit root tests. For visual representation, correlograms and trend plots are plotted for each variable to check for stationarity. Dickey and Fuller (1979) were the pioneers of this work for testing for unit root in time series. Philips and Perron (1986) started the well-known P-P test for stationarity which is a very detailed theory of unit root non-stationarity. The data is tested and found to be non-stationary; it is therefore differenced to several orders until it becomes stationary. The tests are analyzed at various critical values.

Stationarity tests help to avoid spurious regression since time series data is presumed to be non-stationary (Spurious regression is a statistical model that shows misleading statistical evidence of a linear relationship).

According to Wooldridge (2009), the formula for Stationarity is.

Augmented Dickey Fuller Test (ADF) Test:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \ldots + \delta_p \Delta y_{t-p} + \varepsilon_t$$

Where.

y_t is the time series variable being tested for stationarity.

Δy_t represents the differenced series (first difference of y_t).

t is a time trend variable.

α is a constant term.

γ measures the coefficient of the lagged value of y_t (autoregressive coefficient).

δ_1, δ_2..... are coefficients for the lagged differences in the series.

ε_t is the error term.

Lag Length Selection

Caspi, 2013 observes that the most suitable lag length is selected using Schwartz Information Criterion (SIC) when estimating the equations in the full sample at a given number of lags. The length of the lags is chosen by utilizing the information criteria methods; FPE (First prediction error), AIC (Akaike information criterion), HQIC

(Hannan-Quinn information criterion) and SBIC (Schwarz Bayesian information criterion). After the lag-length selection command is run on STATA, the lag length which has the most asterisks on the different information criterion is selected. The lag selected is thereafter assessed to pass the parsimonious characteristic meaning it must be properly specified, well specified and accurately identified. There must be no correlation between the lags, they should have the least number of parameters and best describes the data set.

The lag length selection of a series must be correctly specified, to avoid the problem of misspecification errors. As per Jeffery Wooldridge's “Introductory Econometrics: A Modern Approach” (2009) with annual data, the number of lags is typically small, 1,2, or 3 lags in order not to lose degrees of freedom.

According to Wooldridge (2009), the formula for lag length selection is.

The formula for the Akaike Information Criterion (AIC) is.

$$\mathrm{AIC} = 2k - 2\ln(\hat{L})$$

Where.

K is the number of estimated parameters in the model.

L^is the maximized value of the likelihood function for the estimated model.

The formula for the Schwarz Information Criterion (SIC) and the Bayesian Information Criterion (BIC), is.

$$\mathrm{SIC} = \ln(T)k - 2\ln(\hat{L})$$

Where,

T is the number of observations in the sample.

$K\ and\ L$^ have the same definitions as in the AIC formula.

The formula for Hannan-Quinn Information Criterion (HQIC) is.

$$\mathrm{HQIC} = 2k\ln(\ln(T)) - 2\ln(\hat{L})$$

Where $K\ and\ L$^ have the same meaning as in the AIC formula.

Co-integration Test

Co-integration tests are done as per Engle and Granger, 1987. We say that time series are co-integrated if they move together in the same direction towards a long-term equilibrium. Nielsen (2005) stated that co-integration requires the time series to be non-stationary and linking such series assists in removing such non-stationarity in multivariate time series without having to difference. Johansen's test is utilized for testing for cointegration between the variables. The variables in this research are examined to assess if they move in the same direction i.e., the Foreign Direct Investment (FDI), the different forms of consumption of energy, and the Gross Domestic Product.

The significance of the cointegration test is to test if the time series are co-integrated i.e., if they move together in a similar direction towards a long-term equilibrium. According to Wooldridge (2009), the formula for cointegration using the Johansen test is.

$$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t$$

Where.

β_0 and β_1 are the parameters to be estimated.

ε_t is the error term

Model fitting

Sreedharan (2004) who conducted a Vector Error Correction Model (VECM) of Stock market Returns adopted the model because it is a representation of the cointegrating vectors at a lag of 1. The correct Model will be specified which will either be the vector autoregressive (VAR) or the Vector Error Correction (VEC) Model. The VECM is appropriate if there is co-integration and can interpret long-term and short-term equations. If the VEC model is chosen, then there is need to determine the

number of co-integrating linkages. The advantage of VECM over VAR is that the resulting model representation has more efficient coefficient estimates.

The importance of model fitting is to fit the model from the variables and give the results. The model shows short-term relationships of variables and enables to prediction of the future in the short-term relationships. According to Wooldridge (2009), the formula for model fitting is.

vector autoregressive (VAR).

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + \varepsilon_t$$

Where

Y_t is a k×1 vector of endogenous variables at time t.

C is a k×1 vector of constants.

A_1, A_2.....A_p are coefficient matrices of size k×k, representing the lagged effects of the variables.

εt is a k×1 vector of error terms, assumed to be independently and identically distributed (i.i.d.) with mean zero and covariance matrix Σ.

Vector Error Correction (VEC) Model.

$$\Delta Y_t = \Pi_0 + \Pi_1 Y_{t-1} + \Pi_2 \Delta Y_{t-1} + \ldots + \Pi_p \Delta Y_{t-p} + \varepsilon_t$$

Y_t is a k×1 vector of endogenous variables at time t.

ΔY_t is the first difference of Yt representing the change in the endogenous variables from time $t-1$to time t.

Π_0, Π_2 .....Π_p are coefficient matrices of size k×k capturing the short-run dynamics.

εt is a k×1 vector of error terms, assumed to be independently and identically distributed (i.i.d.) with mean zero and covariance matrix Σ.

The general form of the equation is.

$$\Delta Y_t = \Pi_0 + \Pi_1 Y_{t-1} + \Pi_2 \Delta Y_{t-1} + \ldots + \Pi_p \Delta Y_{t-p} + \Gamma(Y_{t-1} - \beta_1 - \beta_2 Y_{t-2} - \ldots - \beta_p Y_{t-p}) + \varepsilon_t$$

Post-estimation Tests

After fitting either the VAR or VEC model post-estimation tests are performed to check if the residuals are white noise processes, and the residuals are assessed to see if they are normally distributed. Impulse response functions (IRFs) and Forecast Error Variance Decomposition (FEVDs) are estimated using a given forecast horizon and orthogonalized impulse-response function graphs are plotted. Finally, the model is tested for stability. Post-estimation tests are important as they check the mode for stability, the Impulse response functions (IRFs) show how shocks in one variable affect the other variables in the long run. Forecast Error Variance Decomposition (FEVDs) determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables.

Summary

Qualitative methodology is adopted for this study and Secondary data obtained from different websites is utilized. This data has been audited and has been given assurance that it is true and fair. The population is the Kenyan country, and 20 years is assessed. STATA software is used for data analysis. Starting with the preliminary analysis and the various tests to end up with the post-estimation tests and model stability.

Chapter 4: Discussion of Research Findings

Introduction

Chapter four lays down findings of the detailed data analysis undertaken in the research study. The characteristics of data under consideration is analyzed in Microsoft Excel and then Stata for analysis. The results are presented using tables, graphs as well as descriptive statistics. Descriptive tests are done, the data is tested for stationarity and co-integration and the VEC model is deemed to be the better fit as the data is not stationary and therefore differenced. Post-estimation analyses are carried out as the final test. The data used for analysis is as per Appendices, Table 1 -data collected.

Trustworthiness of Data

Merriam (1995) describes the factors that are considered for quantitative analysis to pass the trustworthiness tests, and these include reliability, objectivity internal validity and external validity. Researchers using quantitative methodologies, analyze trustworthiness by the extent to which the threats to internal validity have been mitigated, and how valid the measurements and instruments utilized in the study are. There are many quantitative researchers who have used the VECM methodology and conclude on their studies wholesomely, some of them include; Asafu-Adjaye and Mahadevan (2007) who reassess the economic growth, energy consumption and prices for developing and developed countries, Bagchi and Pradhan (2013) who reviewed how transport infrastructure affects economic growth in India and Al-Majali and Al-Assaf (2014) perform a short-run and long-run linkage between the stock market index (SMI) and macro-economic variables in the country Jordan using the vector error correction model method.

Johnson and Christensen (2000) define external validity as the degree to which the findings from the research can be generalized to suit a whole population. External validity gauges whether the research sample can be generalized to the bigger population. Data applied in the study are macro-economic data that has an impact to the whole country, sampling risk therefore does not apply in this study and the results can be used both in Kenya, the East African region and gauging developing economies. External validity also takes the form of statistical confident limits. From this study, all the tests are

presented with 95% confidence levels and results are based on only the significant values (less than 0.05 P Levels).

Onwuegbuzie (2000) explained that reliability is another technique for determining trustworthiness in quantitative studies. Quantitative studies show there is reliability by testing how consistent a class of measuring instruments are utilized in a study. Other scholars have also utilized the test-retest technique which is referred to as stability for assessing the reliability. This is done by conducting a test using one methodology and waiting for a period, then re-administering the same instrument to the same data. The other test for reliability is equivalence whereby a measure is used to conduct two forms of the same test to data and then examining how they correlate in terms of scores arising from the two. This study is run on Stata more than 10 times, giving the same results. The Stata codes are provided as an appendix, and anyone can conduct the tests to yield the same results. The data is also run through a different statistical software- SPSS, and the results yielded are the same as those for Stata.

The threats to internal validity that are enumerated by Campbell & Stanley (1963) enumerated eight threats to internal validity. The threats affecting quantitative methods have been adequately addressed in this study. The threat of history states that special events, different from the intended ones might have occurred in between the pretest and post-test period, hence obscuring the results. This study is conducted over 20 years and no event occurred which would affect the results. The threat of statistical regression called the regression to the mean, whose cause is picking of data on the basis of extreme characteristics and scores. This is eliminated as the summary table done for variables showed there are no outliers. Data is also normalized to fit in the same scale.

Burnett and Kolbe (1991) examine how research objectivity and reliability can be improved in quantitative techniques as a content analysis study. They state that for a study to pass the objectivity test, it is assessed throughout the methodological procedures of randomization & instrumentation, data collection, and analysis. The methodology used in this study is the acceptable one for time-series data which either uses the VEC or VAR models depending on the results of stationarity. Data collection is done for secondary data and the data is publicly available, analysis of data is done in Stata. Objectivity also talks about the independence of a researcher to the data to lessen bias.

Data used in this data is secondary data which is public information from the Kenya National Bureau of Statistics.

Results of Findings

Descriptive Analysis

The data is screened at top-level on the ranges. A summary of the data is done in Stata to explore the data and graphs are plotted; no outliners are detected in any range of the variables. The data measurements are different; gross domestic product is measured in Trillions Kenya shillings, electricity energy consumption is measured in Million Kilowatt Hours, petroleum energy consumption is measured in thousands Metric tonnes, renewable energy consumption is measured in Gigawatt hours while foreign direct investment is measured in Millions Kenya shillings. The data for this study is enormous and is therefore normalized in order to fit in one scale and be analysed in STATA. The normalized data is then transformed to logarithms for the analysis.

Marshall and Fisher (2009) look at the usefulness of statistical analysis explain that the analyses allow scholars to collapse the data gathered into a summary format, and hence allows the scholars to derive meaning from the numbers. They opine that, at the preliminary phase of a study, it is important for a scholar to appreciate the levels of measurement and to analyze the data in order to adequately answer the study research questions. They further state that descriptive analyses are usually the easiest to conduct and interpret the data obtained for a study. They give a helpful strategy to summarize data.

This study considers 80 time series measurements for all the variables that is, these are 20 quarters from January 2002 up to and including December 2021. A summary of the basic characteristics is as per the representation in the below table. The summary Table 4. 1 below gives the preliminary analysis showing the mean, mode, median and standard deviation for each of the variables. The individual trend plots for the variables are plotted as shown in appendix III that give the visual representation. Additionally, the descriptive analyses included the maximum values, minimum values, skewness, and kurtosis of the variables. The mean, median and mode present the measures of central tendency. The mean specifies the average value of the data, the median specifies the distribution of the data, and the mode gives the quantity which appears the most.

In the visual presentation, maximum, minimum, kurtosis and skewness, explain if the data is either light-tailed or heavy-tailed when compared to a normal distribution. From the summary table, Table 4. 1 below, the results indicate no value that is an outlier and that all the data values lie within the acceptable limits. Figure 13 shows the combined trend plots for the variables over the period January 2002 to December 2021, quarterly values hence 80 observations. The highest maximum value is 8.4731 for log_fdi variable and the least minimum value is 2.8820 also for the log_fdi variable. The means range from 6.1779 to 7.2832.

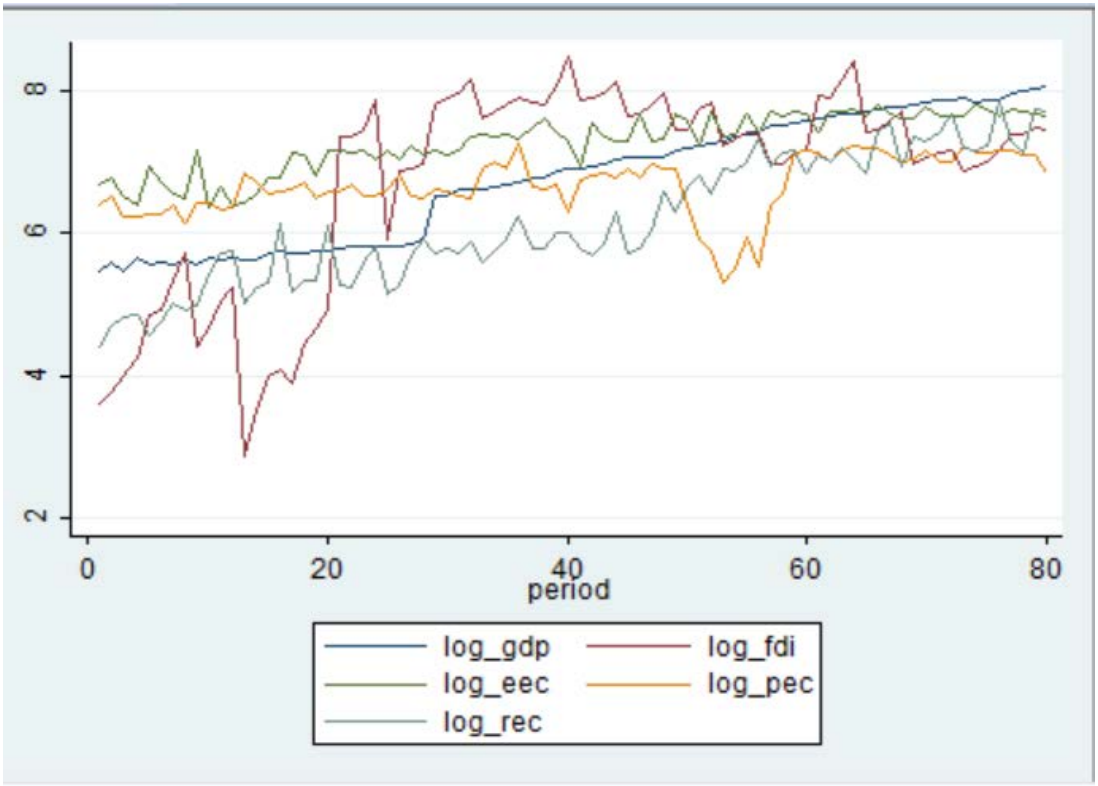
A skewness value greater than 1 or less than -1 indicates a highly skewed distribution which is not the case for any of the variables. A value between 0.5 and 1 or -0.5 and -1 is moderately skewed which is the case for variable pec. A value between -0.5 and 0.5 indicates that the distribution is fairly symmetrical which is the case for variables, log_fdi, log_eec and log_pec while variables log_gdp (0.6121) and log_rec (0.8244) are a bit skewed positively. George & Mallery (2010) explain that the values for kurtosis and asymmetry should lie between positive 2 and negative 2 so as to have a normal univariate distribution, which is the case for all the variables below.

Table 4. 1

Summary Table of Variables

	log_gdp	Log_fdi	Log_eec	Log_pec	Log_rec
Mean	6.7625	6.7474	7.2832	6.6726	6.1779
Median (p50)	6.9202	7.3636	7.3536	6.6775	5.9630
Minimum	5.4530	2.8820	6.3634	5.3022	4.4152
Maximum	8.0642	8.4731	7.8002	7.2512	7.8248
Std.Dev.	0.8809	1.4533	0.4081	0.4203	0.9054
Skewness	0.6121	0.0002	0.0093	0.0009	0.8244
Kurtosis	0.0000	0.9754	0.3451	0.0589	0.0000
Observations	80	80	80	80	80

Figure 13: Combined Trend Plot of Variables



Nick (2007) explains that plots and graphs are important elements in portraying how the set of observations shapes up in the study. The combined trend plot gives a graphical representation of the movement of the variables at a glance. The x-axis is the periods, in this case the quarters with 0 representing the first quarter of the year 2002 and 80 representing quarter 4 of the year 2021. The 20 years are represented in quarters hence 80 quarters with each year having 4 quarters. The log_gdp line in the graph represented by a blue line, shows an increasing or positive trend. The log_gdp continues increasing steadily from quarter 0 to quarter 80. There is a sharp log_gdp increase between years 2008 quarter 4 and 2009 quarter one. There is a slight decline between the 73rd and 74th quarters. The log_fdi represented by a maroon line has an erratic trend with sharp increases and sharp decreases at different periods. The log_fdi values are stable from period 0 to period 20. There is a sharp increase between the 20th quarter and

the 21st quarter, there is also a sharp decline between the 24th and the 25th quarters. The log_fdi values are relatively stable in the years 2010, 2011 and 2013.

The log_eec, represented by the light green line, has an overall increasing positive trend from quarter 0 to quarter 20. There are however periods of sharp declines and sharp uprises within the 80 periods. The log_pec is represented by the orange line which is fairly stable over the whole period. Quarters 40,50 and 60 have sharp decreases. The log_rec, represented by the dark green light, has small stable increases from period 0 to period 40, followed by a steady increase from period 41 to period 80. The individual trend plots are represented in Appendix III.

Correlation Analysis

The correlation matrix is run to determine the strength of the relationship between the variables with each other, in this research. Table 4.2 below shows the correlation analysis. In his study Daoud (2017) made 3 conclusions; Multicollinearity causes severe problems in data analysis and must be remediated before data modelling is done, there is a great recommendation that all assumptions of a regression analysis must be adhered to since they contribute to the accuracy of the conclusions and would assist in inferring to the population and a scholar should dismiss and ignore the whole model if multicollinearity is discovered this is due to the fact that the model will not be able to be interpreted.

Table 4. 2

Correlation Matrix

Variables	Log_gdp	Log_fdi	Log_eec	Log_pec	Log_rec
Type of Variable	Dependent Variable	Moderating Variable	Independent Variable	Independent Variable	Independent Variable
Log_gdp	1.0000				
Log_fdi	0.6913***	1.0000			
Log_eec	0.8796***	0.7300***	1.0000		
Log_pec	0.4158***	0.2450***	0.4213***	1.0000	
Log_rec	0.9244***	0.5776***	0.4003***	0.3441***	1.0000

There is a strong positive relationship between log_gdp and log_fdi (0.6913). This indicates that when gross domestic product increases, foreign direct investment increases and when gross domestic product decreases, foreign direct investment also decreases. There is also a strong positive relationship between log_gdp and log_rec (0.9244) indicating that when gross domestic product rises, renewable energy consumption rises and when gross domestic product declines, renewable energy consumption declines as well. Additionally, there is a strong positive relationship between log_fdi and log_eec (0.7300). This means the variables move in the same direction either by increasing or reducing together.

There is a moderate positive relationship between log_fdi and log_rec (0.5776). This shows that when foreign direct investment goes up, renewable energy consumption will also go up and when foreign direct investment goes down then renewable energy consumption will also go down. There is a weak positive relationship between log_gdp and log_pec (0.4158) and between log_eec and log_rec (0.4003). This implies that an increment in gross domestic product leads to an increment in petroleum energy consumption while a decrement in gross domestic product leads to a decrement in petroleum energy consumption. Moreover, there is a weak positive relationship between log_fdi and log_pec (0.2450) implying that the variables foreign direct investment and petroleum energy consumption are positively related but only to some extent. Furthermore, there is a weak positive relationship between log_eec and log_pec (0.4213) and between log_rec and log_pec (0.3441). This means that these variables – electricity energy consumption & petroleum energy consumption and renewable energy consumption & petroleum energy consumption, affect the movement of each other to a limited extent.

From the results of the correlation matrix, the relationships between the independent variables with each other have either a weak or moderate relationship including log_eec & log_pec and log_rec & log_pec and log_eec & log_rec. Transforming the variables to logarithms makes the relationship more linear. The correlation coefficients between the moderating variable (FDI) and independent variables log_rec and log_pec are moderate and weak respectively. The model will therefore be fitted. As part of the post-estimation tests, the serial autocorrelation test is run to help ensure the validity of the regression model by detecting and addressing any autocorrelation present in the residuals.

Pre-Analysis Test for Time series

Stationarity Tests

Stationarity is assessed. For all the stationarity tests in this study, the null hypothesis (H_o) is non-stationarity whereas the alternative hypothesis (H_a) is for stationarity. Majority of macro-economic data is assumed to be integrated of order one I (1). There is need to confirm this before proceeding to fit the appropriate multivariate model. The Null hypothesis (H_o) is non-stationarity while our alternative hypothesis (H_A) is stationarity. Table 4.3 presents the results of the Dickey-Fuller (1979) test run on Stata for both the variables and their first differences; the critical values at the different levels of significance (1%, 5% & 10%) are also displayed at the bottom of the table.

The p-values at level for log_gdp, log_fdi, log_eec, log_pec, and log_rec are; 0.9090, 0.1306, 0.0574, 0.0984, and 0.3281 respectively. None of the logarithms of variables is stationary at level. The p-values at the first difference for log_gdp, log_fdi, log_eec, log_pec, and log_rec are all 0.0000, showing that they are stationary at 1st difference.

Table 4. 3

Dickey Fuller Test

variables	**Level**		**First Difference**	
	Test statistic	p-value for Z(t)	Test statistic	p-value for Z(t)
Log_gdp	-0.407	0.9090	-10.017	0.0000
Log_fdi	-2.441	0.1306	-10.407	0.0000
Log_eec	-2.806	0.0574	-15.391	0.0000
Log_pec	-2.575	0.0984	-9.961	0.0000
Log_rec	-1.908	0.3281	-12.667	0.0000

Critical values			Critical values		
1%	5%	10%	1%	5%	10%
-3.539	-2.907	-2.588	-3.541	-2.908	-2.589

Table 4.4 below shows the results of the Phillip-Perron (1988) unit test, the critical values at the different levels of significance (1%, 5% & 10%) are also displayed at the bottom of the table for both Z(rho) and Z(t). Both tables 3 (above) and 4 (below), clearly show that the series under investigation is not stationary at level but becomes stationary after differencing once {All the P Values are 0.0000 at first difference}. The p-values at level for log_gdp, log_fdi, log_eec, log_pec, and log_rec are; 0.9090, 0.1306, 0.0574, 0.0984, and 0.3281 respectively. This therefore means that the series are integrated of order one or I (1). Generally, the Dickey-Fuller and Phillip Perron tests have the null hypothesis (H_0) for data having a unit root (non-stationarity) against an alternative hypothesis (H_A) of no unit root (stationarity).

The null hypothesis is accepted because, in both the Dickey fuller and Phillip-Perrons tests, the test statistics are less than the critical values at the different levels of significance. The alternative hypothesis stating that there is stationarity is rejected. On the other hand, if the Both tests imply that the variables are non-stationary at level and stationary when differenced to order 1. The correlograms and trend plots for both the variables and the differenced variables are as per Appendices III, IV, V and VI.

Table 4. 4

Phillip-Perrons unit root Test

variables		**Level**			**First Difference**		
		Test statistic	p-value for Z(t)		Test statistic	p-value for Z(t)	
Log_gdp	Z(rho)	-0.301			-93.435		
	Z(t)	-0.392	0.9114		-9.946	0.0000	
Log_fdi	Z(rho)	-7.078			-87.634		
	Z(t)	-2.350	0.1563		-10.520	0.0000	
Log_eec	Z(rho)	-8.093			-101.696		
	Z(t)	-2.263	0.1843		-20.179	0.0000	
Log_pec	Z(rho)	-14.393			-97.608		
	Z(t)	-2.761	0.0641		-9.894	0.0000	
Log_rec	Z(rho)	-2.683			-80.870		
	Z(t)	-1.334	0.6135		-18.623	0.0000	
		Critical values			Critical values		
		1%	5%	10%	1%	5%	10%
	Z(rho)	-19.422	-13.532	-10.874	-19.404	-13.524	-10.868
	Z(t)	-3.539	-2.907	-2.588	-3.541	-2.908	-2.589

Lag selection.

Table 4. 5 below shows the results of the number of lags to be included in the model from the different information criteria methodologies.

Table 4. 5

Lag Selection Criteria

Selection-order criteria
Sample: 6 - 80 Number of obs = 75

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	12.1677				5.7e-07	-0.1911*	-.129448*	-0.0367*
1	35.7558	47.176	25	0.005	5.9e-07	-0.1535	0.2167	0.7735
2	53.5144	35.517	25	0.079	7.2e-07	0.0396	0.7182	1.7391
3	82.2205	**57.412***	25	0.000	**6.7e-07***	-0.0592	0. 9278	2. .4128
4	96.8053	29.17	25	0.257	9.2e-07	0.2185	1.5140	3.4630

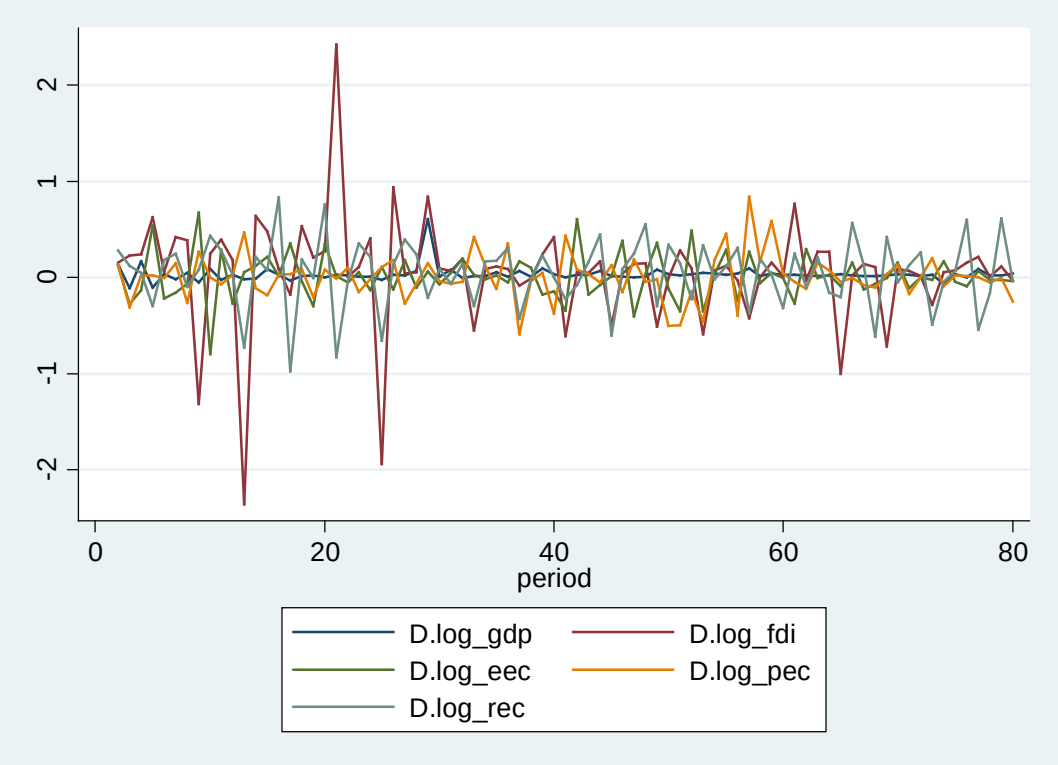
Endogenous: D.log_gdp D.log_fdi D.log_eec D.log_pec D.log_rec
Exogenous: _cons
FPE: Final Prediction Error
AIC: Akaike Information Criterion
SBIC: Schwarz Bayesian Information Criterion
HQIC: Hannan-Quinn Information Criterion

The results in Table 4.5 above indicate that the Hannan-Quinn Information Criterion, the Akaike Information Criterion and the Schwarz Bayesian Information Criterion have chosen no lag for the model (lag zero with the asterisks); while the likelihood ratio (LR) and the Final Prediction Error have proposed that three lags be included in the model. The decision criterion is normally to choose and use the number of lags preferred by most criteria. As seen in the above results, three lags will be used in the model.

