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COLLEGE OF BUSINESS AND ECONOMICS

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Master of Science in Regulatory Economics and Competition Policy

ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN RWANDA PERIOD OF STUDY 1995 – 2019

A thesis submitted to the School of Economics in partial fulfilment of the requirements for the Master degree of Science in Regulatory Economics and Competition Policy by the University of Rwanda.

By: Noël MUSABYIMANA

Reg. No. 219015782

Supervisor:

Joseph NKURUNZIZA (PhD)

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DECLARATION

I declare that this thesis contains my own work and has not been presented for a master's degree at the University of Rwanda or any other universities. All sources of materials that have been used are fully acknowledged.

Noël Musabyimana

Signature…….

Date……

DEDICATION

To my family.

To my supervisor.

To my Lecturers.

To my classmates.

To my friends.

May God bless you all?

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First and foremost, I thank God for the gift of life granted to me freely.

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ABBREVIATION

ADF : Automated Dickey Fuller

AGECC : Advisory Group on energy and Climate change

EDPRS : Economic Development and Poverty Reduction Strategies

EIA : Energy Information Administration

EUCL : Electricity Utility Corporation Limited

GDP : Growth Domestic Product

HIC : High-Income Country

IEA : International Energy Agency

IT : Information Technology

MIC : Middle Income Country

MINECOFIN : Ministry of Economics and Finance

MINICOM : Ministry of Trade and Industry

MW : Meg Watt

NISR : National Institute of Statistics of Rwanda

NST1 : National Strategies for Transformation

PVs **:** Photovoltaics

REG : Rwanda energy Group

RURA : Rwanda Utilities Regulatory Authority

SDGs : Sustainable Development Goals

SNA : System of National Accounts1993

UNCSD : United Nations Conference on Sustainable Development

ABSTRACT

Electricity is one of the most basic materials of the national economy, which plays an important role in national production and life.

This study investigated the relationship between electricity consumption and economic growth in Rwanda considering annual data from 1995 to 2019 in Rwanda.

Knowledge of the relationship between them is of primary importance for policy makers on the purpose of prioritization of electricity policies and its conservation measures.

Apart from the relationship between economic growth and electricity consumption, the study also estimated the causality relationship between real economic growth and electricity consumption in Rwanda for the period of from 1995 to 2019, the study considered among other variables that could lead both economic growth and or electricity consumption and are capital , employment, trade openness as percentage of gross domestic product and electricity end user prices for industrial and non-residential customers.

Using the methods of co-integration analysis and Granger Causality test to examine the relationship between electricity consumption and economic growth for Rwanda from 1995 to 2019.

The investigation results illustrated that real gross domestic Product had a long run as well as short run positive relationship with electricity consumption within the period of from 1995 to 2019 in Rwanda.

The study found also a oneway causality relationship from real gross Domestic Product to electricity consumption and it confirm with conservation hypothesis (H_3) that economic growth contributes to electricity consumption within that period of from 1995 to 2019 in Rwanda.

Therefore, electricity conservation policies together with the establishment of a competitive electricity market may be feasible with little or no detrimental side effects to economic growth.

Key words: ELECTRICITY, CONSUMPTION, ECONOMIC GROWTH .

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CHAPTER I : INTRODUCTION

1.1 Introduction

Expansion in economic activity is principally assessed by measuring gross domestic product and has influenced to be connected with improvement of electricity demand in producing more goods and services. However, more recently this link has been decoupling in various countries due to different causes including the countries' corresponding level of improvement, accessibility of electricity, component of economy, and standards of income.

A form of energy that can be produced in several ways that can provides power to devices that produce light, heat, etc, is known as electricity. Despite all types of energies that exist in Rwanda, most of them are converted into electricity which is sold and consumed by end users except fuel that is used in public transport services, gas that is used in cooking and consumed as energy and other small non -significance use of energy.

The energy sector, as a driver of national growth, is of priority to the Rwanda government. It comprises of three subsectors; electricity, biomass and petroleum, and focus is on increasing efficiency in generation, distribution and consumption. The government policies are effectively implemented under different stakeholders' cooperation including policy makers represented by Infrastructure ministry, Economic and Finance ministry; Electricity supplier through its subsidiaries known as energy development and Energy Utility ltd and the Regulatory board.

Apart from petroleum that are used in generators to support national grid; renewable and non-renewable energy have been used to generate electricity too which meant that at least all forms of energy are consumed in term of electricity and this has been the reason why the study focused only on looking how the demand for electricity is related to the progress of economy in Rwanda from 1995 to 2019.

The distributed electricity in Rwanda is generated locally and imported from neighbour countries and shared power plants from regional and all are generated from various sources such as hydropower plants, methane gas and solar energy, thermal power plants (Diesel and Heavy fuel generators).

Business players couldn't build nor run an office neither factories that provide the jobs, couldn't even people's lives be more comfortable and secured without electricity that is considered as the engine of economic activities.

It is also one of various important resources to the combination of both public and private competitive markets and processes that transform these inputs into outputs.

Unfortunately, the political procedures of compromise and negotiation, electricity policy matters do not always produce an optimal electricity policy which contributes a considerable function in needed goods and services sustainably produced.

Because of its position in illuminating poverty, living standards, improvement, empowering progress of economy; it has been taken as a social economic development main catalyst (Lawrence, 2012).

The shape of global economy and Politics, international cooperation's are constituted on the electricity that has been considered as generation inputs and a strategic commodity worldwide.

There were three main function of electricity suppliers that were vertically integrated across generation, transmission and distribution which are separately managed, unfortunately, in Rwanda there is one electric Utility that is monopoly which manage the entire major component above. Electricity is a principal source for the process of generation in each and every developing and developed countries.

Both Price increases, power shortages quickly become major social and economic issue" (Fezzi, 2007).

Because of these circumstances, which were not unexpected, the management of the entire power industry was regulated by regulatory boards until relatively recently, and tariffs were kept unaltered for lengthy periods of time till 2007 whereby the government of Rwanda introduced different tariffs with different customer's classification by enhancing and promoting new investors entrance in Rwanda parallel with lifeline tariff where the government enhance the electricity accessibility through its affordability which is achieved through government subsidies.

Several studies have found a strong positive relationship between power use and economic growth. A number of research have looked into whether bidirectional or unidirectional causes exist.

From a policy standpoint, the causation association in a unidirectional or bidirectional from either consumption of electricity or from the progress of economy has been proved to have a substantial impact on energy.

Electricity is pivotal to most of the challenges and opportunities the world faces today. Whether one speaks of maintaining national stability, economic growth, protecting ecosystems or promoting social equity, they all hinge at least to some degree on access to secure and sustainable electricity.

In Rwanda, energy is a critical productive sector that can catalyse broader economic growth and contribute significantly to facilitating the achievement of the country's socio-economic transformation agenda.

The thesis will be based on secondary data from different institutions including National Institute of Statistics of Rwanda (NISR), Rwanda Energy Group (REG), Rwanda Regulatory board, Ministry of Economics planning and Finance (MINECOFIN), and Ministry in charge of Trade and Industries for the years 1995 to 2019.

The thesis has five chapters with different contents and are Chapter One which