Co-integration test

Time series are said to be co-integrated if they co-move towards long run equilibrium. Figure 13 shows that the variables are clearly co-moving together towards a long-term equilibrium. This is a visual representation. The Johansens methodology is utilized to determine if there is co-integration in the series and therefore fit the appropriate model. In the case for this study, the appropriate model would be the vector autoregressive (VAR) model if no co-integration exists or the vector error correction model (VECM) if co-integration exists.

Figure 14: Trend Plot for Cointegration



In order to find out the existence of both short-run and long-run equilibrium relationships among the variables in this study, the Johansen co-integration test is performed as per Table 4.6 below in Stata V.12.0 and utilizing three lags as determined in the lag selection information criteria. The null hypothesis (H_o) is that there is no co-integration while the alternative hypothesis (H_A) is that there is co-integration. From the first table below, the trace statistics for maximum ranks 0, 1, 2 and 4 are all more than the critical values at 5% and therefore we reject the null hypothesis (which states that there

is no co-integration) and accept the alternative hypothesis which states that there is co-integration.

Table 4. 6

Johansen Co-integrating Test

Trend: constant — Number of obs = 76
Sample: 5 - 80 — Lags = 3

Maximum rank	parms	LL	eigenvalue	Trace statistic	5% Critical value
0	55	-27.6753	.	217.9404	68.52
1	64	22.9725	0.73627	116.6448	47.21
2	71	52.9884	0.54611	56.6130	29.68
3	76	64.8176	0.26750	32.9546	15.41
4	79	74.8412	0.23186	12.9073	3.76
5	80	81.2949	0.15619		

Maximum rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	55	-27.6753		3.86238	2.849758	2.8498
1	64	22.9725	0.7363	3.0424	1.864071	1.0797
2	71	52.9884	0.5461	2.6514	1.344181	0.4740
3	76	64.8176	0.2675	2.6250	1.225747	0.2943
4	79	74.8412	0.2319	2.5322	1.077684	0.1094
5	80	81.2949	0.1562	2.4194	.9464223	-0.0341

Evaluation of findings
VEC Model

Table 4. 7

Model Fitness

Sample: 5 - 80				No. of obs	= 76
				AIC	= 1.079672
Log likelihood = 22.97248				HQIC	= 1.864071
Det (Sigma_ml) = 3.76e-07				SBIC	= 3.042394

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D2_log_gdp	12	0.0884	0.4501	52.3946	0.0000
D2_log_fdi	12	0.6568	0.5363	74.0190	0.0000
D2_log_eec	12	0.2627	0.6570	122.5645	0.0000
D2_log_pec	12	0.2667	0.5178	68.71184	0.0000
D2_log_rec	12	0.2576	0.8360	326.1607	0.0000

From Table 4.7 above, the Parms show the number of parameters which for this study is 12. The RMSE is the root mean square error which show the standard deviation. The R-sq is the R squared that explains the proportions; gross domestic product for the current quarter, is explained by 45.01% of its own lags and the lags of foreign direct investments, electricity energy consumption, petroleum energy consumption and renewable energy consumption.

Foreign Direct Investment for the current quarter is explained by 53.63% of its own lags and the lags of Gross Domestic Product, electricity energy consumption, petroleum energy consumption and renewable energy consumption. Electricity energy consumption in the current quarter is explained by 65.70% of its own lags and the lags of gross domestic product, foreign direct investments, petroleum energy consumption, and renewable energy consumption. Petroleum energy consumption in the current quarter is explained by 51.78% of its own lags and the lags of gross domestic product, foreign direct investments, electricity energy consumption, and renewable energy consumption. Renewable energy consumption this quarter is explained by 83.60% of its own lags and the lags of gross domestic product, foreign direct investments, electricity energy consumption, and petroleum energy consumption.

All the 5 model variables; gross domestic product, foreign direct investment, electricity energy consumption, petroleum energy consumption, and renewable energy consumption are significant 1% since the P>chi2 = 0.0000 which is less than 0.05.

Table 4. 8

Speed of Adjustment

_Cel L1

	Coef.	Std. Err	z	p>|z|	[95% Conf. Interval]	
D2_log_gdp	-0.0206	0.0250	-0.82	0.410	-0.0696	0.0284
D2_ log_fdi	0.5471	0.1858	2.94	0.003	0.1829	0.9112
D2_ log_eec	-0.1659	0.0743	-2.23	0.026	-0.3116	-0.0203
D2_ log_pec	-0.1038	0.0754	-1.38	0.169	-0.2516	0.0440
D2_ log_rec	0.9055	0.0728	12.42	0.000	0.7626	1.0483

Model specification.

We fit the Vector Error Correction Model with the 5 variables of the study. These are represented as below.

$$\Delta log_gdp_t = \alpha_{10} + €_{11}\Delta log_gdp_{t-1} + \mu_{11}\Delta\ log_fdi_{t-1} + ¥_{11}\Delta\ log_eec_{t-1} + ø_{11}\Delta\ log_pec_{t-1} + Ł_{11}\Delta log_rec_{t-1} + \beta_{11}\{\infty + log_gdp_{t-1} - \alpha_{12}\ log_fdi_{t-1} + \alpha_{13}\ log_eec_{t-1} - \alpha_{14}\ log_pec_{t-1} + \alpha_{15}\ log_rec_{t-1}\} + Ø_{1t} \ldots\ldots\ldots \text{(a)}$$

$$\Delta log_fdi_t = \alpha_{20} + \mu_{21}\Delta log_fdi_{t-1} + €_{21}\Delta log_gdp_{t-1} + ¥_{21}\Delta log_eec_{t-1} + ø_{21}\Delta\ log_pec_{t-1} + Ł_{21}\Delta log_rec_{t-1} + \beta_{21}\{\infty + log_gdp_{t-1} - \alpha_{12}\ log_fdi_{t-1} + \alpha_{13}\ log_eec_{t-1} - \alpha_{14}\ log_pec_{t-1} + \alpha_{15}\ log_rec_{t-1}\} + Ø_{2t} \ldots\ldots\ldots \text{(b)}$$

$$\Delta log_eec_t = \alpha_{30} + ¥_{31}\Delta log_eec_{t-1} + €_{31}\Delta log_gdp_{t-1} + \mu_{31}\Delta log_fdi_{t-1} + ø_{31}\Delta\ log_pec_{t-1} + Ł_{31}\Delta log_rec_{t-1} + \beta_{31}\{\infty + log_gdp_{t-1} - \beta_{12} log_fdi_{t-1} + \beta_{13}\ log_eec_{t-1} - \beta_{14} log_pec_{t-1} + \beta_{15} log_rec_{t-1}\} + Ø_{3t} \ldots\ldots \text{(c)}$$

$$\Delta log_pec_t = \alpha_{40} + ø_{41}\Delta log_pec_{t-1} + €_{41}\Delta\ log_gdp_{t-1} + \mu_{41}\Delta log_fdi_{t-1} + ¥_{41}\Delta\ log_eec_{t-1} + Ł_{41}\Delta log_rec_{t-1} + \beta_{41}\{\infty + log_gdp_{t-1} - \alpha_{12}\ log_fdi_{t-1} + \alpha_{13}\ log_eec_{t-1} - \alpha_{14}\ log_pec_{t-1} + \alpha_{15}\ log_rec_{t-1}\} + Ø_{4t} \ldots\ldots \text{(d)}$$

$$\Delta log_rec_t = \alpha_{50} + Ł_{51}\Delta log_rec_{t-1} + €_{51}\Delta log_gdp_{t-1} + \mu_{51}\Delta log_fdi_{t-1} + ø_{51}\Delta\ log_pec_{t-1} + ¥_{51}\Delta log_eec_{t-1} + \beta_{51}\{\infty + log_gdp_{t-1} - \alpha_{12}\ log_fdi_{t-1} + \alpha_{13}\ log_eec_{t-1} - \alpha_{14} log_pec_{t-1} + \alpha_{15} log_rec_{t-1}\} + Ø_{5t} \ldots\ldots \text{(e)}$$

Definition of the terms.

Δlog_gdp_t, Δlog_fdi_t, Δlog_eec_t , Δlog_pec_t and Δrec_t are first differences i.e.

$\Delta log_gdp_t = log_gdp_t - log_gdp_{t-1}$, $\Delta log_fdi_t = log_fdi_t - log_fdi_{t-1}$, $\Delta log_eec_t = log_eec_t - log_eec_{t-1}$, $\Delta log_pec_t = log_pec_t - log_pec_{t-1}$, $\Delta log_rec_t = log_rec_t - log_rec_{t-1}$

$\mu, €, ¥, ø, Ł$ - These are the coefficients of the variables, they define the short-run relationship between the variables

$\beta_{11}, \beta_{21}, \beta_{31}, \beta_{41}, \beta_{51}$ -This are the coefficients for the long-run correlation/relationship between variables.

$Ϙ_{1t}, Ϙ_{2t}, Ϙ_{3t}, Ϙ_{4t}, Ϙ_{5t}$ – These are the white noise/shock terms

$\alpha_{10}, \alpha_{20}, \alpha_{30}, \alpha_{40}, \alpha_{50}$- These are constants.

$\{\infty + gdp_{t-1} - \alpha_{12}fdi_{t-1} + \alpha_{13}eec_{t-1} - \alpha_{14}pec_{t-1} + \alpha_{15}rec_{t-1}\}$-This is the error correction term per variable and corrects values for the previous period. This term corrects the previous errors and ensures differences are not zero.

$$\Delta log_gdp_t = \underset{(0.010)}{-0.0008} - \underset{(0.124)}{0.662}\Delta log_gdp_{t-1} - \underset{(0.016)}{0.014}\Delta log_fdi_{t-1} + \underset{(0.040)}{0.044}\Delta log_eec_{t-1} -$$

$$0.038\Delta log_pec_{t-1} - 0.019\Delta rec_{t-1} - 0.0206 \{0.079 + log_gdp_{t-1} -$$
$$(0.040) \quad (0.057) \quad (0.025)$$

$$0.325log_fdi_{t-1} + 0.137log_eec_{t-1} - 0.397log_pec_{t-1} - 3.11log_rec_{t-1}\} \ldots \textbf{I}$$
$$(0.112) \quad (0.450) \quad (0.247) \quad (0.264)$$

$$\Delta log_fdi_t = -0.062 - 0.678\ \Delta log_fdi_{t-1} + 0.294\Delta log_gdp_{t-1} - 0.278\Delta log_eec_{t-1} +$$
$$(0.075) \quad (0.120) \quad (0.897) \quad (0.303)$$

$$0.278\Delta log_pec_{t-1} + 1.391\Delta log_rec_{t-1} + 0.547\{0.079 + log_gdp_{t-1} -$$
$$(0.304) \quad (0.427) \quad (0.186)$$

$$0.325log_fdi_{t-1} + 0.137log_eec_{t-1} - 0.397log_pec_{t-1} - 3.11log_rec_{t-1}\} \ldots \textbf{II}$$
$$(0.112) \quad (0.450) \quad (0.247) \quad (0.264)$$

$$\Delta log_eec_t = 0.0031 - 0.902\Delta log_eec_{t-1} - 0.130\Delta log_gdp_{t-1} - 0.037\Delta log_fdi_{t-1} -$$
$$(0.030) \quad (0.121) \quad (0.359) \quad (0.048)$$

$$0.056\Delta log_pec_{t-1} - 1.391\Delta log_rec_{t-1} - 0.166\{0.079 + log_gdp_{t-1} -$$
$$(0.122) \quad (0.427) \quad (0.074)$$

$$0.325log_fdi_{t-1} + 0.137log_eec_{t-1} - 0.397log_pec_{t-1} - 3.11log_rec_{t-1}\} \ldots \textbf{III}$$
$$(0.112) \quad (0.450) \quad (0.247) \quad (0.264)$$

$$\Delta log_pec_t = -0.002 - 0.934\Delta log_pec_{t-1} + 0.059\Delta log_gdp_{t-1} - 0.083\Delta log_fdi_{t-1} +$$
$$(0.031) \quad (0.124) \quad (0.364) \quad (0.049)$$

$$0.0394\Delta log_eec_{t-1} - 0.252\Delta log_rec_{t-1} - 0.104\{0.079 + log_gdp_{t-1} -$$
$$(0.123) \quad (0.173) \quad (0.075)$$

$$0.3250log_fdi_{t-1} + 0.137log_eec_{t-1} - 0.397log_pec_{t-1} - 3.11log_rec_{t-1}\} \ldots \textbf{IV}$$
$$(0.112) \quad (0.450) \quad (0.11) \quad (0.264)$$

$$\Delta log_rec_t = 0.0042 + 1.140\Delta log_rec_{t-1} - 0.027\Delta log_gdp_{t-1} + 0.188\Delta log_fdi_{t-11} +$$
$$(0.030) \quad (0.167) \quad (0.131) \quad (0.047)$$

$$0.156\Delta log_pec_{t-1} - 0.431\Delta log_eec_{t-1} + 0.906\{0.079 + log_gdp_{t-1} -$$
$$(0.119) \quad (0.173) \quad (0.073)$$

$$0.325log_fdi_{t-1} + 0.137log_eec_{t-1} - 0.397log_pec_{t-1} - 3.11log_rec_{t-1}\} \ldots \textbf{V}$$
$$(0.112) \quad (0.450) \quad (0.11) \quad (0.264)$$

Table 4. 9

Vector Error Correction Estimates

(ALL SIGNIFICANT VALUES)

	Lags	Coef.	Std.Err.	z	p>|z|	[95% Conf.	Interval]
D2_ log_ gdp	Log_gdp LD2.	-0.6622	0.1239	-5.49	0.000	-0.8987	-0.4256
	Constant	-0.0008	0.0101	-0.08	0.935	-0.0207	0.0190
D2_ log_fdi	Log_fdi LD2.	-0.6784	0.1202	-5.64	0.000	-0.9141	-0.4428
	Log_fdi L2D2.	-0.4222	0.1145	-3.69	0.000	-0.6467	0.0198
	Log_eec LD2.	-0.2775	0.3032	-0.92	0.036	-0.8718	0.3168
	Log_eec L2D2.	-0.2793	0.2698	-1.03	0.030	-0.8081	0.2496
	Log_rec LD2.	1.3912	0.4268	3.26	0.001	0.5548	2.2276
	Log_rec L2D2.	0.6496	0.2530	2.57	0.010	0.1537	1.1455
	Constant	-0.0062	0.0754	-0.08	0.934	-0.1539	0.1415
D2_ log_ eec	Log_fdi LD2.	-0.0369	0.0481	-0.77	0.044	-0.1311	0.0574
	Log_fdi L2D2.	-0.0473	0.0458	-1.03	0.030	-0.1371	0.0425
	Log_eec LD2.	-0.9019	0.1213	-7.44	0.000	-1.1396	-0.6642
	Log_eec L2D2.	-0.5034	0.1079	-4.67	0.000	-0.7149	-0.2919
	Log_rec LD2.	-0.4162	0.1707	-2.44	0.015	-0.7508	-0.0817
	Constant	0.0031	0.0301	0.10	0.918	-0.0560	0.0622
D2_ log_ pec	Log_pec LD2.	-0.9339	0.1235	-7.57	0.000	-1.1758	-0.6920
	Log_pec L2D2.	-0.4076	0.1205	-3.38	0.001	-0.6437	-0.1714
	Constant	-0.0019	0.0306	-0.03	0.974	-0.0610	0.0590
D2_ log_ rec	Log_fdi LD2.	0.1882	0.0472	3.99	0.000	0.0958	0.2806
	Log_fdi L2D2.	0.1386	0.0449	3.09	0.002	0.0506	0.2266
	Log_eec LD2.	-0.6418	0.1189	-5.40	0.000	-0.8749	-0.4087
	Log_rec LD2.	1.1402	0.1674	6.81	0.000	0.8121	1.4683
	Log_rec L2D2.	0.4908	0.0992	4.95	0.000	0.2963	0.6854
	Constant	0.0042	0.0296	0.14	0.888	-0.0538	0.0621

Table 4.9 above gives the short-run relationships of the variables. None of the constant values are statistically significant; they are all above 5%. From equation I, if the gross domestic product increases by one unit (1%) in the last quarter; then the gross domestic product in this quarter will decrease by 66.2%, foreign direct investments will increase by 1.4%, electricity energy consumption will increase by 4.4%, petroleum energy consumption will decrease by 3.8% and renewable energy consumption will decrease by 1.9%. The t-statistic value for log_gdp lag1 is significant at 5% but not significant for lag2.

As per equation II, if the foreign direct investment goes up by one unit (1%) in the last quarter; then foreign direct investment in the current quarter goes down by 67.8%, gross domestic product will go up by 29.4%, electricity energy consumption will go down by 27.8%, petroleum energy consumption will go up by 27.8% and renewable energy consumption will go up by 139.1%. Foreign direct investment, electricity energy consumption and renewable energy consumption are significant at lag 1 with their P values below 5%.

According to equation III, if the electricity energy consumption in the previous quarter hiked by one unit (1%); electricity energy consumption in the present quarter will reduce by 90.2%, gdp will reduce by 13%, foreign direct investment will reduce by 3.7%, petroleum energy consumption will reduce by 5.6% and renewable energy consumption will go down by 139.1%. Foreign direct investment, electricity energy consumption and renewable energy consumption for lag 1 are all significant at 5% level.

Equation IV shows that when petroleum energy consumption decreases by one unit (1%) in a preceding quarter; petroleum energy consumption will decrease by 93.4% in the succeeding quarter, gdp will increase by 5.9%, foreign direct investment will decrease by 8.3%, electricity energy consumption will increase by 3.94% and renewable energy consumption will decrease by 25.2%. The petroleum energy consumption is significant at levels.

Equation V indicates that when renewable energy consumption rose by one unit (1%) in the past quarter; renewable energy consumption will rise in the current quarter by 114%, gdp will decrease by 2.7%, foreign direct investment will rise by 18.8%, petroleum

energy consumption will rise by 15.6% and electricity energy consumption decline by 43.1%. The t-statistic values (p>|z|) for foreign direct investment, electricity energy consumption, and renewable energy consumption, are all significant, below 5%.

The error correction term- {0.079 + log_gdp_{t-1} - 0.325log_fdi_{t-1} + 0.137log_eec_{t-1} – 0.397log_pec_{t-1} – 3.11log_rec_{t-1}} corrects values for the previous period/quarter and ensures that the differences are not zero. The coefficients for long term relationship are 0.112 for foreign direct investment, 0.450 for electricity energy consumption, 0.247 for petroleum energy consumption and 0.264 for renewable energy consumption.

Post-estimation Tests

Normal distribution of residuals

Table 4. 10

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D2_ log_gdp	1242.356	2	0.00000
D2_ log_fdi	33.611	2	0.00000
D2_ log_eec	6.007	2	0.04961
D2_ log_pec	3.943	2	0.13925
D2_ log_rec	1.904	2	0.38600
ALL	1287.821	10	0.00000

Table 4. 11

Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D2_ log_gdp	2.6937	91.913	1	0.0000
D2_ log_fdi	0.1587	0.319	1	0. 5721
D2_ log_eec	0.4271	2.310	1	0. 1285
D2_ log_pec	0.0830	0.087	1	0. 7677
D2_ log_rec	0.0433	0.024	1	0. 8774
ALL		94.653	5	0.0000

Table 4. 12

Kurtosis Test

Equation	Kurtosis	chi2	df	Prob > chi2
D2_ log_gdp	22.0600	1150.4430	1	0.0000
D2_ log_fdi	6.2424	33.292	1	0.0000
D2_ log_eec	4.0805	3.697	1	0.0545
D2_ log_pec	4.1035	3.856	1	0.0496
D2_ log_rec	2.2295	1.880	1	0.1703
ALL		1193.168	5	0.0000

In the Jarque-Bera test**,** Table 4.10 above, the null hypothesis (H_o) states that the residuals are normally distributed whereas the alternative hypothesis (H_A) states that the residuals not normally distributed. For variables log_gdp (0.00000) and log_fdi (0.00000) have a Prob > chi2 of less than 5% meaning their residuals are not normally distributed. These results obtained are not surprising because the dataset is generated from 80 random variables which followed a uniform distribution. Therefore, the data is expected to be uniformly distributed, not normally distributed. For variables log_eec (0.04961), log_pec (0.13925) and log_rec(0.38600) the Prob > chi2 is more than 5% showing that the residuals of these variables are normally distributed.

Serial Autocorrelation

The residuals are tested for serial autocorrelation.
Table 4. 12

Langrange-multiplier Test

Lag	chi2	df	Prob > chi2
1	33.5914	25	0.11693
2	36.7086	25	0.06151

H_o : No autocorrelation at lag order

The null hypothesis (H_o) is that there is no serial autocorrelation while the alternative hypothesis (H_A) is there is serial autocorrelation. The results of Table 4.12 above, at lag order 1, the Prob > chi2 = 0.11693 which is greater than 5% confidence level, we therefore accept the null hypothesis meaning that there is no autocorrelation of the residuals. At lag order 2, the Prob > chi2 = 0.06151 which is also more than 5% confidence level, we therefore accept the null hypothesis as well, implying that there is no autocorrelation/serial correlation of the residuals.

Impulse Response Functions (IRFs)

From Table 4.13 a) below on log_gdp IRFs, immediately there is a shock in log_gdp, log_gdp itself increases by 0.088 units and by 0.0279 units in the first quarter. A shock in log_gdp also causes an instant increase in log_fdi and log_rec but a decrease in log_eec and log_pec by 0.043 units and 36.6 units respectively. Shocks in gross domestic product cause increases in gross domestic product over the next 12 quarters in different quantities/units. This implies that there is a positive permanent effect on gross domestic product. The shock on gross domestic product also has a permanent positive effect on foreign direct investment.

From Table 4.13 b) log_fdi IRFs, immediately there is a shock in log_fdi, there is zero effect on log_gdp but log_fdi itself increases by 0.640 units. The shock on foreign direct investment has a transitory effect on gross domestic product, electricity energy consumption and renewable energy consumption over the next 12 quarters as the effects rotate around the zero mark. The shock on foreign direct investment causes a permanent negative effect on petroleum energy consumption as all the units are negative over the next twelve periods. The shock effects of foreign direct investment cause a permanent positive effect on foreign direct investment itself.

From Table 4.13 c) log_eec IRFs, at the point when there is a shock in electricity energy consumption, there is no effect on the gross domestic product and foreign direct investment. The shock on electricity energy consumption has a transitory effect on; gross domestic product, foreign direct investment, electricity energy consumption itself and

petroleum energy consumption. The shock on electricity energy consumption has a permanent positive effect on renewable energy consumption.

From Table 4.13 d) log_pec IRFs, at the instance when there is a shock in petroleum energy consumption, there is no effect on gross domestic product, foreign direct investment, and petroleum energy consumption itself. The shock has transitory effect on gross domestic product, foreign direct investment, and electricity energy consumption. The shock has a permanent positive effect on petroleum energy consumption itself as all its values over the next 12 quarters are positive. The shock has also a lasting negative effect on renewable energy consumption as the values over the 12 subsequent periods are negative.

From Table 4.13 e) log_rec IRFs, a disturbance in renewable energy consumption has no immediate effect on gross domestic product, foreign direct investment, electricity energy consumption and petroleum energy consumption but causes an increase in renewable energy consumption itself by 0.2496 units. A shock in renewable energy consumption has a transitory effect on all the variables except gross domestic product which has a permanent positive effect over the period.

Table 4. 13

Impulse Response Function Tables

Log_gdp IRFs – Table 4.13 a)

step	(1-log_gdp) oirf	(2- log_fdi) oirf	(3- log_eec) oirf	(4- log_pec) oirf	(5- log_rec) oirf
0	.088353	.146109	-.042787	-.009781	.035613
1	.027878	.068872	-.016259	-.006201	.023353
2	.054213	.046224	-.038635	-.001482	-.037882
3	.046533	.044588	.002878	.004883	-.024425
4	.045652	.100349	-.046724	-.012898	.038867
5	.048785	.068837	-.023366	-.004076	.006819
6	.046733	.061125	-.014328	.000136	-.01927
7	.048195	.054795	-.029771	-.0029	-.015858

8	.046222	.076663	-.024148	-.005004	.022951
9	.047751	.081308	-.026239	-.006152	.002915
10	.047727	.056028	-.022958	-.001142	-.011
11	.047042	.061291	-.022354	-.002517	-.007102
12	.047308	.077093	-.027057	-.005236	.009284

Log_fdi IRFs -Table 4.13 b)

step	(6-log_gdp) oirf	(7-log_fdi) oirf	(8- log_eec) oirf	(9- log_pec) oirf	(10-log_rec) oirf
0	0	.640364	-.015196	-.062547	.00881
1	-.003075	.08007	.01264	-.036063	-.067426
2	-.008137	.201324	-.017733	-.015913	.010873
3	.005708	.354429	.017283	-.036701	-.084529
4	-.009676	.216676	-.013496	-.042501	.040033
5	-.000346	.242524	-.011182	-.027546	-.039641
6	-.001408	.283824	.018675	-.029397	-.040882
7	-.004538	.223373	-.014124	-.038229	-.028426
8	-.002472	.26584	-.004572	-.030006	.002569
9	-.002129	.271576	.005609	-.035541	-.037227
10	-.003104	.234265	-.007466	-.0318	-.027859
11	-.0027	.251771	.000836	-.031125	-.025655
12	-.002825	.270967	-.002574	-.035622	-.01553

Log_eec IRFs Table 4.13 c)

step	(11-log_gdp) oirf	(12-log_fdi) oirf	(13-log_eec) oirf	(14-log_pec) oirf	(15-log_rec) oirf
0	0	0	.25875	.025519	.002172
1	.004781	.090034	-.022982	-.017453	.093698
2	.005534	-.027993	.115614	.017367	.036597
3	-.001171	.056332	.13492	.006881	.000839
4	.008355	-.013028	.052793	.006125	-.007879
5	-.001408	.026062	.112911	.007924	.085844
6	.005155	.066926	.09065	-.000569	.017811
7	.003996	-.019406	.091453	.012801	.01975
8	.001531	.018076	.102253	.007385	-.027896
9	.00424	.049082	.088063	.002976	.04558

10	.002656	.011177	.094024	.006136	.037178
11	.00335	.02048	.097455	.008569	.02219
12	.003582	.020897	.094897	.00684	-.026084

Log_pec IRFs- Table 4.13 d)

step	(16-log_gdp) oirf	(17-log_fdi) oirf	(18-log_eec) oirf	(19-log_pec) oirf	(20-log_rec) oirf
0	0	0	0	.257795	-.052053
1	-.010054	.031798	-.002737	.023975	-.017232
2	-.011417	-.007885	-.00566	.126586	.007977
3	.001018	.023009	.00254	.127534	-.007678
4	-.011565	.019714	-.003927	.087162	-.033032
5	-.004633	-.011002	-.00199	.124359	.018541
6	-.006697	.022068	.00172	.106723	-.012998
7	-.00703	.02147	-.00765	.105493	-.013998
8	-.005983	-.002788	.002022	.114524	-.022541
9	-.006846	.015834	-.001433	.10859	-.020701
10	-.006344	.012257	-.003705	.10938	.016005
11	-.006812	.011104	-.001089	.110004	-.01326
12	-.006266	.012783	-.001857	.109745	-.022362

Log_rec IRFs -Table 4.13 e)

step	(21-log_gdp) oirf	(22-log_fdi) oirf	(23-log_eec) oirf	(24-log_pec) oirf	(25-log_rec) oirf
0	0	0	0	0	.249643
1	.011214	-.077514	.024933	.017728	-.168828
2	.00301	-.124734	.040447	.037101	-.023741
3	.000855	-.050322	-.004296	-.003859	.041568
4	.004853	.035273	.001886	.006739	.108859
5	.005828	-.097083	-7.49912	2.59441	-.0638
6	.003366	-.098778	.016829	.023549	-.018284
7	.003905	-.036364	.01265	.008463	.028203
8	.002964	-.01612	.007069	.005397	.063008
9	.005626	-.076622	.019375	.016879	-.022994
10	.003866	-.075492	.022625	.019148	-.011492
11	.00359	-.047556	.010184	.009464	.022262
12	.003744	-.036527	.011066	.010021	.039121

orif - orthogonalized impulse–response function

Factor Error Variance Decomposition (FEVDs)

The factor error variance decomposition determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. Table 4.14 below shows the summary results of the variance decomposition test. The factor error variance decomposition graphs are as per Appendix IX.

Table 4. 14

Factor Error Variance Decomposition Tables

Log_gdp IRFs

step	(1- log_gdp) fevd	(2- log_fdi) fevd	(3- log_eec) fevd	(4- log_pec) fevd	(5- log_rec) fevd
0	0	0	0	0	0
1	1	.049484	.026528	.001345	.019106
2	.970694	.057006	.029678	.001821	.016631
3	.958779	.054624	.041032	.001488	.028859
4	.962648	.046443	.033934	.001465	.031493
5	.948757	.056786	.051997	.002745	.03875
6	.952291	.057487	.050354	.002532	.035632
7	.953393	.05527	.048492	.002313	.037375
8	.953887	.055227	.051384	.002181	.038396
9	.955735	.056821	.051462	.002148	.040267
10	.955889	.058234	.052879	.002196	.039251
11	.956924	.057731	.052885	.002057	.039347
12	.957557	.057503	.052697	.00196	.039212

Log_fdi IRFs

step	(6- log_fdi) fevd	(7- log_gdp) fevd	(8- log_eec) fevd	(9- log_pec) fevd	(10- log_rec) fevd
0	0	0	0	0	0
1	0	.950516	.003346	.055009	.001169
2	.001069	.909947	.005534	.070776	.0424
3	.006296	.884362	.008065	.059666	.042125

4	.007613	.895512	.009473	.062328	.097355
5	.012144	.88744	.010671	.072456	.097598
6	.010598	.878938	.010437	.06919	.099336
7	.009563	.871601	.012325	.069041	.108314
8	.009454	.873636	.012881	.072611	.111778
9	.008892	.876866	.012095	.071896	.107841
10	.008304	.873063	.011635	.07349	.113275
11	.007982	.872215	.01129	.073628	.116066
12	.007649	.874137	.010675	.ó	.118634

Log_eec IRFs

step	(11- log_eec) fevd	(12- log_gdp) fevd	(13- log_fdi) fevd	(14- log_pec) fevd	(15- log_rec) fevd
0	0	0	0	0	0
1	0	0	.970127	.009157	.000071
2	.002585	.017711	.955876	.012978	.080549
3	.00445	.017202	.924631	.013726	.089928
4	.003858	.018541	.934682	.011937	.082916
5	.007499	.017243	.916269	.011284	.073697
6	.006644	.016486	.91222	.010367	.115786
7	.007183	.019713	.911885	.009474	.115694
8	.007122	.018957	.908751	.009736	.11638
9	.006612	.017837	.911041	.009263	.117021
10	.006691	.018583	.909155	.008652	.12635
11	.006408	.017672	.907981	.008266	.132505
12	.006303	.017012	.90974	.008099	.133928

Log_pec IRFs

step	(16- log_pec) fevd	(17- log_gdp) fevd	(18- log_fdi) fevd	(19- log_eec) fevd	(20- log_rec) fevd
0	0	0	0	0	0
1	0	0	0	.934488	.040818
2	.011431	.002209	.000106	.910158	.027569
3	.019257	.002077	.000452	.906663	.027273
4	.016349	.002463	.000434	.908665	.025627
5	.022029	.002807	.000552	.898796	.030533
6	.020338	.002697	.00052	.902939	.030101
7	.020278	.002946	.000507	.901754	.030637
8	.02029	.003265	.000879	.898997	.031409

9	.019957	.003024	.000842	.901379	.033414
10	.019934	.003008	.000809	.899924	.035093
11	.019719	.002972	.000842	.899539	.036050
12	.019757	.002903	.000802	.900430	.036681

Log_rec IRFs

step	(21- log_rec) oirf	(22- log_gdp) oirf	(23- log_fdi) oirf	(24- log_eec) oirf	(25- log_pec) oirf
0	0	0	0	0	0
1	0	0	0	0	.938836
2	.014221	.013128	.008806	.004267	.83285
3	.011218	.041734	.02582	.018457	.811815
4	.009533	.037041	.021478	.015605	.762609
5	.009571	.035723	.02051	.014720	.759422
6	.010129	.044392	.026468	.014973	.719145
7	.009583	.050469	.026791	.017418	.707981
8	.009247	.048916	.026105	.016475	.702037
9	.008805	.045452	.02456	.015314	.701456
10	.009182	.047111	.025521	.015738	.686031
11	.008966	.049411	.027002	.016510	.676032
12	.008734	.048445	.026085	.015911	.671545

Table 4.14 above on factor error variance decomposition, displays the evidence of relationships among the variables under investigation and the proportion of the forecast error of one variable due to another. Ordinarily, the forecast errors should add up to 100%. The implication of this is that the variables in this study are more exogeneous meaning that they are explained by the shocks of the other variables. However, the renewable energy consumption performance is endogenous in relation to other variables i.e., foreign direct investment, electricity energy consumption and petroleum energy consumption, since 93.88% of its variance is explained by its own shocks or disturbances after one quarter.

Renewable energy forecast error is explained substantially by itself over the next 12 quarters with the least percentage being 67.15%. Gross domestic product has a forecast error which is also explained by itself to a great extent as it is 97.07% in the first quarter and 95.76% in the last quarter. Gross domestic product and renewable energy consumption are endogenous.

Model Stability
Table 4. 15

Model Stability

Eigenvalue stability condition	
Eigenvalue	**Modulus**
1	1
1	1
1	1
1	1
.01191852 + .8622354i	. 862318
. 01191852 - .8622354i	. 862318
-.7772587	. 777259
-.4307949 + .6392833i	. 770887
-.4307949 - .6392833i	. 770887
-.5620242 + .4306973i	. 708076
-.5620242 - .4306973i	. 708076
-.368148 + .453155i	. 583851
-.368148 - .453155i	. 583851
-.3617528 + .3062255i	. 473961
-.3617528- .3062255i	. 473961

The VECM specification imposes 4-unit moduli.

The output in Table 4.15 contains a table showing the eigenvalues of the companion matrix and their associated moduli. The table displays that four of the roots is 1. The table footer informs us that the specified VECM imposes four-unit moduli on the companion matrix. The output indicates that there is a real root at about 0.8623. Even though there is no distribution theory to measure how close this root is to one, according to the other discussions in the literature, we conclude that the root of 0.8623 supports our earlier analysis, in which we conclude that the predicted co-integrating equation is not stationary.

Summary of the Section

Chapter 4 analyses data from secondary sources specifically the Kenya National Bureau of Statistics (KNBS) to see how to answer the 5 research questions which are discussed in chapter one. The findings showed that the variables in question have co-integration meaning they co-move towards a long-run equilibrium. The short run relationships showed that there are bi-directional linkages between foreign direct investment & electricity energy consumption, between foreign direct investment & renewable energy consumption and between renewable energy consumption & electricity energy consumption. In the long-run, permanent changes are found from gross domestic product to foreign direct investment, from foreign direct investment to petroleum energy consumption, from electricity energy consumption to renewable energy consumption, from petroleum energy consumption to renewable energy consumption and from renewable energy consumption to gross domestic product.

Chapter 5: Implications, Recommendations, and Conclusions

This chapter presents the findings of the study, the conclusion, and recommendations from the study findings. Discussions of the findings relate to the five objectives as specified in Chapter One. The general objective of the study is to find out the function of financial deepening indicators and the stock market performance in Kenya. The findings have answered the five research questions enumerated in Chapter One as below.

1. There is a long-run relationship between petroleum energy consumption and gross domestic product in Kenya. Where a shock in petroleum energy consumption causes a permanent change in GDP.
2. There is no statistically significant between electricity energy consumption and economic growth in Kenya both in the short-run and in the long-run.
3. There is no statistically significant relationship between renewable energy consumption and economic growth in Kenya both in the short-run and in the long-run.
4. There is a bidirectional relationship between foreign direct investments and renewable energy consumption in the short-run while in the long-run, a shock in FDI has a permanent effect on renewable energy consumption in Kenya.

   There is a bidirectional relationship between foreign direct investments and electricity energy consumption in the short run but no statistically significant relationship in the long run.

   In the long run, a shock in the gross domestic product in Kenya causes a long-lasting effect on foreign direct investment.
5. There is no bi-directional relationship between energy consumption and economic growth in Kenya both in the short-run and long-run

Gross Domestic Product (GDP)

Gross domestic product for the current quarter, is explained by 45.01% of its own lags and the lags of foreign direct investments, electricity energy consumption, petroleum energy consumption and renewable energy consumption. If the gross domestic product increased by one unit (1%) in the last quarter; then the gross domestic product in this quarter will decrease by 66.2%. Immediately there is a shock in gross domestic product, GDP itself increases by 0.088 units and by 0.278 units in the first quarter. GDP adjusts at a speed of 2.06% upwards towards the long-term equilibrium. Gross domestic product has a forecast error which is also explained by itself to a great extent as it is 97.07% in the first quarter and 95.76% in the last quarter. Gross domestic product is an endogenous variable. The shock on GDP causes a positive permanent effect on gross domestic product.

Quah and Blanchard (1989), examined the differences between supply and demand shocks on the growth or output. They opine that demand shocks tend to have a temporary or transient effect on output. In an identical study, King et al. (1991) researched on the permanency of productivity on the movement of output, investment, and consumption. They surmised that shocks which are long-lasting account for more than two-thirds of economic growth. These two studies are in line with the findings of this study.

Foreign Direct Investment (FDI)

Foreign Direct Investment for the current quarter is explained by 53.63% of its own lags and the lags of Gross Domestic Product, electricity energy consumption, petroleum energy consumption, and renewable energy consumption. If the foreign direct investment went up by one unit (1%) in the last quarter; then foreign direct investment in the current quarter will go down by 67.8%. FDI adjusts at a speed of 54.71% downwards towards the long-term equilibrium. FDI is an exogenous variable as the factor error variance decompositions at various steps add up to less than 100%. The shock effect on foreign direct investment has a permanent effect on foreign direct investment which is positive.

The shock therefore is non-permanent. Lee, Co, and Strazicich (2001) examine the movement of investments in portfolios and foreign direct investment for developing countries to check whether the shocks have temporary or permanent impacts. They declared that the shocks are temporary and are dependent on controls of the balance of payments. This is in line with this research results.

Electricity Energy Consumption (EEC)

Electricity energy consumption in the current quarter is explained by 65.70% of its own lags and the lags of gross domestic product, foreign direct investments, petroleum energy consumption and renewable energy consumption. If the electricity energy consumption in the previous quarter hiked by one unit (1%); electricity energy consumption in the present quarter will reduce by 90.2%. Electricity energy consumption adjusts at a speed of 16.59% upwards towards the long-term equilibrium. Electricity energy consumption is an exogeneous variable because its factor error variance decompositions at various steps sum up to more than 100%. A shock in electricity energy consumption over the subsequent 12 quarters has positive and negative units and is therefore a transitory shock. Dogan (2016), sought to investigate if shocks to electricity consumption are temporary or permanent in Turkey. He concludes that, twelve cases are stationary, and forty-eight cases are non-stationary. Therefore, he opines that policies which either shrink or expand the usage of electricity have permanent implications on the consumption of electricity consumption in eighty percent of the cases and non-permanent implications in twenty percent of the cases.

Petroleum Energy Consumption (PEC)

Petroleum energy consumption in the current quarter is explained by 51.78% of its own lags and the lags of gross domestic product, foreign direct investments, electricity energy consumption and renewable energy consumption. When petroleum energy consumption decreases by one unit (1%) in a preceding quarter; petroleum energy consumption will decrease by 93.4% in the succeeding quarter. Petroleum energy consumption adjusts at a speed of 10.38% upwards towards the long-term equilibrium.

Petroleum energy consumption is an exogeneous variable because of the factor error variance decompositions. A shock in petroleum has a permanent positive effect to itself.

Sameh, Abdallah and Ziad (2021) conclude that the petroleum consumption is a unit root process, which implies that the disturbances to the consumption of petroleum products have a perpetual effect, meaning that the consumption does not revert back to its original trend after a disturbance. These findings showed that there are high chances that conservation policy frameworks and energy-demand management policies should be directed to achieve the intended targets in the long term.

Renewable Energy Consumption (REC)

Renewable energy consumption this quarter is explained by 83.60% of its own lags and the lags of gross domestic product, foreign direct investments, electricity energy consumption and petroleum energy consumption. when renewable energy consumption rose by one unit (1%) in the past quarter; renewable energy consumption will rise in the current quarter by 114%. Renewable energy consumption adjusts at a speed of 90.55% downwards towards the long-term equilibrium. Renewable energy forecast error is explained substantially by itself over the next 12 quarters at a percentage that is near 100%. It is an endogenous variable. In the following 12 quarters after the disturbance, renewable energy consumption goes up in some quarters and down in other quarters. The shock is therefore transitory.

Aydin, Mucahit, and Pata (2020) carried out an analysis for the different states in America. Generally, they opine that policy recommendations which are implemented in United States and have long-lasting impacts on seven categories of renewable energy consumption, while the same policy frameworks have non-permanent impacts on biofuels and hydropower consumption of energy. Energy consumption in the US which is very developed would be very significant compared to a developing country such as Kenya. Kenya therefore follows the same conclusion as the renewable energy category with transient shock effects.

Research Implications

Electricity energy consumption and gross domestic product

Equation III indicates the short-run relationship, if the electricity energy consumption in the previous quarter hiked by one unit (1%), the Gross Domestic Product will reduce by 13% but it is not statistically significant. If the gross domestic product increased by one unit (1%) in the last quarter, then electricity energy consumption will increase by 4.4% but not statistically significantly. Table 4.13a) and table 4.13 c) for the long- run relationship, at the point when there is a shock in electricity energy consumption, there is a non-permanent effect on gross domestic product. Immediately the shock happens in electricity energy consumption, GDP has zero effect and then it is positive in the 1st quarter and 2nd quarter and negative in the 3rd quarter and 5th quarter. A shock in gross domestic product also causes an instant decrease in electricity consumption of 0.04 units, then a decrease in the 1st and second quarters and an increase in the third quarter. The shock is therefore not permanent. Over the next 12 quarters of the GDP shock, the effect on electricity energy consumption is negative in all quarters except quarter 3 giving a transient effect.

This finding upholds the growth hypothesis from Payne (2010) which posits that there exists a unidirectional causality emerging from energy consumption to economic growth. In these circumstances, policies should be aimed at conserving electricity because its consumption is vital for the growth in the economy.

Petroleum energy consumption and gross domestic product

Equation IV shows the short run when petroleum energy consumption decreases by one unit (1%) in a preceding quarter; the gross domestic product increases by 5.9% but not statistically significantly. If the gross domestic product increased by one unit (1%) in the last quarter, then electricity energy consumption in the current quarter will increase by 3.8% and is not statistically significant.

Table 4.13a) and Table 4.13 d) for the long run, at the instance when there is a shock in petroleum energy consumption, there is no effect on gross domestic product. In the next twelve periods, all the GDP amounts are negative except for quarter 3, showing the shock is not permanent. Immediately there is a shock in gross domestic product there is a decrease in petroleum energy consumption by 0.01 units and then by 0.006 units in the first period. The shocks in GDP over the subsequent 12 quarters cause negative effects on petroleum energy consumption except for the 3rd and 6th quarters which have positive units. The shock is temporal.

These results support the neutrality hypothesis that posits that the consumption of energy is a small component of ascertaining the gross domestic product hence actions that lead to the conservation of energy usage would not impact the gross domestic product negatively. Zaman and Akhmat (2013) who carried out a bootstrap causality test on a number of Asian countries, concluded that energy consumption & economic growth all favored the neutrality hypothesis for most of the Asian countries.

Renewable energy consumption and gross domestic product

Equation V presents the short-term relationship, after renewable energy consumption rose by one unit (1%) in the past quarter, the gross domestic product will decrease by 2.7% in the current quarter but not significantly. After the gross domestic product increased by one unit (1%) in the last quarter, renewable energy consumption will increase by 1.9% but not significantly. Table 4.13a) and Table 4.13 e), in the long-term, immediately there is a shock in the gross domestic product, there is an increase in renewable energy consumption by 0.035 units. A shock in gross domestic product has a transitory effect on renewable energy consumption over the subsequent 12 periods- some quarters have positive increases in units while others have negative. Immediately there is a shock on renewable energy consumption, there is no effect on GDP. The shock is permanent as all quarters have positive values.

Lehmann et al. (2017) observe that compared to solar and wind, the energy density of ocean waves is far higher and is much more predictable. Furthermore, in the case of the US, resource sites with significant wave power are near major load centres, as coasts tend to be where most of the country's population resides. Due to these factors, there has been a rise of interest in the US in attempting to economically exploit ocean wave power.

The objective of this article is to analyse the current status of ocean wave energy transformation technology Research and Development (R&D), and government backing in the US and to provide some insight into its potential future. Active research teams and commercial ventures have been uncovered, as have current infrastructure, software, and open water experimental facilities and resources. Although the United States is home to more than a third of the world's economically active wave energy companies, very few have achieved a very high-Tech Readiness Level. These results, along with the existence of a useful practical resource and the benefits it offers, suggest that the United States is prepared to lead the way in the development of the wave energy industry.

Electricity energy consumption and foreign direct investment

From equations II and III, at the short-term stage, if the foreign direct investment went up by one unit (1%) in the past quarter; then electricity energy consumption will go down by twenty-seven percent in the current quarter. This is statistically significant with the P Value being less than 5%. If the electricity energy consumption in the previous quarter hiked by one unit (1%), foreign direct investment will go down by 22.4% units and is statistically significant. Tables 4.13 b) and 4.13 c) display the lasting stage, a shock in electricity energy consumption has a non-permanent effect on foreign direct investment. Immediately the shock occurs on EEC, FDI has no impact then it increases by 0.09 units in quarter one and decreases by 0.28 units in quarter 2. A disruption in FDI also causes a non-permanent effect on EEC. The units increase and decrease around the zero mark, at the instant of the shock, EEC goes down by 0.152 units, increases by 0.126 units in quarter one, and decreases by 0.018 units in quarter two.

Alam (2013) performs an empirical analysis for Pakistan and India, between the year 1975 to the year 2008. The results indicated that there is a long-run causality from consumption of electric power to foreign direct investment which boosts economic growth for India. As for Pakistan, there is causality discovered for FDI and GDP which induces the electric power consumption at the long run. The Kenyan results show a bi-directional linkage between FDI and EEC in the short run. Alam (2013) explained that boosting foreign direct investment inflows in Pakistan has contributed to an increase in the consumption of electric power. He opines that it is a fact that foreign direct investment through skill transfers and technology contributes to economic growth. The conclusion is

that foreign direct investment, directly and by its synergies with economic growth in the Pakistan economy, boosts the consumption of electric power.

Petroleum energy consumption and foreign direct investment

Equations II and IV, are an indication of the short-duration linkage, in case the foreign direct investment goes up by one unit (1%) in this quarter; then petroleum energy consumption will go up by 27.8% in the next quarter but statistically insignificant. In the case where petroleum energy consumption increases by one unit (1%) this quarter then foreign direct investment will go down by 8.3% in the next quarter but not significantly. Table 4.13d) and table 4.13 b) show the long-duration linkages, a disruption of PEC, which makes FDI increase and decrease in different units over the next 12 periods, causing a momentary change. An agitation in FDI causes a permanent negative effect on PEC as all quarters have negative amounts.

Muramalla and Gawad (2013) who studied the consequence of foreign direct investment on gas, oil, their refinery, and production, opine that the relationship between foreign direct investment and the production of Crude Oil is not significant in the fourteen countries of study in the world and conclude that the production of Crude Oil does not impact FDI and vice versa. This conclusion is in line with this study for the short-run relationship but contrary for the long-run relationship which confirms that foreign direct investment has a permanent impact on petroleum energy consumption.

Renewable energy consumption and foreign direct investment

Equations V and I, explain that, in the quarter that the foreign direct investment increases by one unit (1%), then renewable energy consumption will increase by 139.1% in the next quarter, and this is statistically significant. In the quarter that renewable energy consumption goes up by one unit (1%), then foreign direct investment goes up by 18.8% which is statistically significant. From Table 4.13e) and Table 4.13 b) At the instance when there is a distraction in REC, there is zero impact on FDI, which then drops by 0.08 units in the first quarter. The shock on REC causes increases and decreases in FDI units in the next twelve quarters causing an impermanent shock. At the moment when there is a disturbance in FDI, there is also an impermanent impact on REC as the units are positive and negative over the next 12 periods.

Khandker, Khan, and Amin (2018) in their research find that FDI and the use of renewable energy are intertwined for either a brief timeline and a lengthy timeline. However, they observe no short-term causal link between renewable energy usage and FDI. According to Maubleu (2006), energy is the basis for all human endeavors; therefore, it's exciting to consider the potential of solar water heaters for Pakistan's textile industry. Pakistan's primary energy source has always been fossil fuels. However, the rapid depletion of fossil fuels and their connection to increasing global warming are two important issues. It is now generally understood that traditional energy sources like fossil fuels and nuclear power must be rapidly supplanted by renewable sources if sustainable development is to be achieved. The latter are environmentally beneficial and can provide enough energy to meet current and forecasted world needs. Pakistan is one of the world's leading cotton producers. Pakistan's textile industry is thriving largely due to the country's abundant supply of domestic cotton. The majority of its cotton goods are exported. Pakistan's textile sector, which competes successfully on the global stage, is always looking for new, cutting-edge machinery to enhance the quality of its wares. To meet international standards, the textile industry in Pakistan is struggling with how to reduce its environmental effects. The intersection of falling prices brought about by technological advancements and government policies encouraging utilization of renewable energy has led to solar power's meteoric rise in popularity in recent years (Timilsina, Kurdgelashvili and Narbel, 2011).

Timilsina, Kurdgelashvili and Narbel, (2011) examine the technological, economic, and policy facets of solar energy creation and implementation. Despite significant price reductions over the past few years, solar energy is still prohibitively expensive compared to more traditional sources of power. Regulatory and financial incentives and mandates, such as tax credits and rebates, feed-in-tariff, favorable rates, policy measures, and optional green power programs, are all to the benefit of solar energy, just as they are for other energy sources. Potential growth in carbon credit markets might also boost incentives for solar energy deployment, although current carbon market mechanisms like the “Clean Development Mechanism of the Kyoto Protocol” can only go so far. Solar energy technologies have enormous technical capacity, but there are still many technical and financial hurdles that need to be cleared before they can be developed and used on

a global scale in response to market forces. The continued implementation of possibly expensive governmental supports will be necessary to keep and expand solar-generated electricity supplies until these obstacles are removed.

Obeng and Hans-Dieter (2009) in their paper “Solar PV rural electrification and energy poverty” review the conceptional framework in Ghana. Despite the fact that governments aim to enhance the incorporation of renewable power in electricity supply, specifically solar photovoltaic for energy alleviating poverty in remote regions of Africa, there seems to be relatively little knowledge on how solar Photovoltaic electrification implications on energy poverty reduction. As a result, there is a lack of relevant published material, calling for ongoing study. Solar photovoltaic (PV) rural electricity in Ghana is examined, including its background trend, donor cooperation, and other factors. The research shows how solar PV electricity is connected to other metrics, such as those for health, learning, food security, and small business growth. Costs and market obstacles, subsidies, stakeholder engagement, political and regulatory ramifications, and so on are all discussed, as they are crucial to the long-term success of the solar PV and renewable energy markets. In summary, a standardized framework is created to supply a fundamental comprehension of the effects of solar PV electrification on energy poverty. This framework organizes the linked ideas and principles that are at play in the problems being considered.

Solangi et al. (2011) observe that many nations have to look into and switch to renewable, ecologically friendly energy sources in order to meet their rising energy needs in light of the environmental repercussions and other challenges associated with burning fossil fuels. When compared to other renewable energy options, solar has one of the minimal environmental impacts. Numerous nations' governments have enacted solar energy initiatives to lessen their reliance on imported fossil fuels and boost homegrown solar power. The purpose of this paper is to provide a comprehensive assessment of the various solar energy policies now in place across the globe. Compared to 2008, the global cumulative deployed solar energy capacity increased by 46.9 percent in 2009, to a total of 22928.9 MW, as reported by the BP Statistical Energy Survey. This article also reviewed the current, viable solar energy initiatives of a handful of countries. A review of the research reveals that feed-in tariffs (FIT), renewable portfolio standards (RPS), and

subsidies are the most effective energy policies now in use in many nations. These regulations give substantial incentive and interest in the research, development, and deployment of renewable energy systems. In addition, the current state of solar energy policy in Malaysia is examined and compared to that of other, more advanced countries. Solar power is among the most potential renewable sources. It's remarkably reliable, and it doesn't seem to be overly sensitive to variations in the seasons. For a wide range of uses, solar energy and solar photovoltaic technologies can be put to good use. Producing electricity from solar energy is not only easier than from non-renewable sources like coals and fossil fuels, but it is also much better for the environment. There has been a steady rise in energy use around the world, so making the switch to solar power could be a good option. The study shows that practically all countries that generate electricity from solar sources have solar-energy-specific legislation in place. Countries like Canada, Germany, the United States, Australia, Spain, China, and France that have successfully implemented solar energy systems are examples of what can be accomplished. The presence of solar energy legislation helped these countries dramatically increase their solar power generation. In most countries, renewable energy is supported by a variety of policies, such as tax breaks, subsidies, a Feed-in Tariff, subsidies for business startup, and renewable energy portfolio criteria. The impacts of external costs on environmental protection, public health, economic progress, or institutional goals like emissions growth management have become increasingly relevant to policy studies around the world. The government of Malaysia has established a number of renewable energy development policies, such as laws, regulatory requirements, economic inspiration, technical R&D, industrialized assistance, and renewable energy design initiatives, etc., to promote and guarantee the rapid, productive, and flawless renewable energy development. These regulations give substantial incentive and interest in the research, development, and deployment of renewable energy systems. Despite its potential, Malaysia's policy on renewable energy development has some shortcomings. These include a shortage of coordination and consistency in the policy framework; minimal motivation at the lower level; an absence of regional policy advancement; a disordered and inadequate financing and investment scheme; and underinvestment in technical R&D of renewable energies. Malaysia joined the “International Energy Agency's Photovoltaic Power System Program”

(IEAPVPS) as a full member on October 23, 2008, in order to implement its own solar energy policy. Malaysia's PV market is still very tiny compared to those of other wealthy countries. With the help of monetary incentives provided by the “Malaysian Building Integrated Photovoltaic” (MBIPV) Project, the grid-connected PV sector got its start in 2006. To further propel the growth of the PV industry, the government of Malaysia plans to enact a fresh Renewable Energy Strategy by 2011. It is expected that renewable energies will play an increasingly important role in Malaysia as the country transitions away from fossil fuels and towards alternative fuels that are really clean, sustainable, and safe.

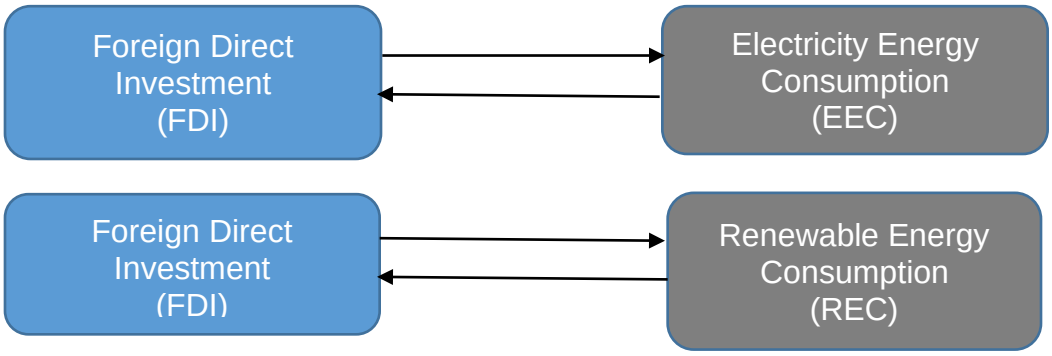
Foreign direct investment and gross domestic product

Equations II and I imply that, when the foreign direct investment escalates by a unit in the current quarter, GDP will go up by 29.4% in the next quarter statistically insignificantly. A unit increase in GDP, makes FDI decrease by 1.4% but not significantly. Tables 4.13 b) and 4.13 a) prove that an impact on FDI has no effect on GDP immediately. It has a non-permanent effect going forward with increases and decreases in the units over the subsequent twelve periods. A disturbance in GDP has a permanent/ long-lasting positive impact on FDI, all the values in the consecutive twelve quarters are positive.

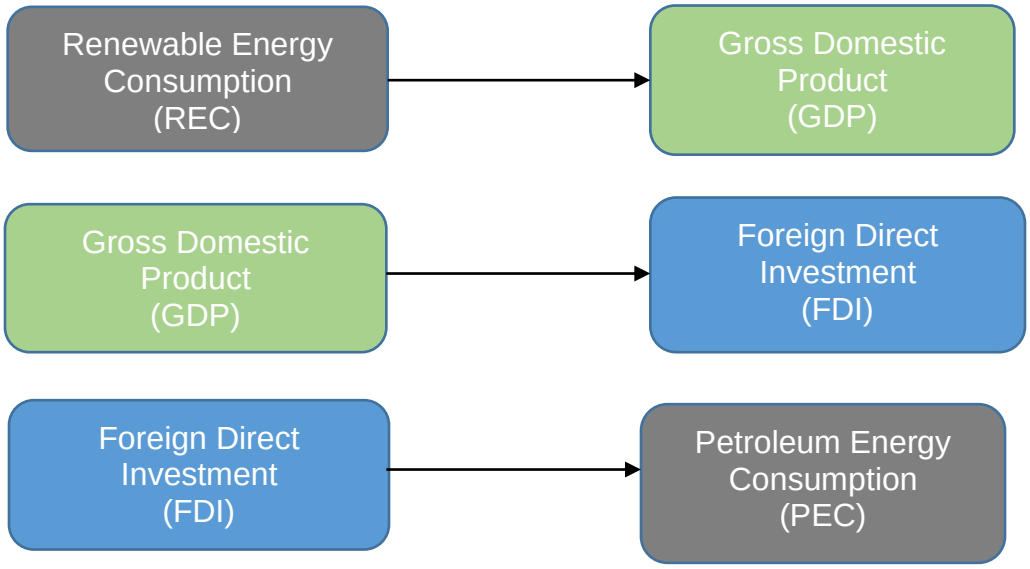
The finding from this study is in line with Mavrotas and Chowdhury (2006) who examine the causality between economic growth and foreign direct investment by applying the Toda-Yamamoto test for 3 economies that are developing and found that GDP impacts FDI but not vice versa. These findings however go against Hansen and Rand (2006), who found out that foreign direct investment has a perpetual effect on the gross domestic product of the thirty-one countries while the gross domestic product has no long-lasting effect on the foreign direct investment of these economies.

Figure 15: Overall impact of Variables Diagrams

Short-run relationships



Long-run relationships



	Moderating Variable
	Independent Variable
	Dependent Variable

The Energy Consumption Theory Implications

The findings of this study are in line with the Energy consumption Theory. The results show that FDI affects all three forms of energy consumption – petroleum, electricity, and renewable energy. FDI's impact on energy consumption extends beyond technological advancements, encompassing its ripple effects on economic growth and consumer behavior. The infusion of FDI often acts as a catalyst for economic expansion, fueling heightened levels of consumption and production. Consequently, this surge in economic activity translates into increased energy demand, as industries and consumers alike ramp up their energy requirements to support burgeoning economic endeavors. FDI has the potential to revolutionize production methodologies, usher in cleaner technologies, and elevate energy management practices. These advancements play a pivotal role in optimizing the overall efficiency of energy utilization within an economy, a central tenet of energy consumption theory. The results also show that renewable energy consumption has a long-term positive effect on the economic growth which is in line with this theory. Government policies and incentives are instrumental in fostering the uptake of renewable energy consumption, leveraging mechanisms such as targets, tariffs, and standards to incentivize investment in renewable projects. These policy frameworks are designed to spur the development and adoption of renewable energy sources by providing financial incentives, setting ambitious targets for renewable energy deployment, and establishing regulatory standards to ensure their integration into the energy mix. The underlying premise of these policies aligns with the recognition of the environmental advantages associated with renewable energy. By tapping into clean, sustainable energy sources such as wind, solar, and hydroelectric power, societies can substantially mitigate their carbon footprint, curbing greenhouse gas emissions and improving overall air quality. The emphasis on sustainability underscores the imperative of transitioning towards renewable energy sources as a crucial component of addressing climate change and promoting environmental stewardship.

Recommendations for application

Foreign direct investment and electricity energy consumption

The findings of this study show that in the short-run, foreign direct investment and electricity energy consumption have a bi-directional relationship. Othman and Bekhet (2011) analyze causality amongst consumption of electricity, consumer expenditure, GDP and FDI in Malaysia. They employ time series data from year 1971 to year 2009. They use the VECM (vector error correction model) for estimate these causal relationships between electricity consumption and the independent variables. The analysis shows that there is a long run causality from electricity consumption to FDI which is significant. They opine that consumption of electricity is a vital component in the growth of the economy in Malaysia and a dominant tool in the execution of government policies for energy-saving.

Policymakers should be aware of how important a stable supply of electricity supply is in order to even gain the confidence of foreign investors to put in their investments. The Ministry of energy in Kenya and the Kenya Electricity Generating Company (KenGen) should make sure that the supply of electricity grows at a much faster rate than the consumption of electricity. From the findings, it is clear that Kenya is an energy-dependent country. Electricity consumption is the largest in size from the data gathered. Going forward, the energy policy framework should target to expand the generation of electricity and concurrently explore possible methods of renewing the generation of electricity. The Kenyan government through the Kenya Revenue Authority should ensure favorable tax regulations for foreign investors to attract them into investing. Foreign investors must also be assured of good management of energy growth policies to ensure that there is value for their money and that the return on investment will be achieved faster.

Foreign direct investment and petroleum energy consumption

The findings of this research show that in the short run, FDI and petroleum energy consumption do not have a statistically significant relationship. In the long run however, foreign direct investment has a permanent effect on petroleum energy consumption. Uzar and Eyuboglu (2019) conducted a comprehensive study on the interrelationships among energy consumption, foreign direct investment (FDI), economic growth, and trade openness in Turkey over the period spanning from 1980 to 2015. Their research

employed innovative analytical techniques including the Fourier ARDL (2017) and ARDL tests to analyze these connections. Their findings revealed that energy consumption, FDI, economic growth, and trade openness in Turkey are cointegrated, indicating a deep-rooted relationship among these variables. They observed that increases in both economic growth and trade openness have positive effects on energy consumption in both the short-term and long-term, while FDI exerts a positive impact on energy consumption only in the long-term. Furthermore, the Vector Error Correction Model (VECM) causality analysis revealed that FDI, economic growth, and trade openness are significant drivers of energy consumption in the long-term. Based on these results, Uzar and Eyuboglu propose policy recommendations for Turkish policymakers. They suggest incentivizing a shift in the composition of FDI towards sectors that promote energy efficiency. Specifically, they advocate for redirecting FDI inflows away from industries utilizing environmentally harmful technologies towards cleaner sectors such as information technology and services. Additionally, they recommend increasing FDI inflows targeting green technologies and renewable energy sources to enhance energy efficiency in Turkey. In essence, their study highlights the importance of strategic policy interventions to leverage FDI inflows towards fostering sustainable economic growth and energy efficiency in Turkey. By incentivizing investments in clean technologies and renewable energy, policymakers can contribute to both economic development and environmental sustainability objectives.

Zangoei and Salehnia (2021) conducted a significant study focusing on the impact of both fossil and alternative energy consumption on foreign direct investment (FDI) and economic growth in selected developing countries over the period from 1986 to 2016. Their research particularly delved into understanding the dynamics of knowledge and technology transfer via FDI and its subsequent influence on economic growth, with a focus on mitigating environmental pollution. Using the Seemingly Unrelated Regression (SUR) technique, the study revealed several key findings. Firstly, it was observed that both alternative energy and fossil fuels exert a positive effect on GDP, indicating that energy consumption contributes to economic growth in these developing countries. Surprisingly, oil rents were found to have no significant impact on economic growth. Furthermore, the study found that FDI also has a positive effect on economic growth, and

energy resources play a crucial role in amplifying foreign investment. However, this amplification comes at the cost of increased CO2 emissions, as higher energy consumption is associated with increased FDI. One critical aspect highlighted by the study is the phenomenon where investors, attracted by lax environmental regulations in low-income and developing countries, tend to transfer industries to these regions. This relocation exacerbates energy consumption, particularly since many of these industries rely heavily on energy. Consequently, there's a heightened importance placed on alternative energy sources in these host countries to mitigate the environmental impact of FDI.

Based on their findings, Zangoei and Salehnia offer pertinent policy recommendations. They advocate for the enhancement of energy policies in these developing countries to better manage the flow of foreign investment. Redirecting foreign investment towards the production of local energy sources can help reduce reliance on fossil fuels and alleviate environmental pressures. This strategic approach aligns economic growth objectives with environmental sustainability goals, ensuring a more balanced and resilient development trajectory for these nations. Latief and Lefen (2019) conducted a study focusing on foreign direct investment (FDI) in Pakistan's energy and power sector. Their research shed light on the significant influence of FDI on the energy landscape of Pakistan, particularly against the backdrop of challenges such as circular debt and loan-based investments. One critical observation from their study is the precarious situation of Pakistan's power and energy sector, characterized by the looming issue of circular debt. The reliance on loan-based investments to address energy needs poses a threat to the country's economic stability, as the inability to repay loans could exacerbate the debt burden and negatively impact energy consumption. To address these challenges, Latief and Lefen offer several pragmatic recommendations for the Pakistani government. Firstly, they propose a concerted effort to reduce reliance on loans and seek alternative investment sources to meet energy requirements. This entails formulating policies aimed at enhancing tax collection and boosting exports to bolster the country's financial resources. Moreover, the study emphasizes the need for the government to address fundamental constraints within the power and energy sector. These include reducing dependence on oil and gas, addressing d e-rated capacity issues, tackling

circular debt through real investments and improved cash flow management, and enhancing energy security measures, particularly in remote areas. Furthermore, improving governance within the power and energy sector is identified as crucial. This involves recruiting skilled personnel, combating corruption, and implementing effective management practices to enhance sectoral performance and efficiency. In summary, Latief and Lefen's study underscores the importance of holistic reforms to address the multifaceted challenges facing Pakistan's power and energy sector. By adopting a comprehensive approach encompassing financial management, investment diversification, policy reforms, and governance enhancements, Pakistan can strive towards a more resilient and sustainable energy landscape.

The Energy and Petroleum Regulatory Authority (EPRA) in Kenya can introduce regulations, standards, and incentives to encourage businesses to adopt energy-efficient technologies and practices, thereby increasing the demand for petroleum-based energy. Since FDI often brings technological expertise and innovation, the Ministry of Energy in Kenya can facilitate technology transfer agreements between foreign investors and domestic firms to promote the adoption of cleaner and more efficient technologies in the energy sector. This will help improve the efficiency of petroleum-based energy production and consumption. The government of Kenya should impose stricter emission standards and pollution control measures, policymakers can incentivize the adoption of cleaner technologies and practices in the petroleum sector. The Government should also redirect FDI towards sustainable infrastructure projects, such as public transportation systems and smart cities this can attract foreign investment in these areas through targeted incentives and investment promotion initiatives. The Government of Kenya through NaMATA (Nairobi Metropolitan Area Transport Authority) had set up the BRT (Bus Rapid Transit) on the Thika Superhighway a project which stalled and never took off. It is now a high time for Kenya to implement such projects in all major cities across the country. Kenya signed an agreement with the UN-Habitat for a smart city -Konza Techno City which is in line with vision 2030. This project also stalled and would be a good place to start off. By implementing these strategies, policymakers can harness the potential benefits of FDI while increasing the consumption of petroleum and at the same time mitigating any negative environmental effects.

Foreign direct investment and renewable energy consumption

The test results of this study revealed that in the short-run, FDI and renewable energy consumption have a bidirectional relationship. In the long run, there are transitory effects on the shocks between foreign direct investment and renewable energy consumption. Insaidoo and Amoako (2021) who determined if there is an asymmetric effect of foreign direct investment on energy consumption in Ghana, opine that, by steadily growing the levels of FDI (foreign direct investment) over a period of time, it can aid in minimizing the energy consumption level which would assist Ghana to be on course in achieving the Sustainable Development Goals (SDG), one of which is accomplishing energy efficiency levels by the year 2030. The researchers also used annual time series data on the period 1981 to 2014 period. They found out that energy-saving benefits from foreign direct investment are yet to be obtained in Ghana.

Kenya set up its long-term development blueprint the vision 2030 which has been implemented and monitored through five-year Medium-Term Plans (MTPs). The third MTP which is the current one for years 2018 -2022 aims to achieve speedy and inclusive sustainable economic growth, social economic transformation and development. For the short-term, Kenya must start promoting the renewable energy sources including the wind energy whose production has been very low. In the long-term plan, Kenya has already started the policy developments of the Africa Union Agenda 2063. The agenda one on a flourishing African continent, based on Inclusive Growth and Sustainable Development advocates for Environmentally sustainable and climate resilient economies and communities and in essence renewable energy. Attracting foreign direct investment will aid in establishing renewable energy sources in different parts of Kenya. The Kenyan Government should ensure there are research and development programs for the energy sector so that alternative energy sources are full exploited. Innovation will be cultivated in the sector which will attract foreign direct investment into Kenya. Some of the research areas into sources of renewable energy include; improvement of storage of renewables, stabilization of power grids, making use of electric vehicles (an initiative that has already been launched by the Kenya Electricity Generating Company PLC (KenGen), concentration on solar power and looking into offshore wind power.

According to Zekai (2004), the widespread use of fossil fuels has resulted in unwelcome occurrences, such as environmental and atmospheric pollutions, that have never before been experienced in human history. This led to the widespread use of phrases like "global warming," "greenhouse effect," "climate change," "ozone layer depletion," and "acid rain" in scientific writing. Since 1970, scientists have known that the burning of fossil fuels contributes to these occurrences by releasing greenhouse gases like carbon dioxide and methane, which trap heat from the Earth's troposphere and prevent it from escaping into space. It is possible to lessen the effects of these phenomena by either improving the efficiency of fossil fuels by reducing their hazardous emissions into the environment or, alternatively, by replacing as much of the use of fossil fuels as plausible with ecologically friendly, clean, and sustainable energy sources. When compared to other renewable energy kinds like wind, geothermal, hydro, wave, and tidal, solar energy is clearly superior due to its abundance and relatively even distribution in nature. It is everyone's responsibility to ensure the planet is preserved for future generations by investing in renewable energy sources. However, the acknowledged limitations of fossil fuels oblige civilizations worldwide to strive together for their progressive substitution by renewable energy options as opposed to improving quality of fossil sources. The sun's rays are crucial to the operation of many eco-friendly power plants. It's the primary input variable, and it comes from the almost infinite sun. The future is bright for solar energy, especially in poor countries, but it also has promising prospects in rich nations. This paper's content has been carefully selected to provide a thorough introduction to solar energy and its various forms of conversion. Background information has been included to help set the stage for engineers and scientists who want to learn more about the topic, whether they're interested in using it or conducting research into it. Solar energy's high and low temperature collector applications are outlined, along with suggestions for future study. In addition, photovoltaic devices for generating electricity in the future via site-exploitation of solar power and transmission via various routes, including fiber-optic cables, are considered. The electrolysis analysis of water using solar energy is predicted to produce hydrogen gas in the not-too-distant future, which can then be used as a clean energy source. Solar-hydrogen energy describes the process of using solar energy in conjunction with water to create hydrogen gas. All the necessary context

for future studies and possible uses is provided. Future novel methods are discussed, and a literature analysis is provided along with suggestions for where future study and implementation could go.

Tie and Tan (2013) note that opportunities for the electric car industry have arisen as a result of climate change and the exhaustion of fossil fuels. Further, high energy-efficient automobiles are now a reality because to the speedy advancement of power electronics technologies. Because transportation uses such a large percentage of the world's energy, EVs may be the solution to reducing global greenhouse gas emissions. However, one-third of the price of an EV is attributable to the battery, creating significant financial obstacles for the industry. This study examines the current state of the art in EV energy generation, storage, power conversion, energy management, and supervisory control algorithms. The advantages and disadvantages of vehicle technology are contrasted and emphasized. Additionally, EV standards and drive cycle patterns are described. The development of power processors and power electronics has allowed for the incorporation of complex controls (low-level and high-level supervisory algorithms) in EVs to attain peak performance and the actualization of fast charging infrastructure. Due to the increasing number of EVs, the utility grid now includes a wider variety of renewable and sustainable energy sources, making demand management more complex than ever. Sales of EVs have increased globally as people become more conscious of environmental issues and the global fuel problem.

Serrano, Guillermo and Martinez (2009) argue that the recent surge in interest in nanotechnology has led to lofty predictions from many sectors, including the scientific community, the business world, government, and the public at large. The ability to create novel structures at the atomic scale has led to the development of materials and gadgets with promising applications in many different areas. In particular, there's need for major innovations in the energy industry to keep up with our ever-increasing demand for power, which rises both as more people enter the developed countries and as our standard of living improves. As more evidence of the societal impact on climate change, biodiversity loss, and environmental degradation in the water, air, and land becomes available, this must be carried out in a manner that accounts for environmental considerations in the process of creating wealth. Although it is beyond the scope of the review to discuss in

depth the many individual ways in which nanotechnology has aided in the development of different forms of sustainable energy, the paper does compile the most recent developments in the application of nanotechnology to these fields. The analysis focuses on the most important nanotechnology applications in the energy industry, including solar panels, hydrogen fuel cells, and cutting-edge batteries and supercapacitors. Using among the most intriguing and multidisciplinary disciplines, nanotechnology, the article aims to present some meaningful advances from several research groups that are largely disconnected and working from different perspectives to develop answers to one of the terrific challenges of our time, namely the production and utilization of energy without compromising the environment.

Renewable Energy Consumption and Gross Domestic Product

The analysis reveals that renewable energy consumption has a lasting effect on gross domestic product. This means that a shock in REC has a permanent impact on GDP. Ashraf and Abdullah (2020) examine the output elasticity coefficients of capital and renewable energy in 12 EU countries using the Cobb-Douglas production function approach, researchers utilized GDP data from 2000 to 2017. Employing a generalized method of moments estimation, they incorporated labor, capital, and renewable energy data. Their findings revealed that a 1% increase in labor, capital, and renewable energy resulted in various percentages of GDP growth, indicating significant relationships between GDP and the explanatory variables, both statistically and economically. The study's recommendation suggests that EU countries producing the most renewable energy should enhance their support policies for renewable energy utilization. This recommendation stems from the observed positive impact of renewable energy on GDP growth, indicating the potential economic benefits of prioritizing renewable energy development and utilization. By bolstering support policies, these countries can further capitalize on the economic advantages offered by renewable energy sources, fostering sustainable economic growth and environmental preservation simultaneously.

Lyeonov et al. (2020) conducted a comprehensive analysis of the interconnections among GDP per capita, greenhouse gas (GHG) emissions, renewable energy (RE) in total final energy consumption, and green investments in EU countries during the critical period of 2008-2016, encompassing both the financial crisis and the post-crisis era.

They utilized data from reputable sources such as Eurostat, the World Data Bank, and the European Environmental Agency to ensure robustness in their findings. Their research employed a variety of statistical techniques including panel unit root tests, Pedroni panel cointegration tests, as well as fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) panel cointegration methods to explore the relationships among these variables. The results of their analysis demonstrate significant linkages between GDP per capita, GHG emissions, renewable energy usage in total final energy consumption, and green investments. This underscores the intricate relationship between economic development, environmental sustainability, and investment in green initiatives. Based on their findings, Lyeonov and colleagues advocate for transformative measures within the energy utility sector, emphasizing alignment with Sustainable Development Goals (SDGs). They suggest that as significant contributors to both GDP generation and environmental degradation, energy utility industries should pivot towards more sustainable practices. This entails increasing investments in green technologies and energy-efficient projects, thereby facilitating the transition towards renewable energy sources and cleaner technologies. In summary, their research underscores the importance of prioritizing green investments to achieve both economic prosperity and environmental sustainability, particularly within the context of the European Union's energy landscape.

The government should ensure that through the Rural Electrification and Renewable Energy Corporation (REREC), they encourage investment in renewable energy infrastructure development, such as subsidies, tax incentives, and grants. These will spur private sector investment in renewable energy projects, create jobs, and stimulate economic activity. The Ministry of Energy must ensure there is renewable energy research and Development Funding by increasing funding for research and development in renewable energy technologies, there will be innovation and technological advancements in the renewable energy sector, driving down costs and improving efficiency, thereby enhancing its contribution to GDP growth. The government of Kenya must ensure there are regulatory support and market mechanisms to facilitate the integration of renewable energy into the energy market. This may include renewable energy targets, feed-in tariffs, net metering policies, and carbon pricing mechanisms,

which provide market incentives for renewable energy adoption. The Government through the state Department of Energy, should launch public awareness and education campaigns to promote the benefits of renewable energy adoption and encourage behavioral change towards more sustainable energy consumption patterns. Educating consumers and businesses about the economic advantages of renewable energy can drive demand and further stimulate growth in the sector. Many Kenyans have taken up solar panels in their homes, but industries have not yet adapted to the change. The Government must ensure that there is integration of renewable energy into economic Planning. This involves aligning renewable energy policies with overall economic objectives, such as job creation, industrial competitiveness, and environmental sustainability, to ensure coherence and effectiveness in policy implementation. Renewable energy must be incorporated into the annual budgeting from the finance bill stage to ensure that there is adequate public participation from the concerned stakeholders. By implementing these policy recommendations, policymakers can harness the positive impact of renewable energy consumption on GDP growth, driving sustainable economic development while mitigating climate change and promoting environmental conservation.

Gross domestic product and foreign direct investment

Findings of the research show that an impact in GDP has a permanent impact on foreign direct investment. Mavrotas and Chowdhury (2006) sought to find out if it is FDI that causes GDP or the vice versa from years 1969 to 2000. They conclude that special attention must be accorded to both the quality and overall role of economic growth as this is a vital component of foreign direct investment. In the same breath, for Kenya, the human labour quality, infrastructure, financial institutions, tax regime, governance, ICT, and legal framework among other factors must be enhanced to expand the GDP and consequently increase foreign direct investment. Rand and Hansen (2005) hypothesized Granger causality between foreign direct investment (FDI) and GDP for thirty-one developing countries over a period of thirty-one years. They note that foreign direct investment has a long-run significant effect on gross domestic product regardless of the level of development in a country. This is the opposite for this study as GDP is the one with a long-run effect to FDI. Soric and Cicak (2015) who also researched on the

relationship between FDI and GDP in European economies and made use of the VAR models, surmised that for Slovenia and Latvia there is evidence that GDP causes FDI.

This finding corroborated the theory that states that investors are attracted to more stable macroeconomic environments. The president through the ministry of foreign affairs and international trade should ensure that there are no administrative barriers, no unnecessary regulations, for foreign investments to be administered with ease into the economy.

Limitations of the research

The data used is from the year 2002 to 2021 (20 years) this is because renewable energy data is not recorded before this year. The Kenya National Bureau of Statistics did not keep renewable energy records before the year 2002. Getting quarterly data (to make 80 observations) ensured that the data was adequate for analysis. Data obtained is published information and therefore reliable and verifiable. Although the data excludes data before 2002, the data obtained is solid and reliable as it is from publicly published information in the country and has the recency element.

Recommendations for future research

For future research, there is a need to incorporate carbon emissions as climate change is now a major issue globally. Ozturk et al (2018) studied the impact of the growth if the economy on the consumption of electricity, FDI (foreign direct investment), and financial advancement on carbon dioxide discharges in Kuwait utilizing time series data for the years 1980 to the year 2013. This will enable institutions like the National Environment Management Authority (NEMA) to set up policies to reduce CO2 emissions across the country. The Kuznets Curve hypothesis can be used.

There is also a need to do the research as sector-based. The Kenyan economy is divided into different industries such as; agriculture, forestry & fishing, manufacturing, construction, electricity & water, transportation & storage, accommodation & food service, financial & insurance and information & communication. Both GDP and energy consumption are analyzed per industry to determine the effect and impact per sector and hence advise appropriately. Echevarria (1997) examines the changes in sectoral composition associated with economic growth in different countries. The Tado – Yamamoto technique has been widely used in similar researches and can be applied in

future researches. The Toda and Yamamoto approach offers an *alternative causality test approach which is based* on the Granger non-causality equation but is augmented with additional lags. Lebe et.al (2010) sought to determine the dynamic causal relation between consumption of electricity consumption and growth in the economy in Romania from the year 2001 to the year 2010 using the Tado - Yamamoto causality test.

Conclusions

This paper researched on the impact of foreign direct investment and how it links to the relations between usage of energy and the growth of the Kenyan economy. In measuring the economic growth of the country, the gross domestic product (GDP) is considered as the measure. The study looks at the petroleum sector, the electricity sector and the emerging renewable energy sector in Kenya. The utilized variables are petroleum energy consumption (PEC) as an independent variable, renewable energy consumption (REC) as another independent variable, electricity energy consumption as the third independent variable. The study used GDP as a dependent variable and foreign direct investment as a moderating variable. This study derived secondary data from the Kenya National bureau of statistics from year 2002 to the year 2021 for 20 years.

The findings indicated that foreign direct investment plays a crucial role in moderating between the relationship between different forms of energy consumption and the gross domestic product. Foreign direct investment has an effect on all the three independent variables – petroleum energy consumption (long run) electricity energy consumption and renewable energy consumption (short run). Gross domestic product affects foreign direct investment permanently in the long period. Shocks on renewable energy consumption have long-lasting effects on gross domestic product. Gross Domestic Product affects FDI permanently in the long run. FDI is a vital moderating variable and the Kenyan government should ensure that foreign investors are encouraged to invest as much as possible and that the barriers of entry are less stringent.

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Appendices

APPENDIX I

UREC provisional – Dissertation one Form

REAF_DSPA - Version 1.0

UNICAF UNIVERSITY
RESEARCH ETHICS APPLICATION FORM
DOCTORAL STUDIES PROVISIONAL APPROVAL

The Provisional Approval - Research Ethics Application Form (REAF) should be completed by Doctoral level candidates enrolled on Dissertation stage 1.

This form is a **provisional approval** which means that the UREC committee has accepted the initial description of the project but this is conditional as changes may have to be implemented following Dissertation Stage 2 and piloting in Dissertation Stage 3.

This is a conditional offer and acceptance of the project needs to be verified and confirmed upon completion of the Research Ethics Application Form in Dissertation Stage 3.

Important Notes:

- An electronic version of the completed form should be uploaded by the student to the relevant submission link in the VLE. Student's supervisor will then review the form and provide feedback commentary. Once supervisor's initial approval is given then the supervisor will forward this to doctoral.studies-aa@unicaf.org, for provisional approval by the Unicaf University Research Ethics Committee (UREC).
- Please type your answers and **do not** submit paper copy scans. Only *PDF* format documents should be submitted to the committee.
- If you need to supply any supplementary material, not specifically requested by the application form, please do so in a separate file. Any additional document(s) should be clearly labelled and uploaded in the relevant VLE link.
- If you have any queries about the form, please address them to your dissertation or project supervisor.

UNICAF UNIVERSITY

UNICAF UNIVERSITY RESEARCH ETHICS APPLICATION FORM DOCTORAL STUDIES PROVISIONAL APPROVAL	UREC USE ONLY: Application No: Date Received:

Student's Name: JOYCE KHASACHA OMINA

Student's E-mail Address: ominajoyce5@gmail.com

Student's ID #: R1812D6990032

Supervisor's Name: Dr. ALI SALEH A. AL ARUSSI

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUM: PhD Doctorate of Philosophy - Accounting and finance

Research Project Title: RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT (GDP) IN KENYA

1. **Please state the timelines involved in the proposed research project:**

Estimated Start Date: 24-Aug-2020 Estimated End Date: 7-Feb-2021

2. **The research project**

a. Project Summary:

In this section please fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect please ensure that you fully explain / define any technical terms or discipline-specific terminology (maximum 300 words +/- 10%).

PURPOSE OF THE RESEARCH AND RATIONALE

The purpose of this study will be to find out the relationship between energy consumption and the gross domestic product (GDP) in Kenya. Energy consumption has a direct/indirect/inverse relationship with the economic growth of a country. Many scholars have examined this relationship in the developing countries but there is no study in the Kenyan market or the East African market to show how these parameters relate with each other.

RESEARCH QUESTIONS TO BE EXAMINED AND HYPOTHESIS

The study will focus on answering the following research questions; What is the relationship between petroleum Energy consumption, Electricity Energy consumption & Renewable Energy consumption {solar, Hydro, Wind, Geothermal & Biomass} to Gross Domestic product (GDP) in Kenya?

EXPECTED RESULTS

If there is a relationship running from energy consumption to income, then this would mean that Kenya is an energy-dependent economy such that energy has an impact income, implying that a shortage of energy may negatively affect the GDP of the country. On the contrary, if there is a reverse chain of causality from income to energy, then this means a less energy-dependent Kenyan economy such that energy conservation policies may be implemented with little adverse or no effects on income.

b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (maximum 200 words).

SIGNIFICANCE OR BENEFITS OF THE STUDY

This is an interesting research area as there is a lot of debate on various energy matters in Kenya including; complaints about the high costs of electricity, debate on if electricity generation and distribution can cease to be monopolies, tapping into solar energy, high costs of fuel and restrictions being placed on the petrol drilling in the Turkana region due to tribal lines. This research will add value to the energy sector in Kenya by explaining how energy consumption affects the country's income. This will help to reduce or mitigate emissions- Kenya is rampantly growing into an industrial hub, this comes with emissions of gases which must be managed and controlled. The research will aid to come up with several policies including reducing energy consumption, increasing energy efficiency, decreasing energy intensity and increasing efforts towards forestation- since there are so many encroached forests in Kenya.

3. **Project execution:**

a. Type of project. The following study is an:

- [ ] experimental study (primary research)
- [x] desktop study (secondary research)
- [ ] desktop study using existing databases involving information of human/animal subjects
- [ ] Other

If you have chosen 'Other' please Explain:

b. Methods. The following study will involve the use of:

Method	Materials / Tools
☐ Qualitative	☐ Face to Face Interviews
	☐ Phone Interviews
	☐ Face to Face Focus Groups
	☐ Online Focus Groups
	☐ Other*
☑ Quantitative	☐ Self-administered Questionnaires
	☐ Online Questionnaires
	☐ Experiments
	☐ Tests
	☑ Other *

*If you have chosen 'Other' please Explain:

Statistical data from organizations such as the Kenya National Bureau of statistics (KNBS) and EPRA (Energy and Petroleum Regulatory Authority)

4. **Participants**

a. Does the Project involve the recruitment of participants?

☐ YES **If YES, please complete all following sections.**

☑ NO **If NO, please directly proceed to Question 5.**

Note: The definition of "participation" includes active participation, such as when participants knowingly take part in an interview or complete a questionnaire.

b. Relevant Participant Details of the Proposed Research

Please state the number of participants you plan to recruit, and describe important characteristics such as: demographics (e.g. age, gender, location, affiliation, level of fitness, intellectual ability etc). It is also important that you specify any inclusion and exclusion criteria that will be applied (e.g. eligibility criteria for participants).

Number of participants

Age range From To

Gender ☐ Female ☐ Male

Eligibility Criteria:

- Inclusion criteria
- Exclusion criteria

Disabilities

Other relevant information (maximum 100 words):

c. Recruitment Process for Human Research Participants:

Please clearly describe how the potential participants will be identified, approached and recruited (maximum 200 words).

d. Relationship between the principal investigator and participants:

Is there any relationship between the principal investigator (student), co-investigators(s), (supervisor) and participant(s)? For example, if you are conducting research in a school environment on students in your classroom (e.g. instructor-student).

☐ YES ☑ NO

If YES, please specify (maximum 100 words).

5. Further Approvals

Are there any other approvals required (in addition to ethics clearance from UREC) in order to carry out the proposed research study?

☐ YES ☑ NO

If YES, please specify (maximum 100 words).

6. **Potential Risks of the Proposed Research Study**

Are there any potential risks, psychological harm and/or ethical issues associated with the proposed research study, other than risks pertaining to everyday life events (such as the risk of an accident when travelling to a remote location for data collection)?

☐ YES ☑ NO

If YES, please specify (maximum 150 words):

7. **Application Checklist**

Please mark √ if the study involves any of the following:

☐ Children and young people under 18 years of age, vulnerable population such as children with special educational needs (SEN), racial or ethnic minorities, socioeconomically disadvantaged, pregnant women, elderly, malnourished people, and ill people.

☐ Research that foresees risks and disadvantages that would affect any participant of the study such as anxiety, stress, pain or physical discomfort, harm risk (which is more than is expected from everyday life) or any other act that participants might believe is detrimental to their wellbeing and / or has the potential to / will infringe on their human rights / fundamental rights.

☐ Risk to the well-being and personal safety of the researcher.

☐ Administration of any substance (food / drink / chemicals / pharmaceuticals / supplements / chemical agent or vaccines or other substances (including vitamins or food substances) to human participants.

☐ Results that may have an adverse impact on the natural or built environment.

UNICAF UNIVERSITY

8. **Final Declaration by Applicants:**

(a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University and Unicaf University Research Ethics Committee (UREC) for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.

(b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.

(c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.

(d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on http://www.who.int/ethics/research/en/ and to which Unicaf University aspires to.

(e) In addition to respect any and all relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.

(f) I understand it is my responsibility to submit a full REAF application during Dissertation Stage 3 to UREC. If a REAF application is not submitted my project is not approved by UREC.

(g) I fully acknowledge that this form does not constitute approval of the proposed project but it is only a provisional approval.

☑ **I agree with all points listed under Question 8**

Student's Name: JOYCE KHASACHA OMINA

Supervisor's Name: Dr. ALI SALEH A. AL ARUSSI

Date of Application: 04-Sep-2020

Important Note:
Please now save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled in copies; **do not** hand fill and submit scanned paper copies of this application.

☑ **Before submitting your application, please tick this box to confirm that all relevant sections have been filled in and the information contained is accurate to the best of your knowledge.**

UREC final approved- Dissertation one Form

REAF_DSPA - Version 1.0

UNICAF UNIVERSITY
RESEARCH ETHICS APPLICATION FORM
DOCTORAL STUDIES PROVISIONAL APPROVAL

The Provisional Approval - Research Ethics Application Form (REAF) should be completed by Doctoral level candidates enrolled on Dissertation stage 1.

This form is a **provisional approval** which means that the UREC committee has accepted the initial description of the project but this is conditional as changes may have to be implemented following Dissertation Stage 2 and piloting in Dissertation Stage 3.

This is a conditional offer and acceptance of the project needs to be verified and confirmed upon completion of the Research Ethics Application Form in Dissertation Stage 3.

Important Notes:

- An electronic version of the completed form should be uploaded by the student to the relevant submission link in the VLE. Student's supervisor will then review the form and provide feedback commentary. Once supervisor's initial approval is given then the supervisor will forward this to doctoral.studies-aa@unicaf.org, for provisional approval by the Unicaf University Research Ethics Committee (UREC).

- Please type your answers and **do not** submit paper copy scans. Only *PDF* format documents should be submitted to the committee.

- If you need to supply any supplementary material, not specifically requested by the application form, please do so in a separate file. Any additional document(s) should be clearly labelled and uploaded in the relevant VLE link.

- If you have any queries about the form, please address them to your dissertation or project supervisor.

UNICAF UNIVERSITY

UNICAF UNIVERSITY RESEARCH ETHICS APPLICATION FORM DOCTORAL STUDIES PROVISIONAL APPROVAL	UREC USE ONLY: Application No: Date Received:

Student's Name: JOYCE KHASACHA OMINA

Student's E-mail Address: ominajoyce5@gmail.com

Student's ID #: R1812D6990032

Supervisor's Name: Dr. ALI SALEH A. AL ARUSSI

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT (GDP) IN KENYA

1. **Please state the timelines involved in the proposed research project:**

Estimated Start Date: 24-Aug-2020 Estimated End Date: 7-Feb-2021

2. **The research project**

a. Project Summary:

In this section please fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect please ensure that you fully explain / define any technical terms or discipline-specific terminology (maximum 300 words +/- 10%).

PURPOSE OF THE RESEARCH AND RATIONALE

The purpose of this study will be to find out the relationship between energy consumption and the gross domestic product (GDP) in Kenya. Energy consumption has a direct/indirect/inverse relationship with the economic growth of a country. Many scholars have examined this relationship in the developing countries but there is no study in the Kenyan market or the East African market to show how these parameters relate with each other.

RESEARCH QUESTIONS TO BE EXAMINED AND HYPOTHESIS

The study will focus on answering the following research questions; What is the relationship between petroleum Energy consumption, Electricity Energy consumption & Renewable Energy consumption {solar, Hydro, Wind, Geothermal & Biomass} to Gross Domestic product (GDP) in Kenya?

EXPECTED RESULTS

If there is a relationship running from energy consumption to income, then this would mean that Kenya is an energy-dependent economy such that energy has an impact income, implying that a shortage of energy may negatively affect the GDP of the country. On the contrary, if there is a reverse chain of causality from income to energy, then this means a less energy-dependent Kenyan economy such that energy conservation policies may be implemented with little adverse or no effects on income.

b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (maximum 200 words).

SIGNIFICANCE OR BENEFITS OF THE STUDY

This is an interesting research area as there is a lot of debate on various energy matters in Kenya including; complaints about the high costs of electricity, debate on if electricity generation and distribution can cease to be monopolies, tapping into solar energy, high costs of fuel and restrictions being placed on the petrol drilling in the Turkana region due to tribal lines. This research will add value to the energy sector in Kenya by explaining how energy consumption affects the country's income. This will help to reduce or mitigate emissions- Kenya is rampantly growing into an industrial hub, this comes with emissions of gases which must be managed and controlled. The research will aid to come up with several policies including reducing energy consumption, increasing energy efficiency, decreasing energy intensity and increasing efforts towards forestation- since there are so many encroached forests in Kenya.

3. **Project execution:**

a. Type of project. The following study is an:

- ☐ experimental study (primary research)
- ☑ desktop study (secondary research)
- ☐ desktop study using existing databases involving information of human/animal subjects
- ☐ Other

If you have chosen 'Other' please Explain:

b. Methods. The following study will involve the use of:

Method	Materials / Tools
☐ Qualitative	☐ Face to Face Interviews
	☐ Phone Interviews
	☐ Face to Face Focus Groups
	☐ Online Focus Groups
	☐ Other*
☑ Quantitative	☐ Self-administered Questionnaires
	☐ Online Questionnaires
	☐ Experiments
	☐ Tests
	☑ Other *

*If you have chosen 'Other' please Explain:

The data is secondary statistical data from organizations and is publicly available. This includes the Kenya National Bureau of statistics (KNBS) and EPRA (Energy and Petroleum Regulatory Authority) websites which have all the data to be used in the study.

4. Participants

a. Does the Project involve the recruitment of participants?

☐ YES **If YES, please complete all following sections.**

☑ NO **If NO, please directly proceed to Question 5.**

Note: The definition of "participation" includes active participation, such as when participants knowingly take part in an interview or complete a questionnaire.

b. Relevant Participant Details of the Proposed Research

Please state the number of participants you plan to recruit, and describe important characteristics such as: demographics (e.g. age, gender, location, affiliation, level of fitness, intellectual ability etc). It is also important that you specify any inclusion and exclusion criteria that will be applied (e.g. eligibility criteria for participants).

Number of participants

Age range From To

Gender ☐ Female ☐ Male

Eligibility Criteria:

- Inclusion criteria
- Exclusion criteria

Disabilities

Other relevant information (maximum 100 words):

c. Recruitment Process for Human Research Participants:

Please clearly describe how the potential participants will be identified, approached and recruited (maximum 200 words).

d. Relationship between the principal investigator and participants:

Is there any relationship between the principal investigator (student), co-investigators(s), (supervisor) and participant(s)? For example, if you are conducting research in a school environment on students in your classroom (e.g. instructor-student).

☐ YES ☑ NO

If YES, please specify (maximum 100 words).

5. **Further Approvals**

Are there any other approvals required (in addition to ethics clearance from UREC) in order to carry out the proposed research study?

☐ YES ☑ NO

If YES, please specify (maximum 100 words).

6. **Potential Risks of the Proposed Research Study**

Are there any potential risks, psychological harm and/or ethical issues associated with the proposed research study, other than risks pertaining to everyday life events (such as the risk of an accident when travelling to a remote location for data collection)?

☐ YES ☑ NO

If YES, please specify (maximum 150 words):

7. **Application Checklist**

Please mark √ if the study involves any of the following:

☐ Children and young people under 18 years of age, vulnerable population such as children with special educational needs (SEN), racial or ethnic minorities, socioeconomically disadvantaged, pregnant women, elderly, malnourished people, and ill people.

☐ Research that foresees risks and disadvantages that would affect any participant of the study such as anxiety, stress, pain or physical discomfort, harm risk (which is more than is expected from everyday life) or any other act that participants might believe is detrimental to their wellbeing and / or has the potential to / will infringe on their human rights / fundamental rights.

☐ Risk to the well-being and personal safety of the researcher.

☐ Administration of any substance (food / drink / chemicals / pharmaceuticals / supplements / chemical agent or vaccines or other substances (including vitamins or food substances) to human participants.

☐ Results that may have an adverse impact on the natural or built environment.

8. **Final Declaration by Applicants:**

(a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University and Unicaf University Research Ethics Committee (UREC) for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.

(b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.

(c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.

(d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on http://www.who.int/ethics/research/en/ and to which Unicaf University aspires to.

(e) In addition to respect any and all relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.

(f) I understand it is my responsibility to submit a full REAF application during Dissertation Stage 3 to UREC. If a REAF application is not submitted my project is not approved by UREC.

(g) I fully acknowledge that this form does not constitute approval of the proposed project but it is only a provisional approval.

☑ **I agree with all points listed under Question 8**

Student's Name: JOYCE KHASACHA OMINA

Supervisor's Name: Dr. ALI SALEH A. AL ARUSSI

Date of Application: 04-Sep-2020

Important Note:
Please now save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled in copies; **do not** hand fill and submit scanned paper copies of this application.

☑ **Before submitting your application, please tick this box to confirm that all relevant sections have been filled in and the information contained is accurate to the best of your knowledge.**

REAF_DS - Version 3.1 AP

UNICAF UNIVERSITY
RESEARCH ETHICS APPLICATION FORM
DOCTORAL STUDIES

UREC USE ONLY:
Application No:
Date Received:

Student's Name: JOYCE KHASACHA OMINA

Student's E-mail Address: ominajoyce5@gmail.com

Student's ID #: R1812D6990032

Supervisor's Name: PROFESSOR ALI ALARUSSI

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUZ: PhD Doctorate of Philosophy

Research Project Title: THE ROLE OF FOREIGN DIRECT INVESTMENT (FDI) ON THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT IN KENYA

1. **Please state the timelines involved in the proposed research project:**

Estimated Start Date: 15-Nov-2021 Estimated End Date: 15-May-2022

2. **External Research Funding (if applicable):**

2.a. Do you have any external funding for your research?

☐ YES ☑ NO

If YES, please answer questions **2b** and **2c**.

2.b. List any external (third party) sources of funding you plan to utilise for your project. You need to include full details on the source of funds (e.g. state, private or individual sponsor), any prior / existing or future relationships between the funding body / sponsor and any of the principal investigator(s) or co-investigator(s) or student researcher(s), status and timeline of the application and any conditions attached.

No external sources of funds required

2.c. If there are any perceived ethical issues or potential conflicts of interest arising from applying or and receiving external funding for the proposed research then these need to be fully disclosed below and also further elaborated on, in the relevant sections on ethical considerations later on in this form.

No perceived ethical issues are anticipated

3. The research project

3.a. Project Summary:

In this section fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect ensure that you fully explain / define any technical terms or discipline-specific terminology (use the space provided in the box).

The general objective of this study will be study the relationship between the energy generation and the economic growth in terms of GDP (Growth Domestic product) in Kenya.

The main objectives are as follows;

1. To examine the relationship between Petroleum energy consumption and Economic Growth (GDP)
2. To examine the relationship between Electricity energy consumption and Economic Growth (GDP)
3. To examine the relationship between renewable energy consumption and Economic Growth (GDP)
4. To examine the relationship between foreign direct investments, Energy Consumption and Economic Growth (GDP)
5. To examine if there is a bi-directional relationship between energy consumption and economic growth in Kenya.

There are seven hypotheses in this study described as below; stating how the relationship of each variable to the other.

EXPECTED RESULTS

If there is a relationship running from energy consumption to income, then this would mean that Kenya is an energy-dependent economy such that energy has an impact income, implying that a shortage of energy may negatively affect the GDP of the country. On the contrary, if there is a reverse chain of causality from income to energy, then this means a less energy-dependent Kenyan economy such that energy conservation policies may be implemented with little adverse or no effects on income.

3.b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (use the space provided in the box).

SIGNIFICANCE OR BENEFITS OF THE STUDY

This research will focus on the role of Foreign Direct Investment (FDI) on the relationship between energy consumption and Gross Domestic Product (GDP) in Kenya. This is the first time that these three types of energy {i.e. petroleum, electricity and renewable energy} are being examined in relation to the economic growth together with the moderating variable- FDI. This study will focus on Kenya as a country. This is due to the fact that very few studies on the topic have been done, especially for the growing markets or developing economies and more so the East African countries. The industry under study is the energy sector because of the fact that this is a well discussed topic with Kenya Power being a monopoly company proving electricity in the whole country. The period of study will be from the year 2001 to the year 2020, covering 20 years. The years are deemed sufficient to analyze the relationships. The starting year of 2001 is due to the fact that renewable energy is still a new phenomenon and has not existed in Kenya for a long time. The ending year of 2020 will show the effect of COVID 19 on the economy variables as well.

4. **Project execution:**

4.a. The following study is an:

- ☐ experimental study (primary research)
- ☑ desktop study (secondary research)
- ☐ desktop study using existing databases involving information of human/animal subjects
- ☐ Other

If you have chosen 'Other' please Explain:

4.b. Methods. The following study will involve the use of:

Method	Materials / Tools
Qualitative:	☐ Face to Face Interviews
	☐ Phone Interviews
	☐ Face to Face Focus Groups
	☐ Online Focus Groups
	☐ Other *
Quantitative:	☐ Face to Face Questionnaires
	☐ Online Questionnaires
	☐ Experiments
	☐ Tests
	☑ Other *

*If you have chosen 'Other' please Explain:

The data is secondary statistical data from organizations and is publicly available. This includes the Kenya National Bureau of statistics (KNBS) and EPRA (Energy and Petroleum Regulatory Authority) websites which have all the data to be used in the study.

5. Participants:

5 a. Does the Project involve the recruitment and participation of additional persons other than the researcher(s) themselves?

☐ YES **If YES, please complete all following sections.**

☑ NO **If NO, please directly proceed to Question 7.**

5 b. Relevant Details of the Participants of the Proposed Research

State the number of participants you plan to recruit, and explain in the box below how the total number was calculated.

Number of participants: 0

N/A

Describe important characteristics such as: demographics (e.g. age, gender, location, affiliation, level of fitness, intellectual ability etc). It is also important that you specify any inclusion and exclusion criteria that will be applied (e.g. eligibility criteria for participants).

Age range From To

Gender ☐ Female ☐ Male

Eligibility Criteria:

- Inclusion criteria: N/A
- Exclusion criteria: N/A

Disabilities: N/A

Other relevant information (use the space provided in the box):

N/A

5 c. Participation & Research setting:

Clearly describe which group of participants is completing/participating in the material(s)/ tool(s) described in 5b above (use the space provided in the box).

None

5 d. Recruitment Process for Human Research Participants:

Clearly describe how the potential participants will be identified, approached and recruited (use the space provided in the box).

N/A

5 e. Research Participants Informed Consent.

Select below which categories of participants will participate in the study. Complete the relevant Informed Consent form and submit it along with the REAF form.

Yes	No	Categories of participants	Form to be completed
☐	☑	Typically Developing population(s) above the maturity age *	Informed Consent Form
☐	☑	Typically Developing population(s) under the maturity age *	Guardian Informed Consent Form

* Maturity age is defined by national regulations in laws of the country in which the research is being conducted.

5 f. Relationship between the principal investigator and participants.

Is there any relationship between the principal investigator (student), co-investigators(s), (supervisor) and participant(s)? For example, if you are conducting research in a school environment on students in your classroom (e.g. instructor-student).

☐ YES ☑ NO

If YES, specify (use the space provided in the box).

6. Potential Risks of the Proposed Research Study.

6 a. i. Are there any potential risks, psychological harm and/or ethical issues associated with the proposed research study, other than risks pertaining to everyday life events (such as the risk of an accident when travelling to a remote location for data collection)?

☐ YES ☑ NO

If YES, specify below and answer the question 6 a.ii.

6 a.ii Provide information on what measures will be taken in order to exclude or minimise risks described in 6.a.i.

N/A

6 b. Choose the appropriate option

		Yes	No
i.	Will you obtain written informed consent form from all participants?	☐	✓
ii.	Does the research involve as participants, people whose ability to give free and informed consent is in question?	☐	✓
iii.	Does this research involve participants who are children under maturity age? **If you answered YES to question iii, complete all following questions.** **If you answered NO to question iii, do not answer Questions iv, v, vi and proceed to Questions vii, viii, ix and x.**	☐	✓
iv.	Will the research tools be implemented in a professional educational setting in the presence of other adults (i.e. classroom in the presence of a teacher)?	☐	☑
v.	Will informed consent be obtained from the legal guardians (i.e. parents) of children?	☐	☑
vi.	Will verbal assent be obtained from children?	☐	☑
vii.	Will all data be treated as confidential? If NO, explain why confidentiality of the collected data is not appropriate for this proposed research project, providing details of how all participants will be informed of the fact that any data which they will provide will not be confidential.	✓	☐
viii.	Will all participants /data collected be anonymous? If NO, explain why and describe the procedures to be used to ensure the anonymity of participants and/or confidentiality of the collected data both during the conduct of the research and in the subsequent release of its findings.	✓	☐

		Yes	No
ix.	Have you ensured that personal data and research data collected from participants will be securely stored for five years?	✓	☐
x.	Does this research involve the deception of participants? If YES, describe the nature and extent of the deception involved. Explain how and when the deception will be revealed, and who will administer this debrief to the participants:	☐	✓

6 c. i. Are there any other ethical issues associated with the proposed research study that are not already adequately covered in the preceding sections?

☐ Yes ✓ No

If YES, specify (maximum 150 words).

6.c.ii Provide information on what measures will be taken in order to exclude or minimise ethical issues described in 6.c.i.

N/A

6 d. Indicate the Risk Rating.

☐ High ✓ Low

5 b. Relevant Details of the Participants of the Proposed Research

State the number of participants you plan to recruit, and explain in the box below how the total number was calculated.

Number of participants: 0

N/A

Describe important characteristics such as: demographics (e.g. age, gender, location, affiliation, level of fitness, intellectual ability etc). It is also important that you specify any inclusion and exclusion criteria that will be applied (e.g. eligibility criteria for participants).

Age range From To

Gender ☐ Female ☐ Male

Eligibility Criteria:

- Inclusion criteria: N/A
- Exclusion criteria: N/A

Disabilities: N/A

Other relevant information (use the space provided in the box):

N/A

6 b. Choose the appropriate option

		Yes	No
i.	Will you obtain written informed consent form from all participants?	☐	✓
ii.	Does the research involve as participants, people whose ability to give free and informed consent is in question?	☐	✓
iii.	Does this research involve participants who are children under maturity age? **If you answered YES to question iii, complete all following questions.** **If you answered NO to question iii, do not answer Questions iv, v, vi and proceed to Questions vii, viii, ix and x.**	☐	✓
iv.	Will the research tools be implemented in a professional educational setting in the presence of other adults (i.e. classroom in the presence of a teacher)?	☐	☑
v.	Will informed consent be obtained from the legal guardians (i.e. parents) of children?	☐	☑
vi.	Will verbal assent be obtained from children?	☐	☑
vii.	Will all data be treated as confidential? If NO, explain why confidentiality of the collected data is not appropriate for this proposed research project, providing details of how all participants will be informed of the fact that any data which they will provide will not be confidential.	✓	☐
viii.	Will all participants /data collected be anonymous? If NO, explain why and describe the procedures to be used to ensure the anonymity of participants and/or confidentiality of the collected data both during the conduct of the research and in the subsequent release of its findings.	✓	☐

		Yes	No
ix.	Have you ensured that personal data and research data collected from participants will be securely stored for five years?	✓	☐
x.	Does this research involve the deception of participants? If YES, describe the nature and extent of the deception involved. Explain how and when the deception will be revealed, and who will administer this debrief to the participants:	☐	✓

6 c. i. Are there any other ethical issues associated with the proposed research study that are not already adequately covered in the preceding sections?

☐ Yes ✓ No

If YES, specify (maximum 150 words).

6.c.ii Provide information on what measures will be taken in order to exclude or minimise ethical issues described in 6.c.i.

N/A

6 d. Indicate the Risk Rating.

☐ High ✓ Low

7. **Further Approvals**

Are there any other approvals required (in addition to ethics clearance from UREC) in order to carry out the proposed research study?

☐ YES ☑ NO

If YES, specify (maximum 100 words).

8. **Application Checklist**

Mark √ if the study involves any of the following:

☐ Children and young people under 18 years of age, vulnerable population such as children with special educational needs (SEN), racial or ethnic minorities, socioeconomically disadvantaged, pregnant women, elderly, malnourished people, and ill people.

☐ Research that foresees risks and disadvantages that would affect any participant of the study such as anxiety, stress, pain or physical discomfort, harm risk (which is more than is expected from everyday life) or any other act that participants might believe is detrimental to their wellbeing and / or has the potential to / will infringe on their human rights / fundamental rights.

☐ Risk to the well-being and personal safety of the researcher.

☐ Administration of any substance (food / drink / chemicals / pharmaceuticals / supplements / chemical agent or vaccines or other substances (including vitamins or food substances) to human participants.

☐ Results that may have an adverse impact on the natural or built environment.

9. **Further documents**

Check that the following documents are attached to your application:

		ATTACHED	NOT APPLICABLE
1	Recruitment advertisement (if any)	☐	☑
2	Informed Consent Form / Guardian Informed Consent Form	☐	☑
3	Research Tool(s)	☐	☑
4	Gatekeeper Letter	☐	☑
5	Any other approvals required in order to carry out the proposed research study, e.g., institutional permission (e.g. school principal or company director) or approval from a local ethics or professional regulatory body.	☐	☑

10. Final Declaration by Applicants:

(a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.

(b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.

(c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.

(d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on http://www.who.int/ethics/research/en/ and to which Unicaf University aspires to.

(e) In addition to respect any and all relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.

☑ **I agree with all points listed under Question 10**

Student's Name: JOYCE KHASACHA OMINA

Supervisor's Name: PROFESSOR ALI ALARUSSI

Date of Application: 04-Dec-2021

Important Note:
Save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled in copies; **do not** hand fill and submit scanned paper copies of this application.

APPENDIX II

Table 16 1

Data Collected

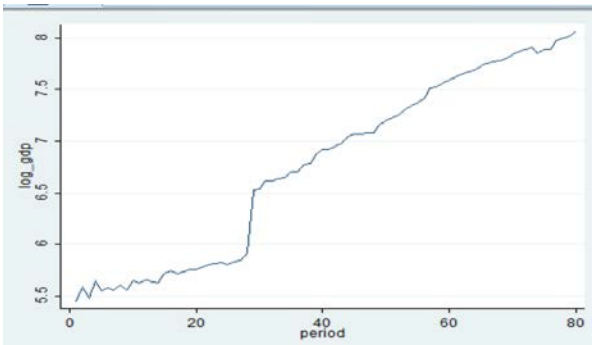
Year	PERIOD (Quarters)	GDP	FDI	EEC	PEC	REC
2002	1	233.46	36.93	789.66	599.08	82.70
	2	267.82	43.20	892.83	685.79	109.80
	3	240.35	54.21	675.57	504.32	124.31
	4	284.06	69.15	592.90	516.71	130.79
2003	5	256.74	129.83	1,020.88	526.70	97.28
	6	265.30	137.88	820.00	525.55	116.55
	7	260.11	209.45	700.50	608.96	149.36
	8	273.73	308.33	655.09	467.39	135.61
2004	9	261.05	82.80	1,283.70	609.72	146.90
	10	284.57	106.13	580.20	611.10	227.43
	11	278.29	157.32	774.37	567.89	301.46
	12	285.86	188.45	590.71	585.79	311.21
2005	13	281.34	17.85	625.43	934.60	150.30
	14	277.86	33.79	704.26	835.00	186.40
	15	303.05	54.77	872.49	696.40	201.50
	16	313.00	59.72	889.01	718.60	463.70
2006	17	304.48	49.99	1,270.30	745.20	175.44
	18	309.49	85.08	1,220.60	817.00	211.33
	19	317.36	104.63	910.30	665.50	210.45
	20	317.67	137.73	1,285.70	724.30	448.80
2007	21	327.18	1,547.32	1,303.20	718.40	196.34
	22	333.84	1,559.36	1,237.60	798.00	189.30
	23	335.79	1,742.12	1,304.70	687.80	269.67
	24	339.80	2,612.38	1,148.70	675.70	333.70
2008	25	331.80	376.18	1,285.00	751.40	173.56
	26	340.90	959.81	1,139.20	903.20	198.23
	27	347.57	998.12	1,364.60	690.90	294.09
	28	371.93	1,057.52	1,226.80	650.10	373.30
2009	29	682.14	2,440.79	1,304.60	755.30	302.44
	30	687.61	2,693.33	1,217.60	726.60	330.44
	31	747.67	2,887.07	1,278.40	681.70	310.20
	32	746.13	3,510.52	1,550.20	651.00	357.10
2010	33	758.34	2,032.24	1,598.80	990.56	265.29

	34	768.43	2,224.43	1,573.80	1,113.44	313.90
	35	812.78	2,489.33	1,614.89	987.32	373.00
	36	819.37	2,712.38	1,533.80	1,409.81	506.60
2011	37	876.86	2,499.44	1,811.64	781.11	328.70
	38	886.65	2,465.71	2,003.63	754.53	322.80
	39	974.11	3,131.46	1,684.03	790.70	404.89
	40	1,012.18	4,784.47	1,454.90	542.80	404.90
2012	41	1,012.87	2,598.35	1,029.10	840.30	323.88
	42	1,040.72	2,737.65	1,893.97	913.14	300.45
	43	1,074.09	2,869.27	1,583.70	943.62	353.23
	44	1,151.73	3,401.98	1,467.60	894.75	552.70
2013	45	1,171.62	2,074.94	1,495.50	1,017.16	302.90
	46	1,180.00	2,158.73	2,194.59	872.53	330.40
	47	1,182.30	2,494.36	1,469.60	1,052.86	423.67
	48	1,189.94	2,887.44	1,524.60	1,007.03	738.60
2014	49	1,288.32	1,732.24	2,189.78	990.91	550.21
	50	1,337.17	1,724.43	1,942.61	600.10	772.30
	51	1,372.09	2,289.33	1,366.70	365.43	896.40
	52	1,420.96	2,512.38	2,225.35	316.03	715.50
2015	53	1,489.82	1,395.82	1,573.61	200.77	1,000.56
	54	1,552.58	1,505.81	1,625.39	240.78	980.45
	55	1,598.00	1,698.57	2,164.92	380.07	1,100.53
	56	1,662.72	1,645.09	1,696.54	255.33	1,498.90
2016	57	1,829.37	1,080.06	2,214.01	592.91	1,035.21
	58	1,854.43	1,082.20	2,095.62	696.37	1,260.22
	59	1,929.75	1,267.24	2,203.54	1,249.93	1,300.10
	60	1,988.44	1,287.64	2,191.86	1,302.35	945.10
2017	61	2,053.16	2,766.46	1,668.59	1,247.08	1,210.00
	62	2,103.84	2,681.12	2,235.61	1,110.21	1,100.56
	63	2,143.23	3,497.36	2,221.70	1,296.57	1,351.50
	64	2,188.26	4,584.47	2,284.14	1,398.27	1,155.50
2018	65	2,266.85	1,690.00	2,092.55	1,333.86	941.21
	66	2,318.77	1,724.43	2,441.10	1,324.01	1,664.54
	67	2,358.46	1,989.33	2,161.28	1,227.21	1,890.23
	68	2,398.80	2,213.69	2,032.60	1,106.23	1,021.10
2019	69	2,446.72	1,080.06	2,021.48	1,146.03	1,554.10
	70	2,537.09	1,182.20	2,356.72	1,314.09	1,478.30
	71	2,617.61	1,267.24	2,112.30	1,111.05	1,679.00
	72	2,657.59	1,287.64	2,113.70	1,111.93	2,178.30
2020	73	2,731.75	973.24	2,064.27	1,359.28	1,333.60
	74	2,570.12	1,025.68	2,438.91	1,238.28	1,275.45

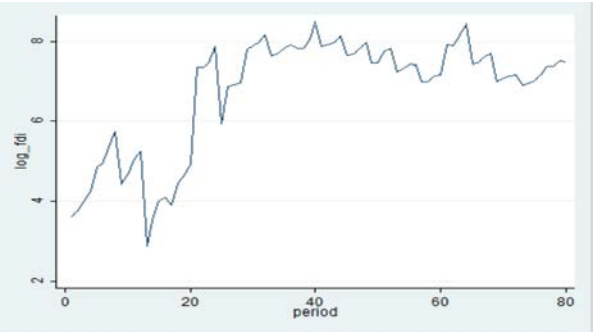
	75	2,656.14	1,103.33	2,333.77	1,262.53	1,368.78
	76	2,657.59	1,287.11	2,127.06	1,281.10	2,501.80
2021	77	2,914.17	1,595.82	2,274.75	1,288.15	1,458.00
	78	2,970.13	1,605.81	2,223.63	1,226.43	1,237.00
	79	3,040.67	1,798.57	2,165.76	1,217.41	2,289.90
	80	3,178.57	1,745.09	2,079.22	945.43	2,204.30

APPENDIX III
Trend plots per variable

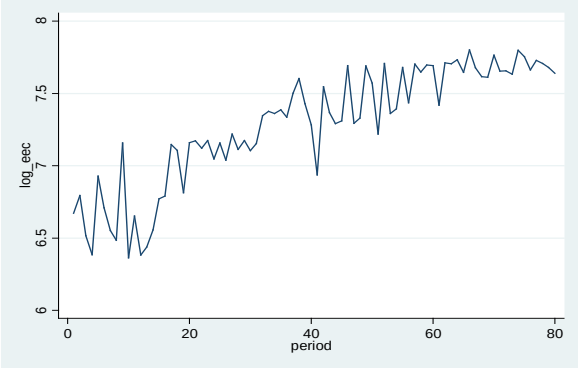
Log_gdp



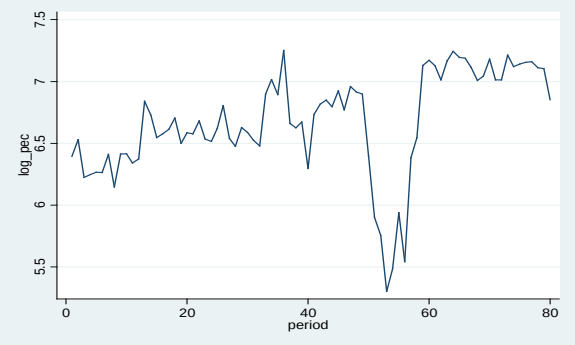
Log_fdi



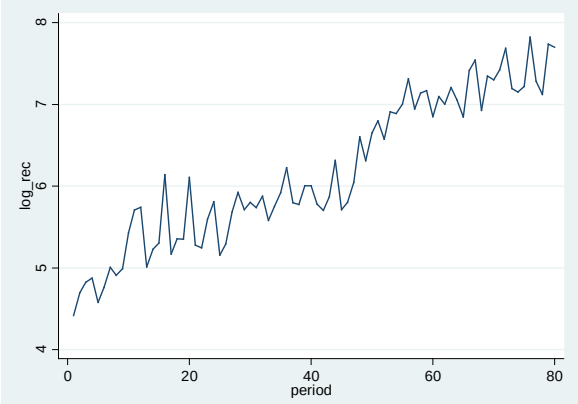
Log_eec



Log_pec

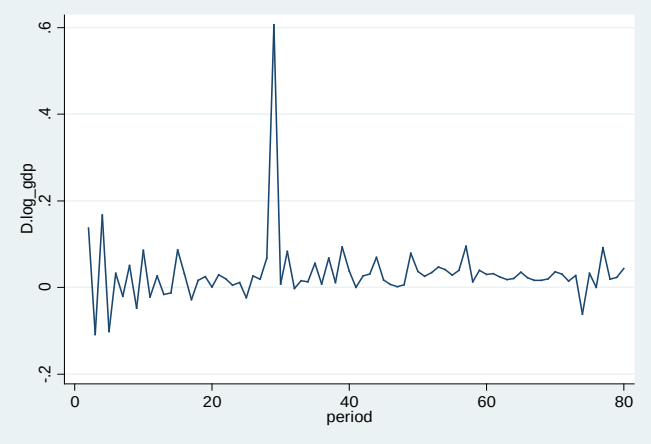


Log_rec

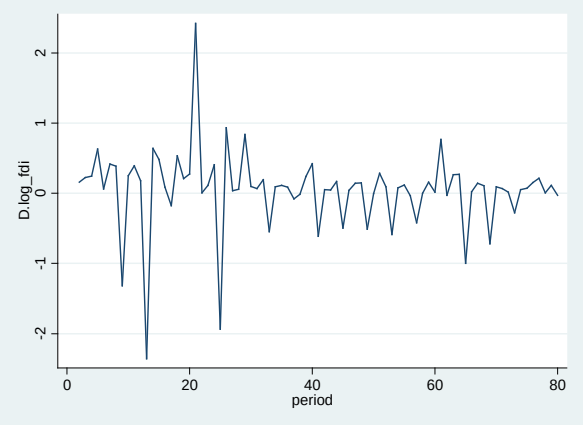


APPENDIX IV
Trend plots per variable

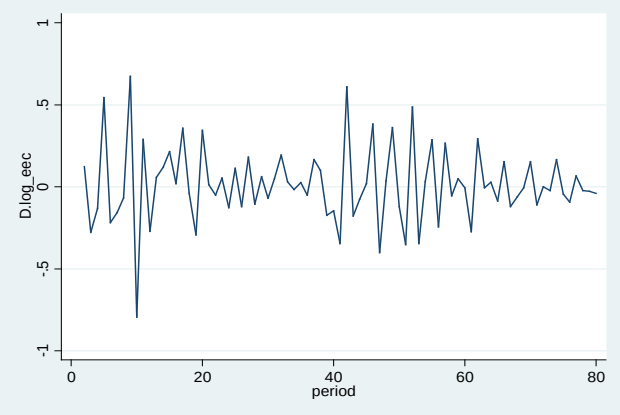
d.log_gdp



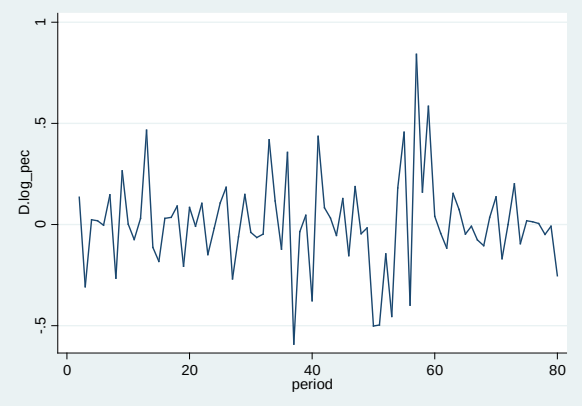
d.log_fdi



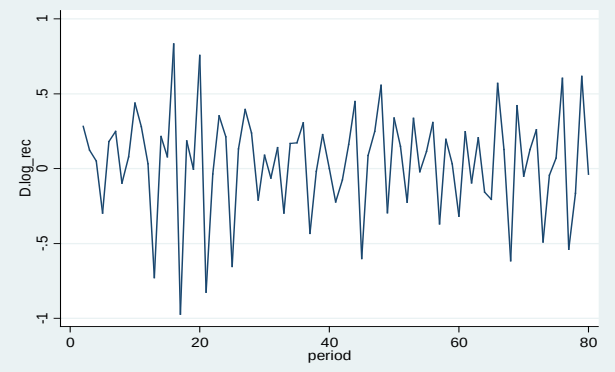
d.log_eec



d.log_pec

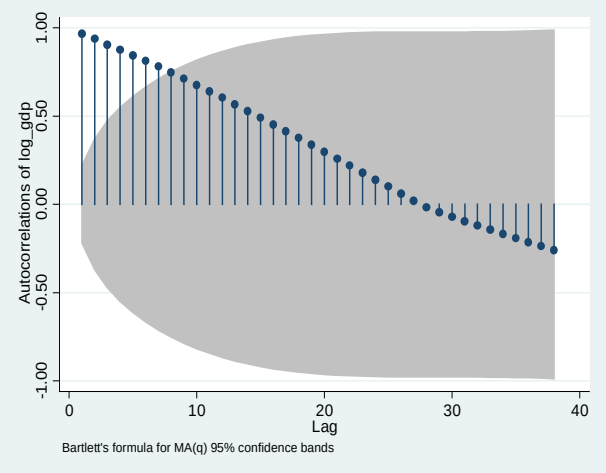


d.log_rec

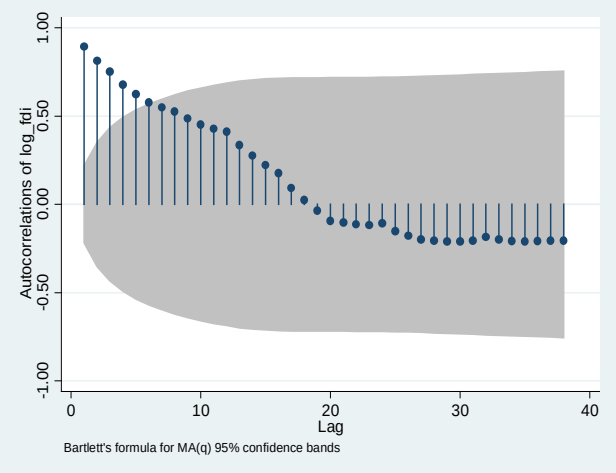


APPENDIX V
Correlograms per variable

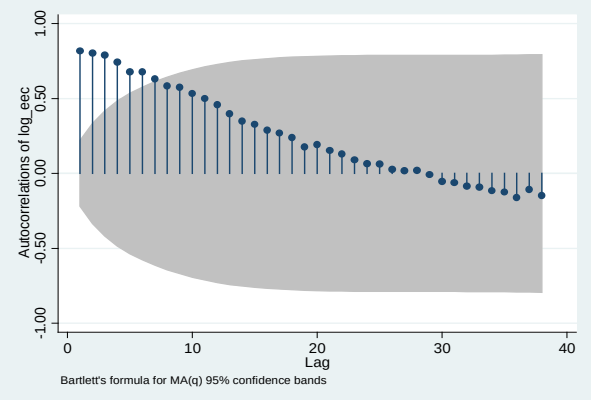
Log_gdp



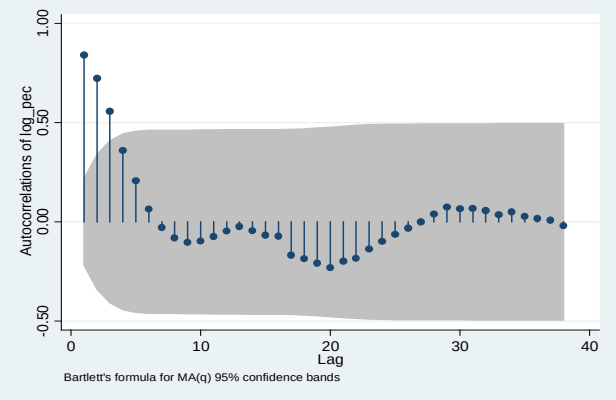
Log_fdi



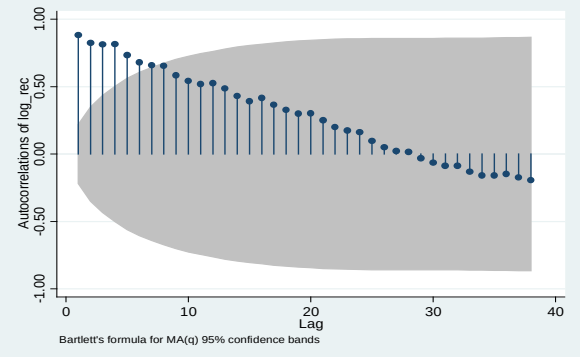
Log_eec



Log_pec

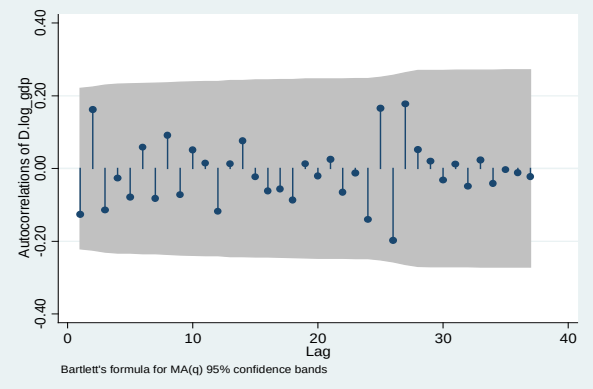


Log_rec

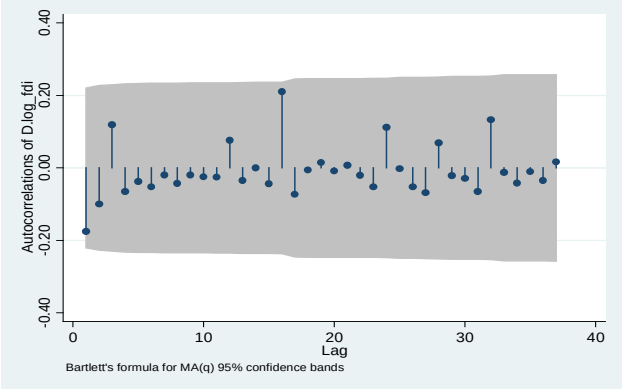


APPENDIX VI
Correlograms for first differences

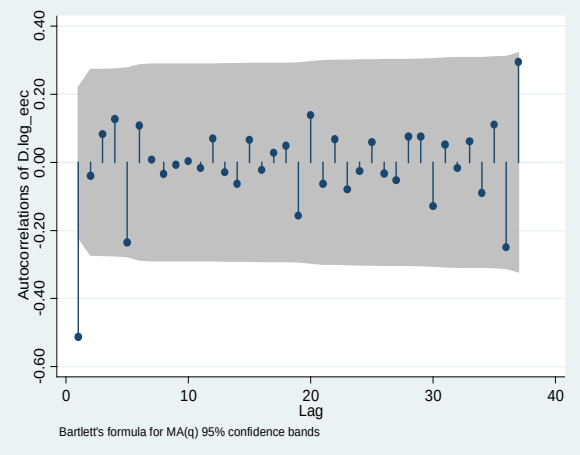
d.log_gdp



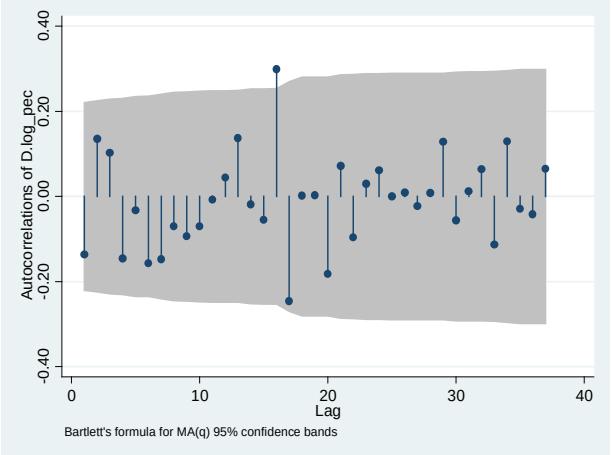
d.log_fdi



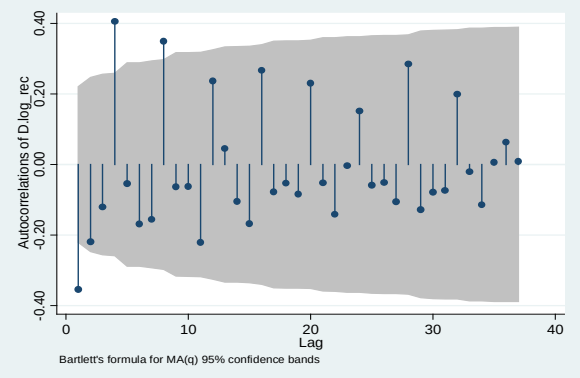
d.log_eec



d.log_pec



d.log_rec



APPENDIX VII

VECTOR ERROR CORRECTION ESTIMATES

		Coef.	Std.Err.	z	p>|z|	[95% Conf.	Interval]
D2_log_gdp	log_gdp						
	LD2.	-0.6622	0.1239	-5.49	0.000	-0.8987	-0.4256
	L2D2.	-0.1473	0.1171	-1.26	0.208	-0.3769	0.0822
	log_fdi						
	LD2.	-0.0145	0.0162	-0.90	0.369	-0.0462	0.0172
	L2D2.	-0.0243	.01540	-1.58	0.114	-0.0545	0.0059
	log_eec						
	LD2.	0.0444	0.0408	1.09	0.276	-0.0355	0.1244
	L2D2.	.0420931	0.0363	1.32	0.186	-0.0231	0.1192
	log_pec						
	LD2.	-0.0381	0.0409	-0.93	0.351	-0.1182	0.0420
	L2D2.	-0.0578	0.0400	-1.45	0.147	-0.1361	0.0204
	log_rec						
	LD2.	-0.0191	0.0574	-0.33	0.740	-0.1316	0.0934
	L2D2.	-0.0067	0.0340	0.20	0.844	-0.0600	0.0734
D2_ log_fdi	log_gdp						
	LD2.	0.2940	0.8971	0.33	0.743	-1.4644	2.0524
	L2D2.	0.4433	0.8707	0.51	0.611	-1.2632	2.1499
	log_fdi						
	LD2.	-0.6784	0.12023	-5.64	0.000	-0.9141	-0.4428
	L2D2.	-0.4222	0.1145	-3.69	0.000	-0.6467	0.0198
	log_eec						
	LD2.	-0.2775	0.3032	-0.92	0.036	-0.8718	0.3168
	L2D2.	-0.2793	0.2698	-1.03	0.030	-0.8081	0.2496
	log_pec						
	LD2.	0.2779	0.3040	0.91	0.361	-0.3178	0.8737
	L2D2.	0.0900	0.2968	0.30	0.762	-0.4916	0.6716
	log_rec						
	LD2.	1.3912	0.4268	3.26	0.001	0.5548	2.2276
	L2D2.	0.6496	0.2530	2.57	0.010	0.1537	1.1455
D2_ log_eec	log_gdp						
	LD2.	-0.1295	0.3588	-0.36	0.718	-0.8328	0.5737
	L2D2.	-0.4202	0.3483	-1.21	0.228	-1.1027	0.2624

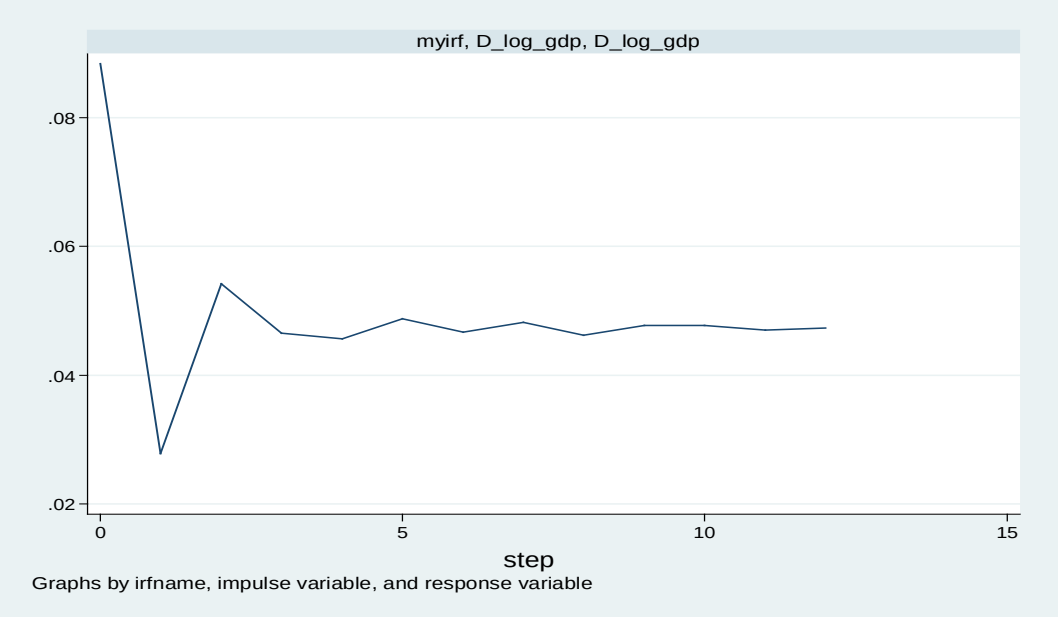
	log_fdi						
	LD2.	-0.0369	0.0481	-0.77	0.044	-0.1311	0.0574
	L2D2.	-0.0473	0.0458	-1.03	0.030	-0.1371	0.0425
	log_eec						
	LD2.	-0.9019	0.1213	-7.44	0.000	-1.1396	-0.6642
	L2D2.	-0.5034	0.1079	-4.67	0.000	-0.7149	-0.2919
	log_pec						
	LD2.	-0.0564	0.1216	-0.46	0.643	-0.2946	0.1819
	L2D2.	-0.0353	0.1187	-0.30	0.766	-0.2680	0.1973
	log_rec						
	LD2.	-0.4162	0.1707	-2.44	0.015	-0.7508	-0.0817
	L2D2.	-0.1597	0.1019	-1.58	0.115	-0.3580	0.0386
D2_ log_pec	log_gdp						
	LD2.	0.0593	0.3643	0.16	0.871	-0.6546	0.7732
	L2D2.	-0.0187	0.3535	-0.05	0.958	-0.7116	0.6742
	log_fdi						
	LD2.	-0.0825	0.0488	-1.69	0.091	-0.1782	0.0132
	L2D2.	-0.0374	0.0465	-0.80	0.422	-0.1285	0.0538
	log_eec						
	LD2.	0.0394	0.1231	0.32	0.749	-0.2019	0.2807
	L2D2.	0.0454	0.1095	0.41	0.679	-0.1693	0.2601
	log_pec						
	LD2.	-0.9339	0.1235	-7.57	0.000	-1.1758	-0.6920
	L2D2.	-0.4076	0.1205	-3.38	0.001	-0.6437	-0.1714
	log_rec						
	LD2.	-0.2519	0.1733	-1.45	0.146	-0.5915	0.0877
	L2D2.	-0.0681	0.1027	-0.66	0.507	-0.2695	0.1332
D2_ log_rec	log_gdp						
	LD2.	-0.0269	0.3519	-0.08	0.939	-0.7166	0.6629
	L2D2.	0.1312	0.3415	0.38	0.701	-0.5382	0.8006
	log_fdi						
	LD2.	0.1882	0.0472	3.99	0.000	0.0958	0.2806
	L2D2.	0.1386	0.0449	3.09	0.002	0.0506	0.2266
	log_eec						
	LD2.	-0.6418	0.1189	-5.40	0.000	-0.8749	-0.4087
	L2D2.	-0.1949	0.1058	-1.84	0.066	-0.4023	0.0125
	log_pec						
	LD2.	0.1562	0.1192	1.31	0.190	-0.0775	0.3899
	L2D2.	0.0194	0.1164	0.17	0.867	-0.2087	0.2476
	log_rec						

LD2.	1.1402	0.1674	6.81	0.000	0.8121	1.4683
L2D2.	0.4908	0.0992	4.95	0.000	0.2963	0.6854

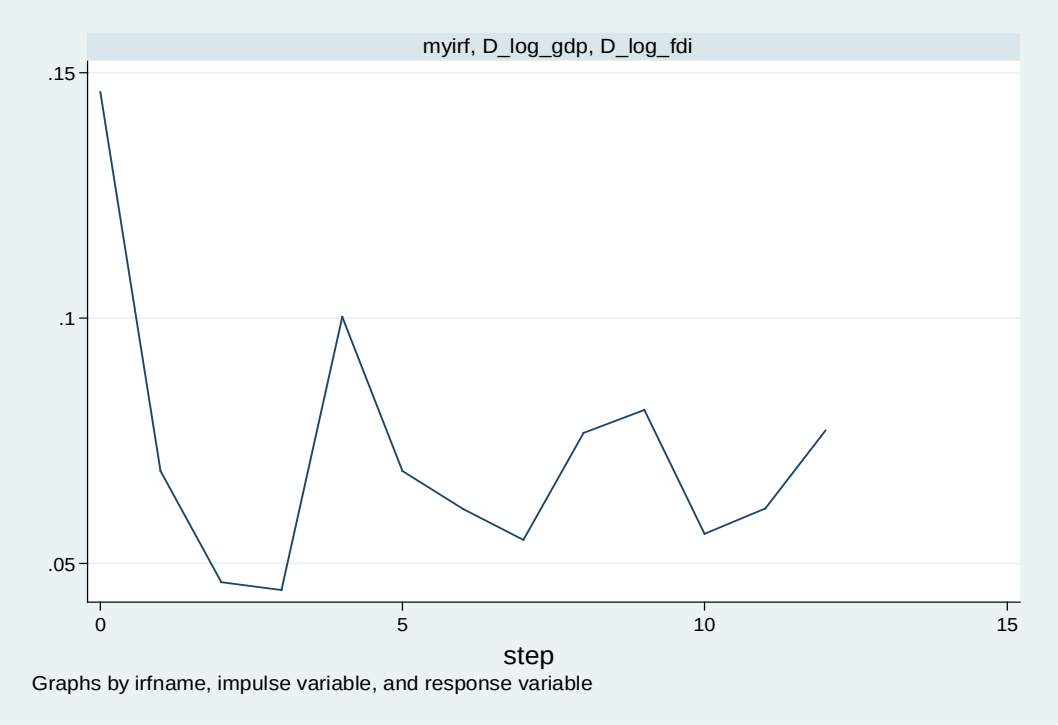
APPENDIX VIII

OTHORGONALIZED IMPULSE RESPONSE FUNCTION GRAPHS (OIRFs)

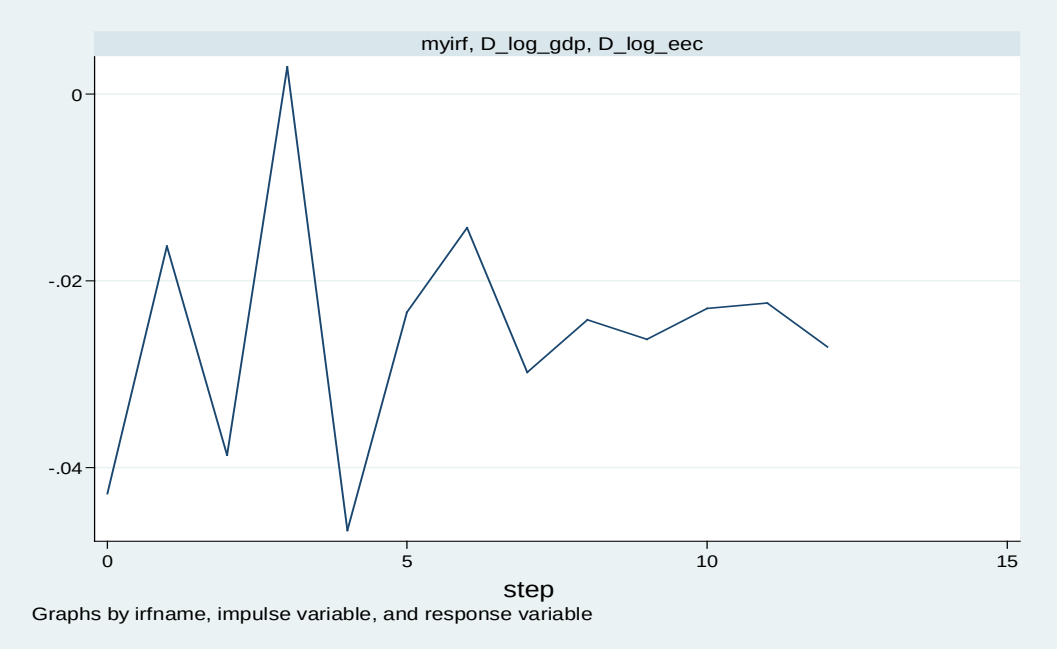
(1) irf graph oirf, impulse(D_log_gdp) response(D_log_gdp)



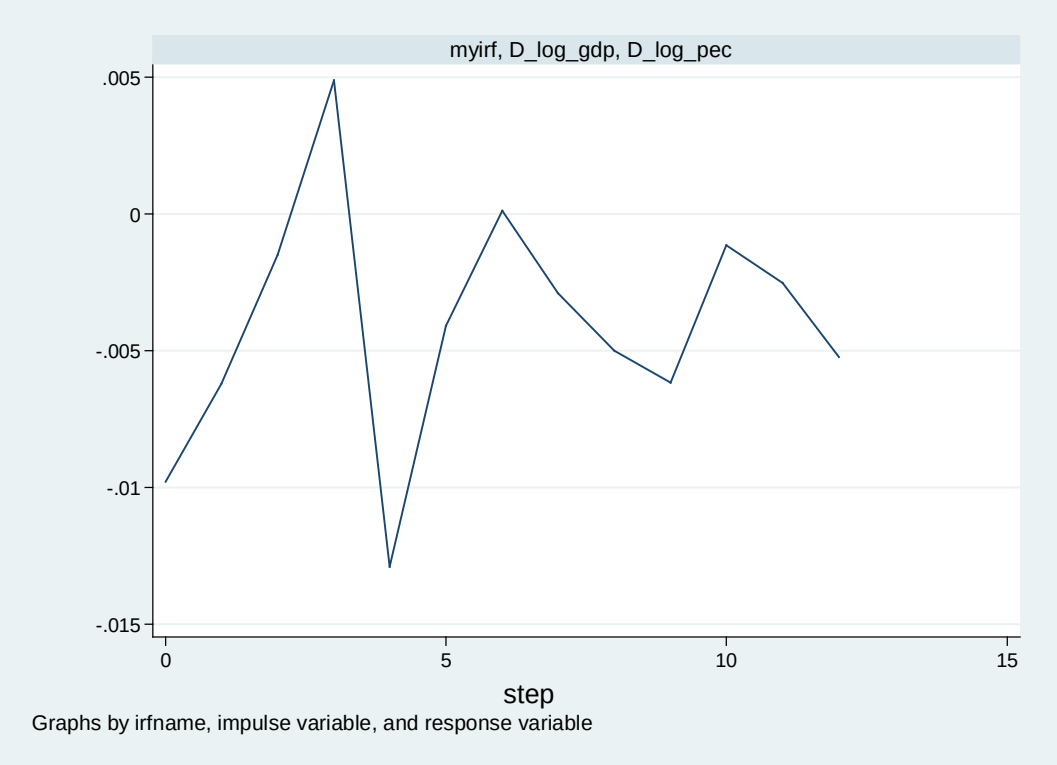
(2) irf graph oirf, impulse(D_log_gdp) response(D_ log_fdi)



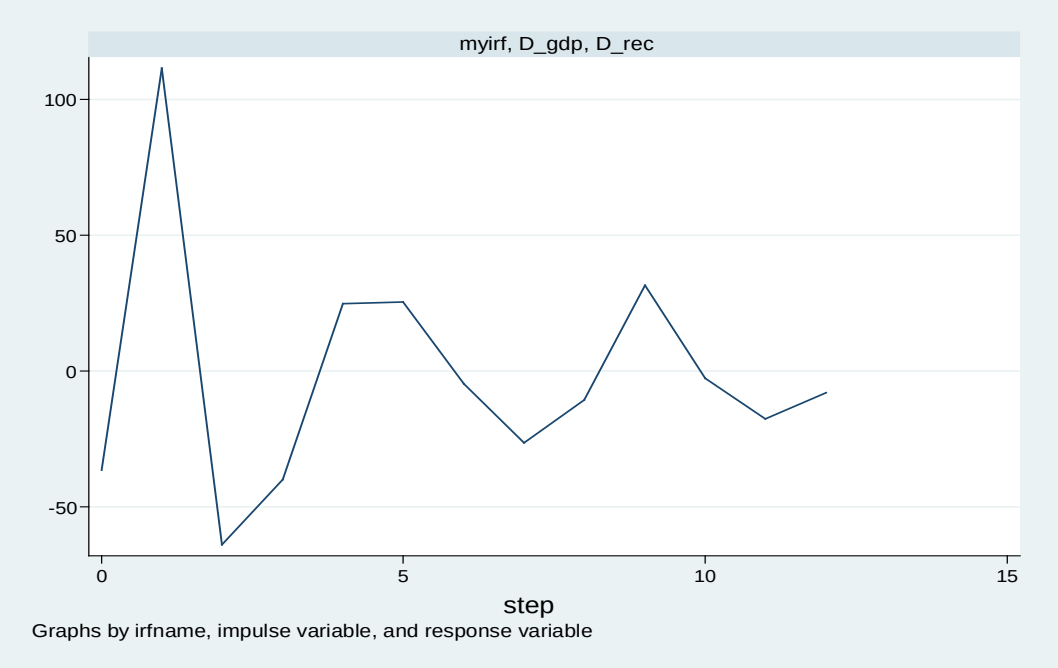
(3) irf graph oirf, impulse(D_log_gdp) response(D_log_eec)



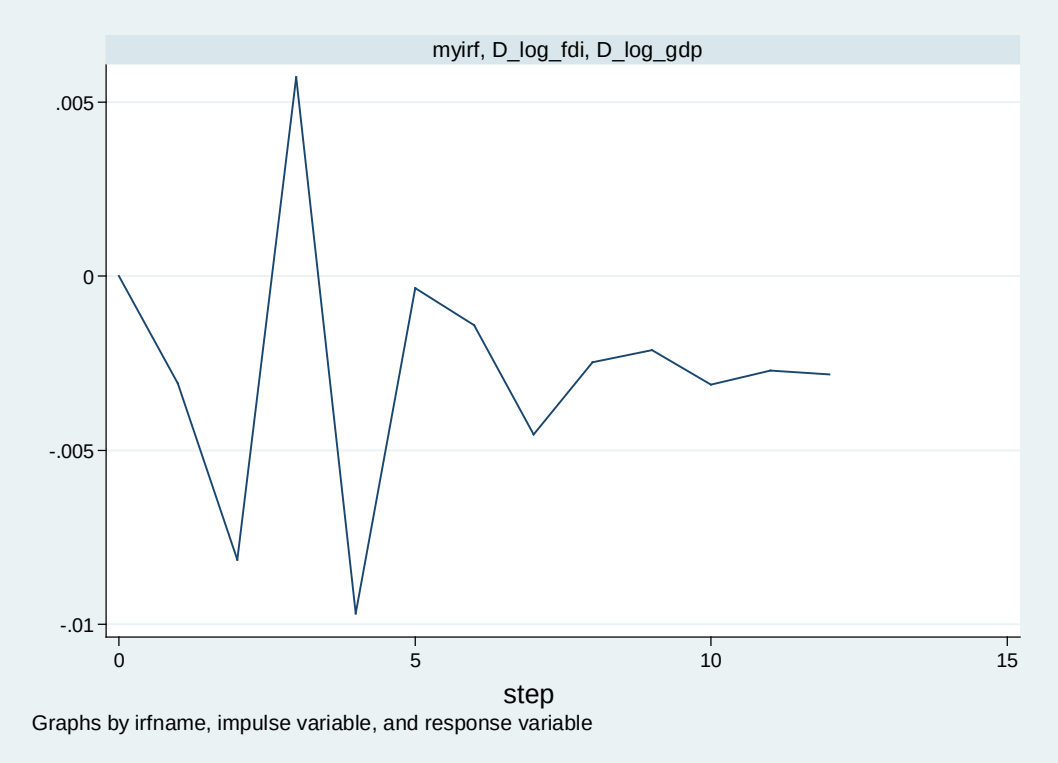
(4) irf graph oirf, impulse(D_log_gdp) response(D_log_pec)



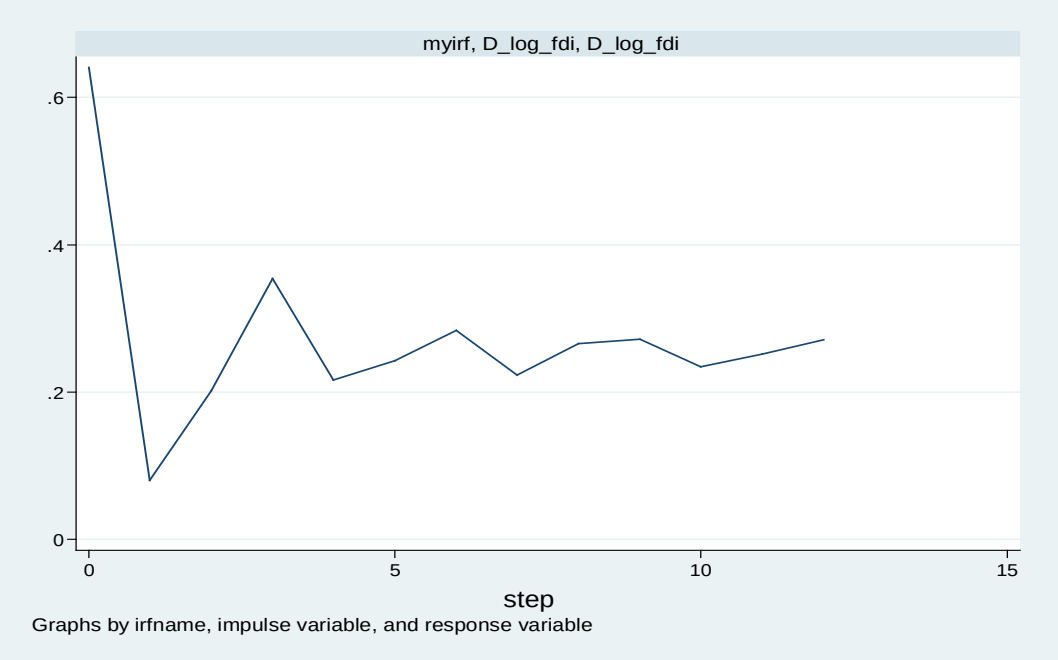
(5) irf graph oirf, impulse(D_log_gdp) response(D_log_rec)



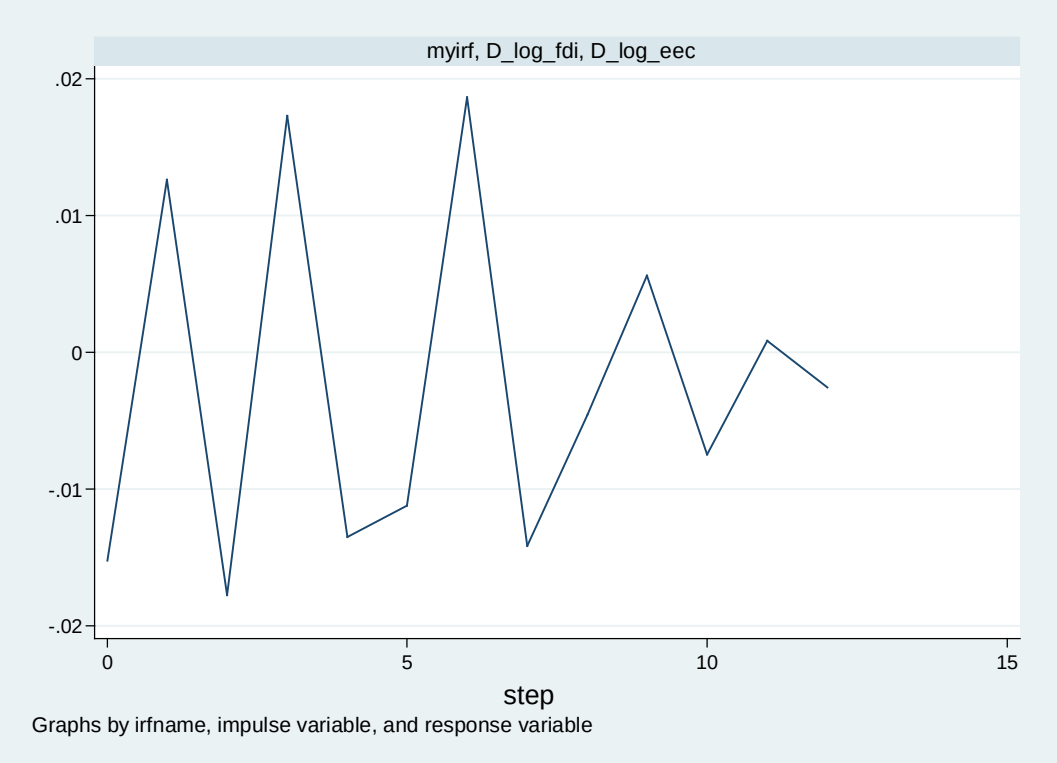
(6) irf graph oirf, impulse(D_log_fdi) response(D_log_gdp)



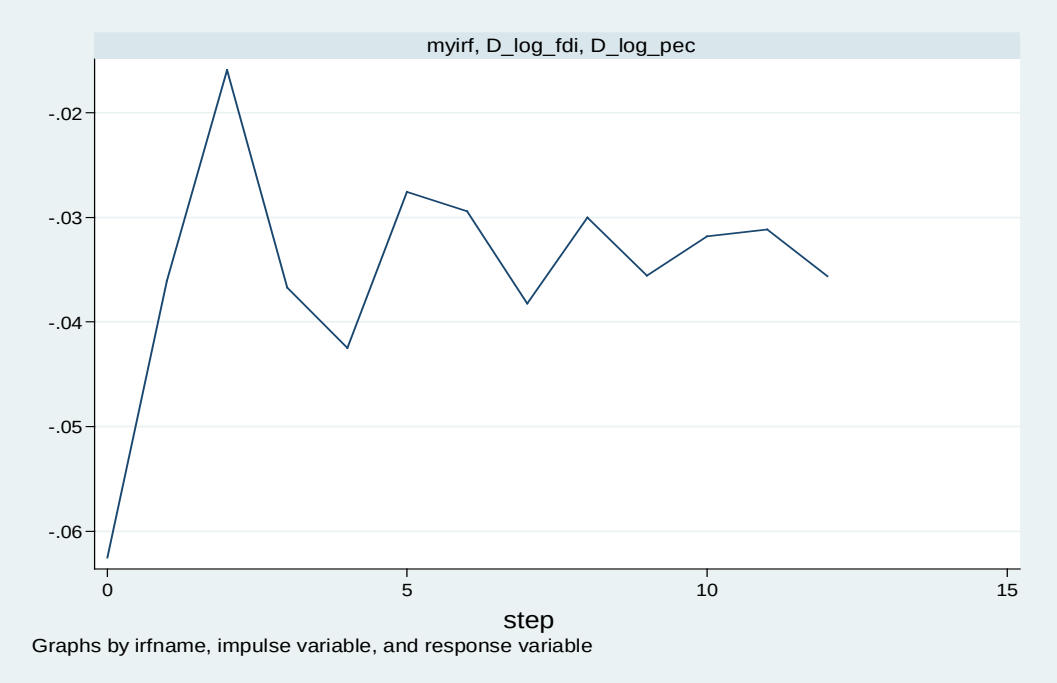
(7) irf graph oirf, impulse(D_log_fdi) response(D_log_fdi)



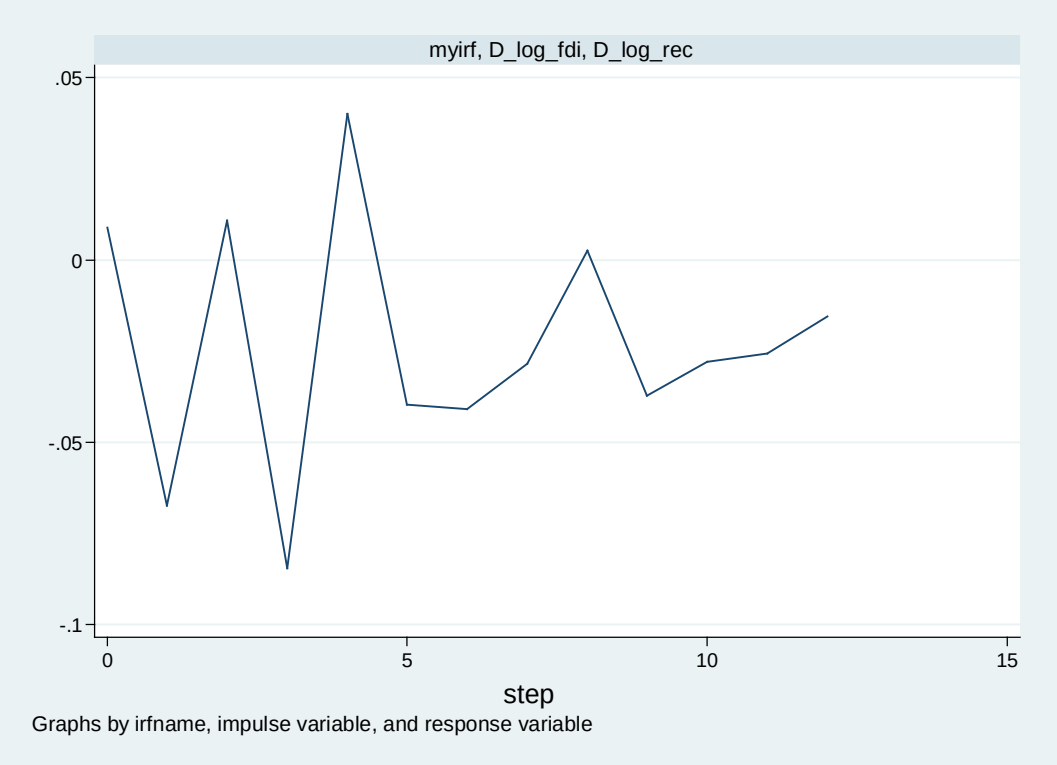
(8) irf graph oirf, impulse(D_log_fdi) response(D_log_eec)



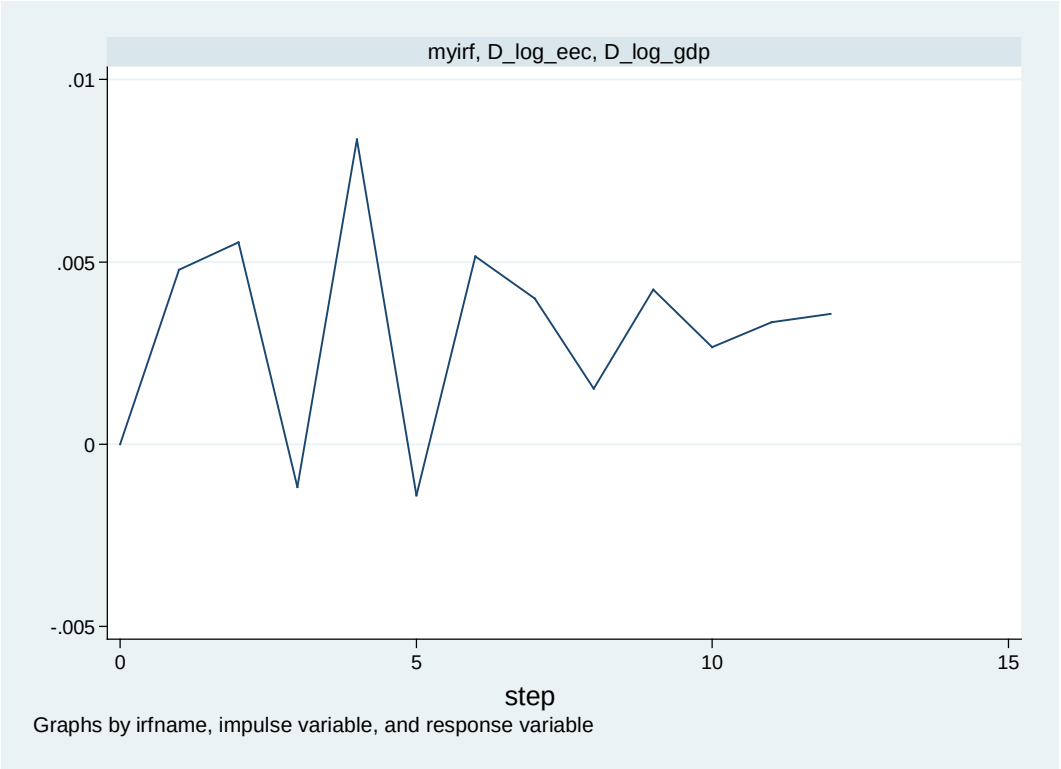
(9) irf graph oirf, impulse(D_log_fdi) response(D_log_pec)



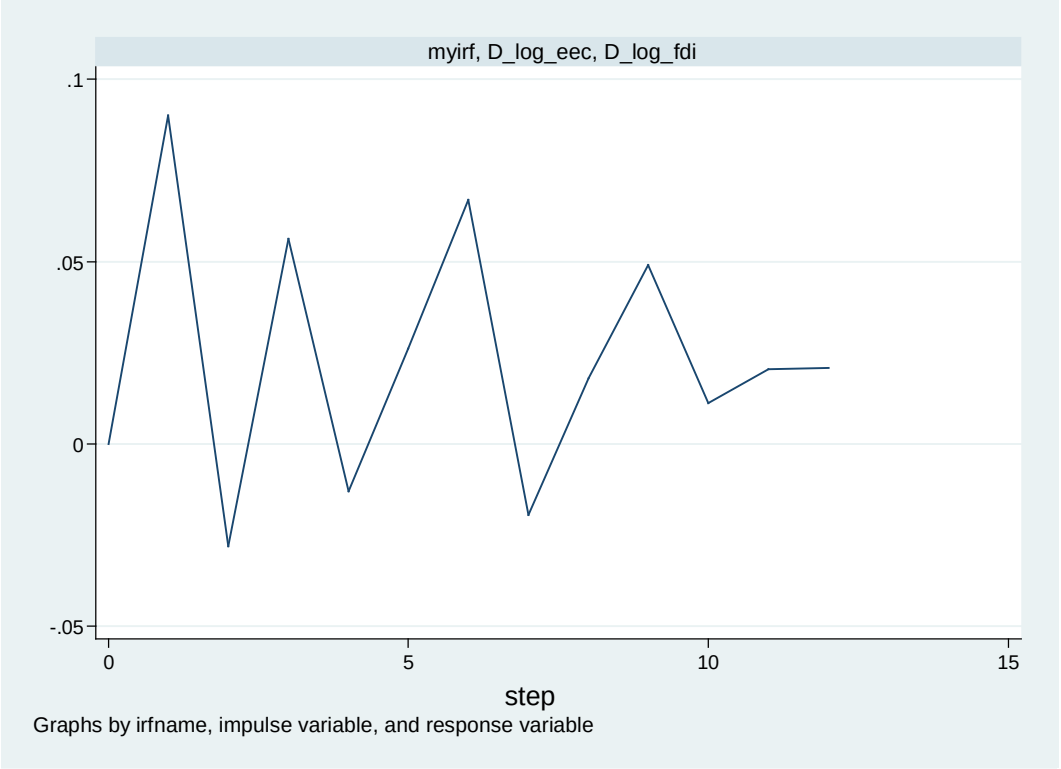
(10) irf graph oirf, impulse(D_log_fdi) response(D_log_rec)



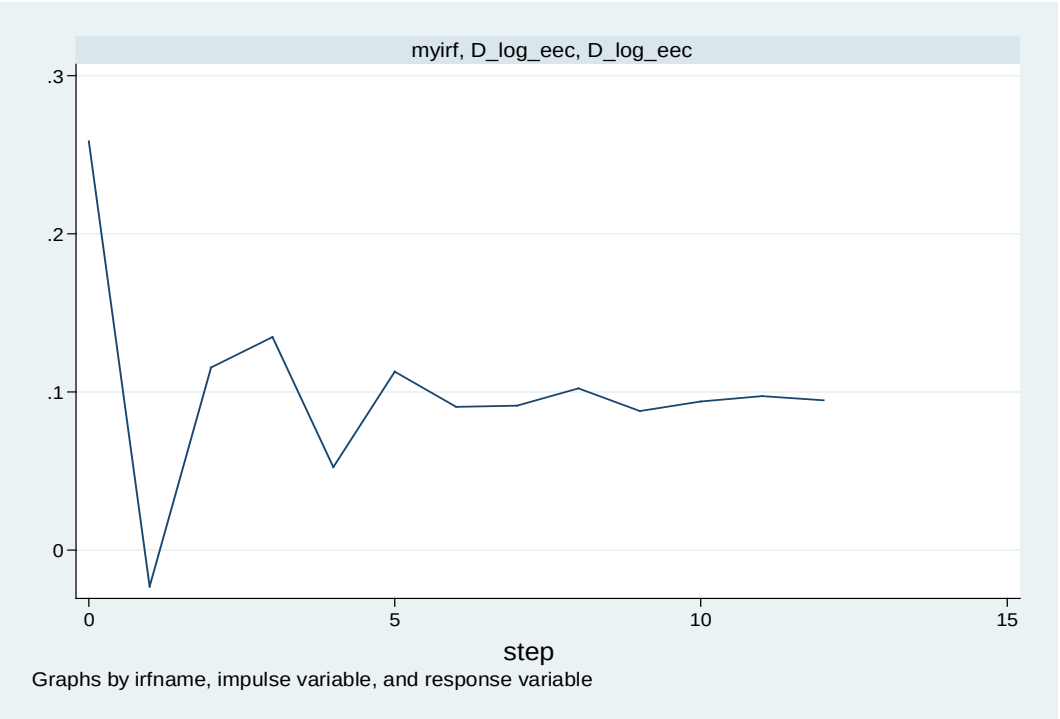
(11) irf graph oirf, impulse(D_log_eec) response(D_log_gdp)



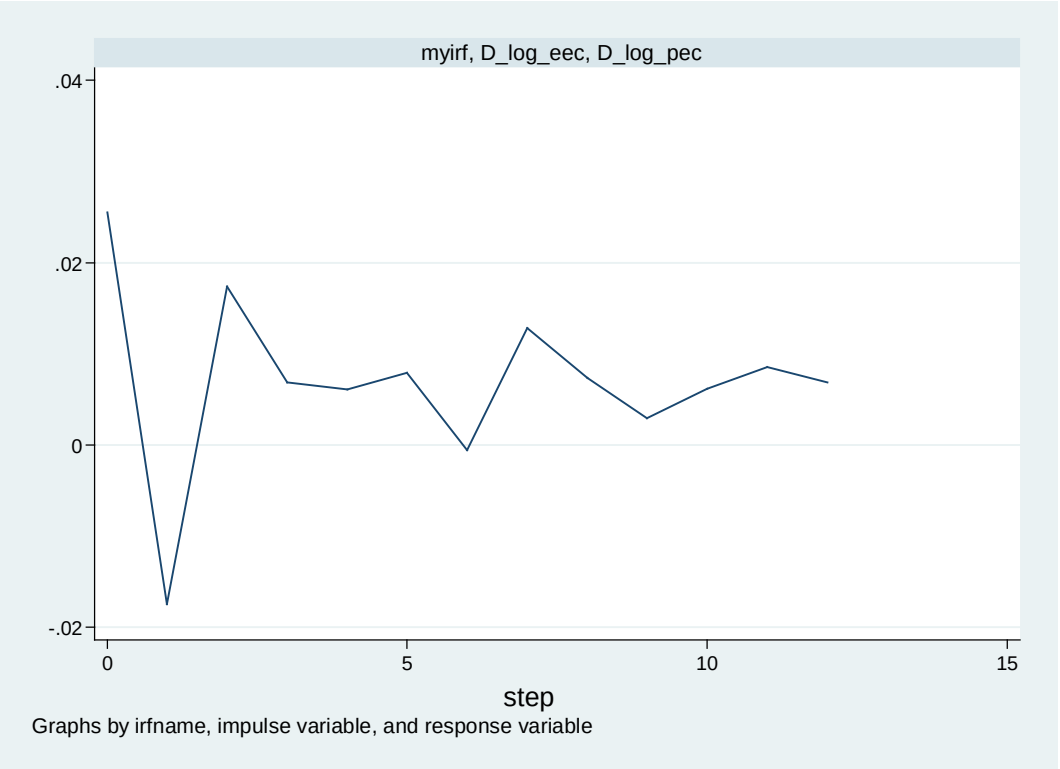
(12) irf graph oirf, impulse(D_log_eec) response(D_log_fdi)



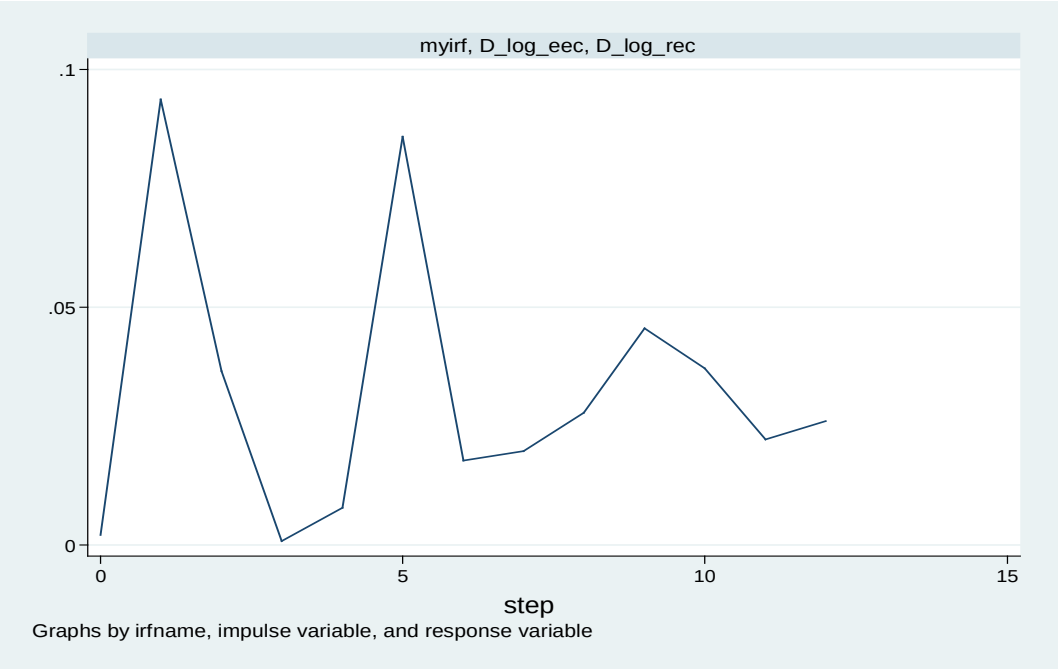
(13) irf graph oirf, impulse(D_log_eec) response(D_log_eec)



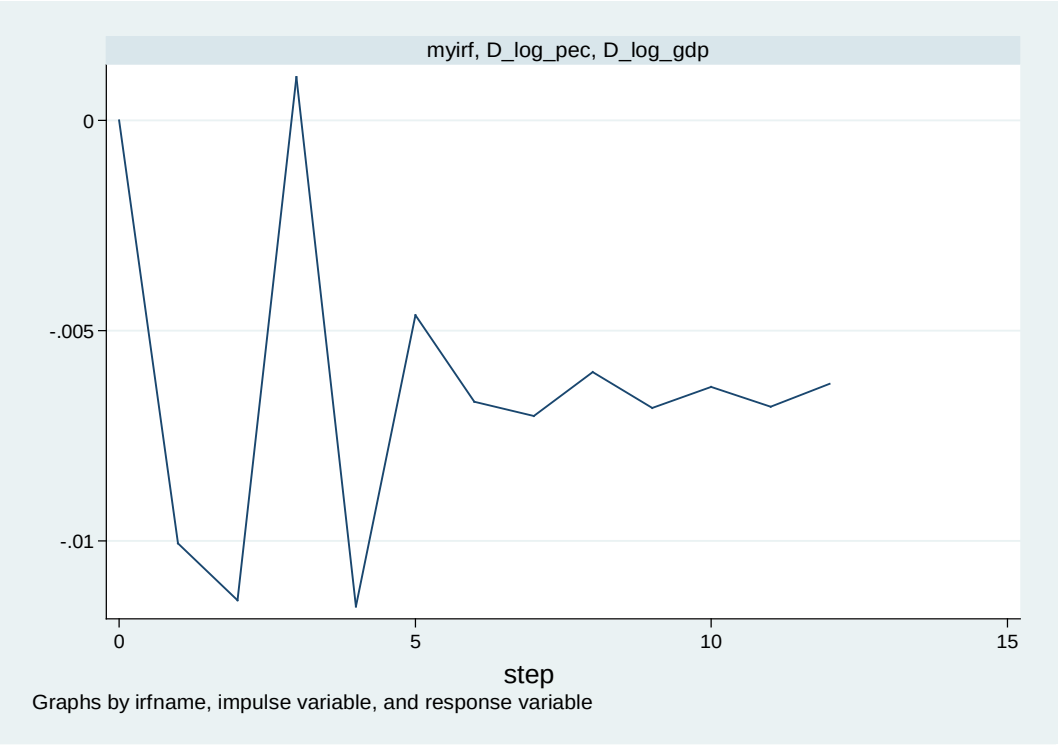
(14) irf graph oirf, impulse(D_log_eec) response(D_log_pec)



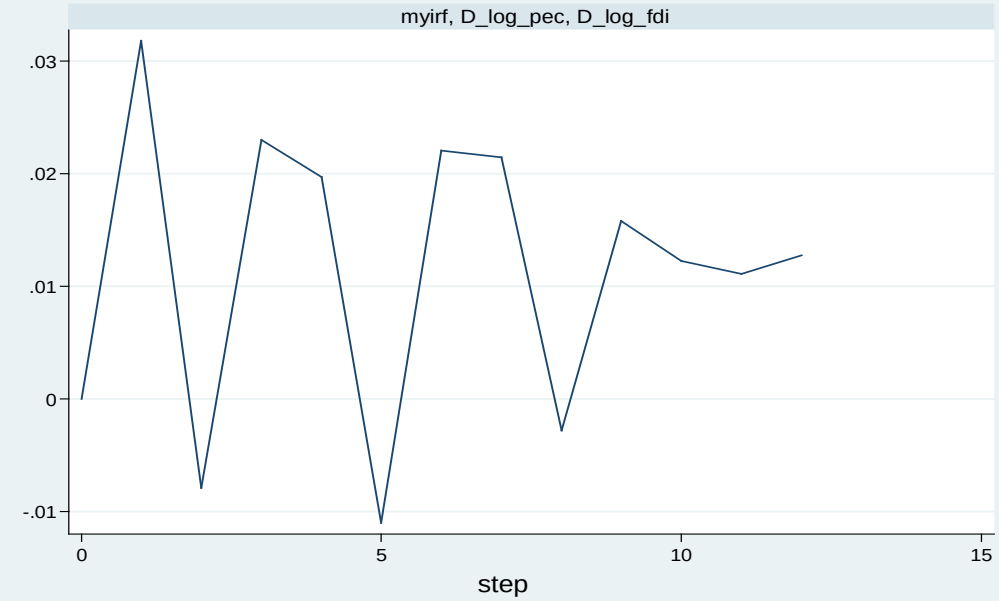
(15) irf graph oirf, impulse(D_log_eec) response(D_log_rec)



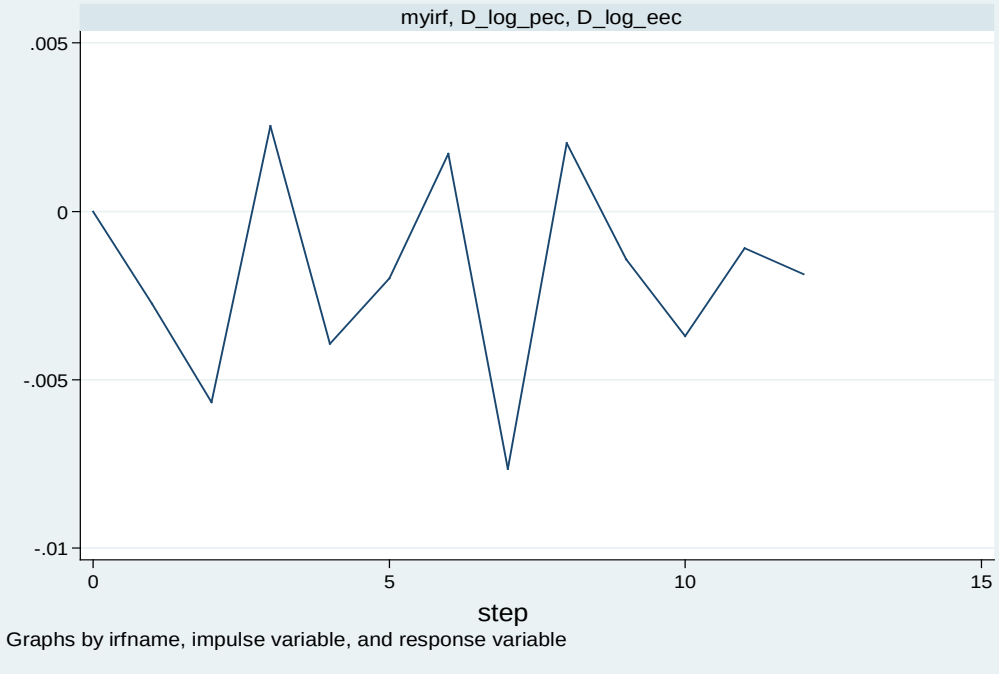
(16) irf graph oirf, impulse(D_log_pec) response(D_log_gdp)



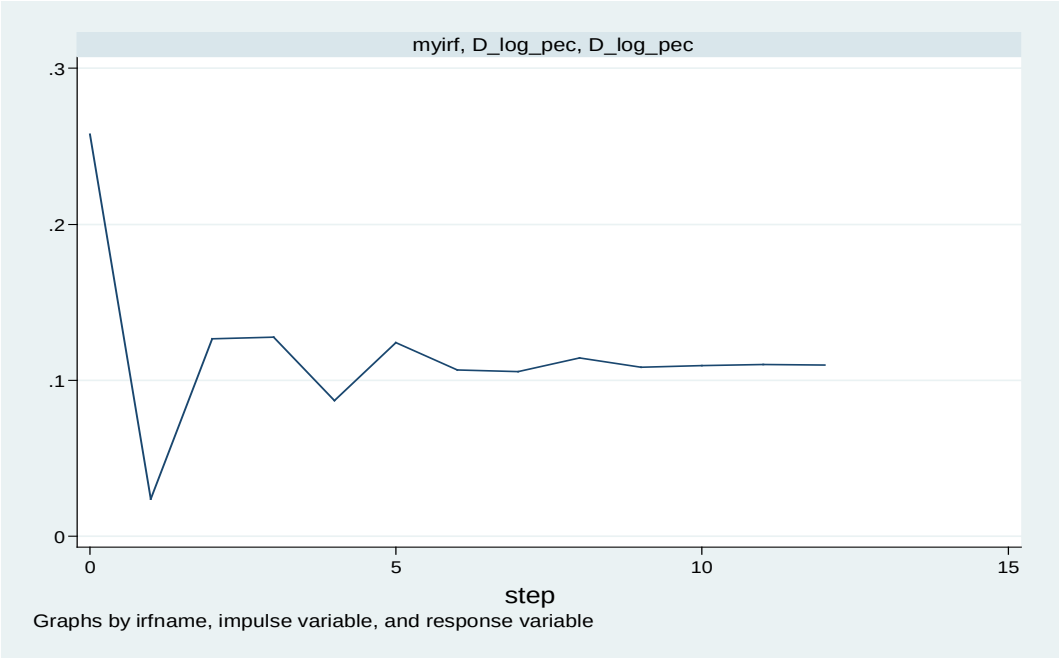
(17) irf graph oirf, impulse(D_log_pec) response(D_log_fdi)



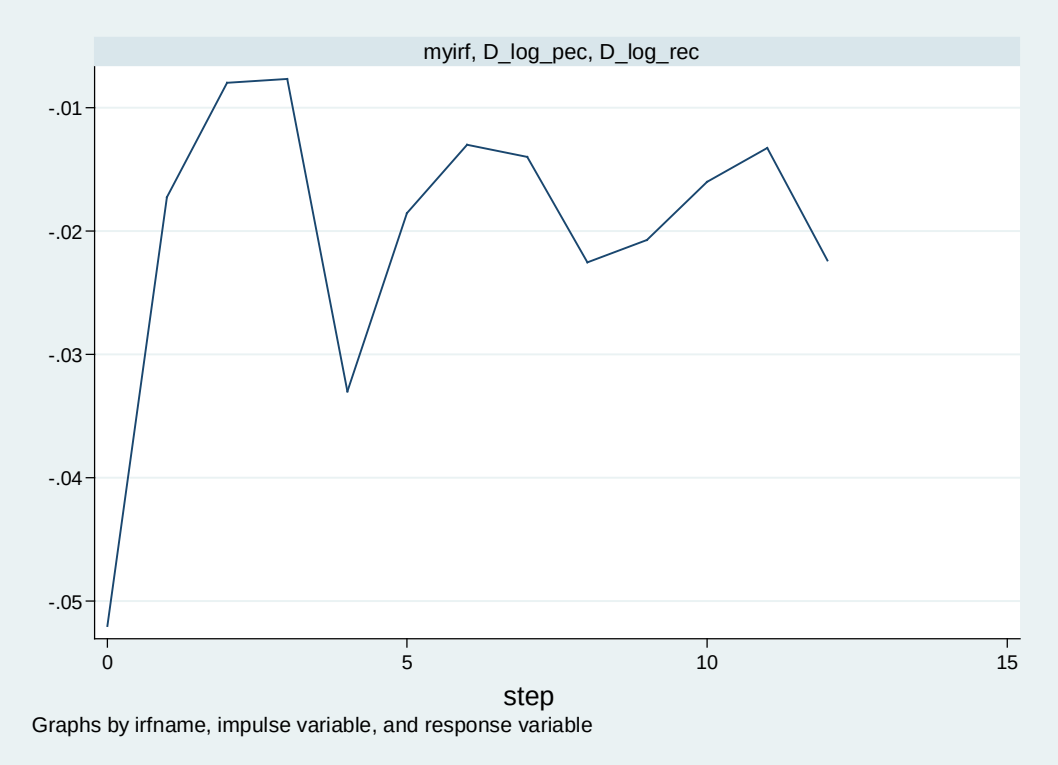
(18) irf graph oirf, impulse(D_log_pec) response(D_log_eec)



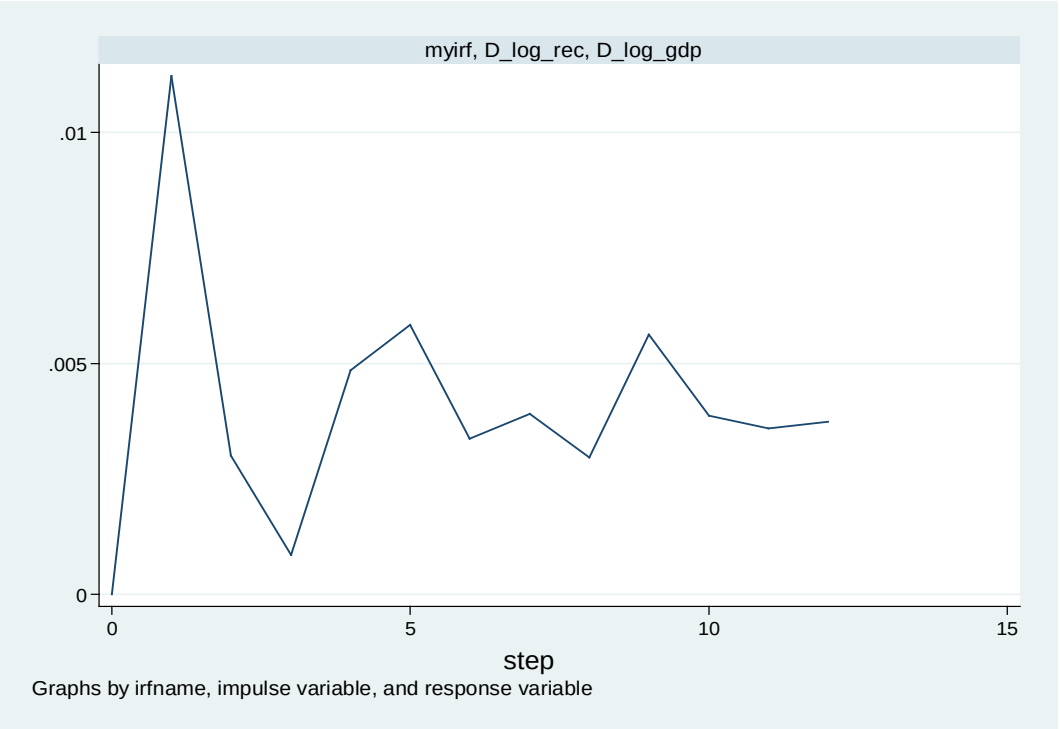
(19) irf graph oirf, impulse(D_log_pec) response(D_log_pec)



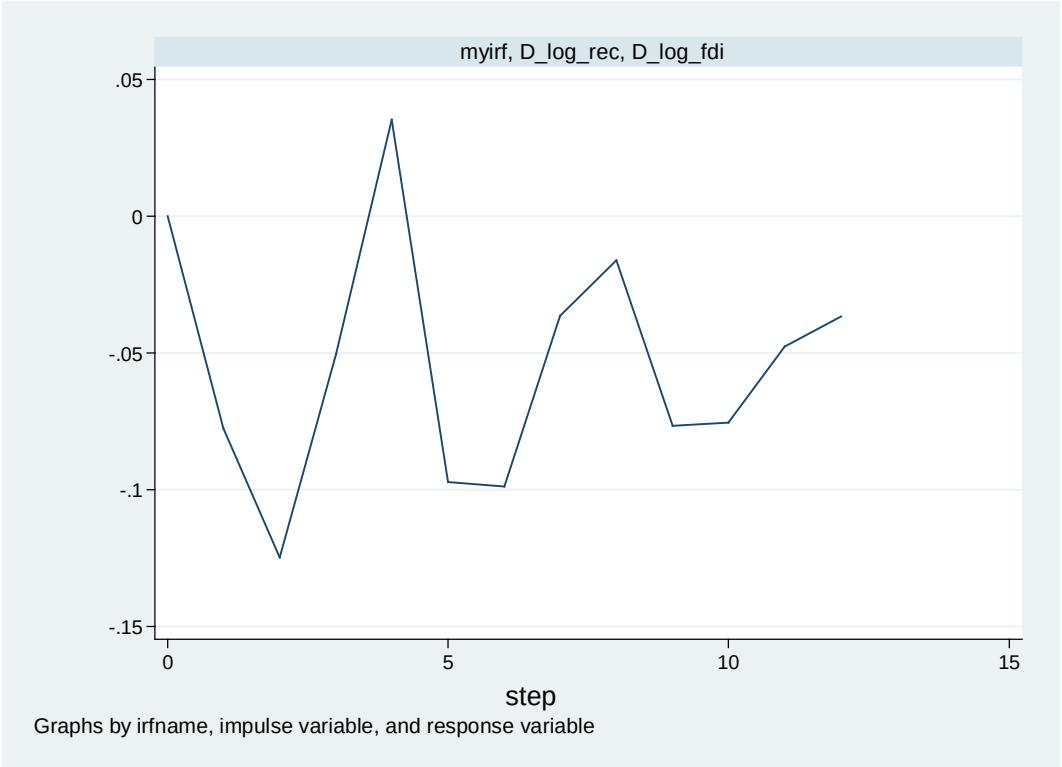
(20) irf graph oirf, impulse(D_log_pec) response(D_log_rec)



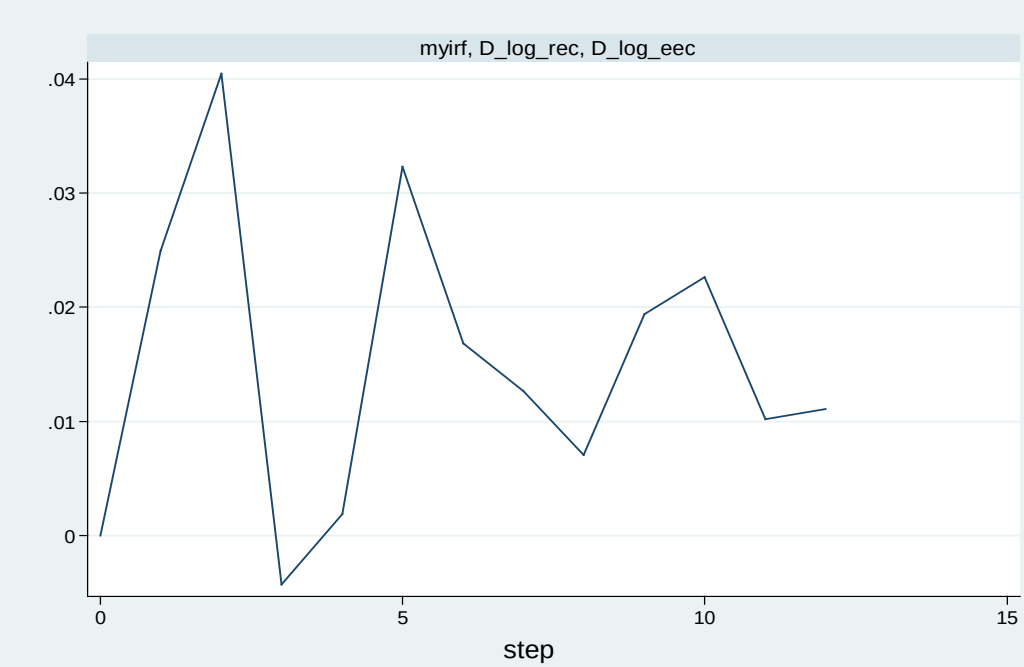
(21) irf graph oirf, impulse(D_log_rec) response(D_log_gdp)



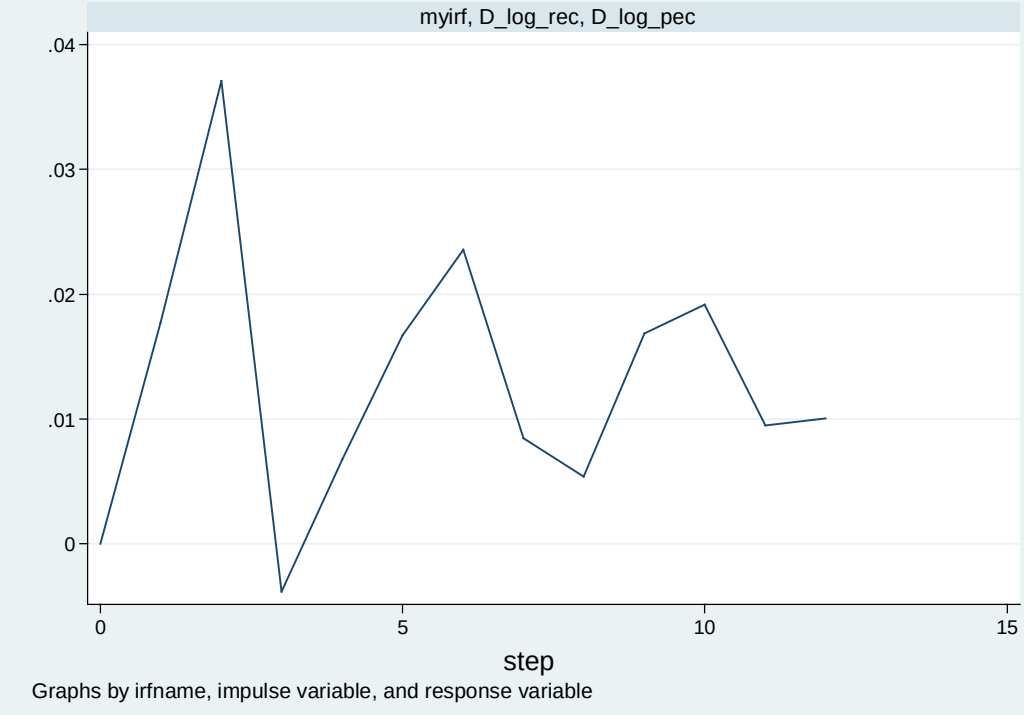
(22) irf graph oirf, impulse(D_log_rec) response(D_log_fdi)



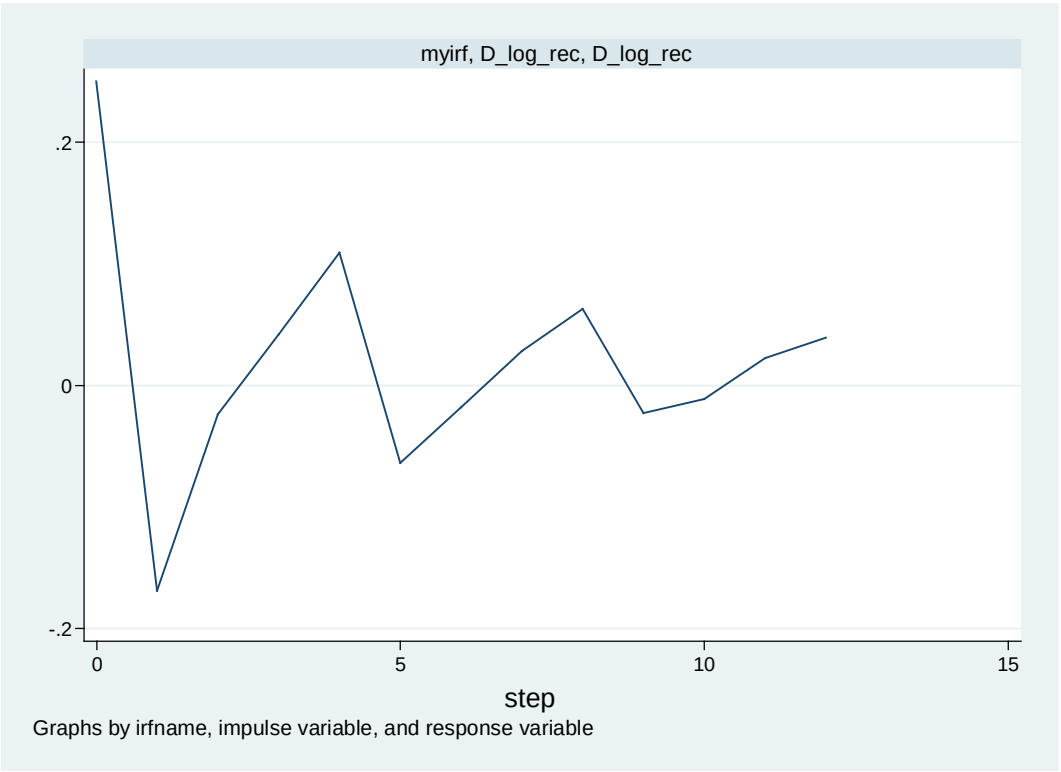
(23) irf graph oirf, impulse(D_log_rec) response(D_log_eec)



(24) irf graph oirf, impulse(D_log_rec) response(D_log_pec)



(25) irf graph oirf, impulse(D_log_rec) response(D_log_rec)



APPENDIX IX

VARIANCE DECOMPOSITION GRAPHS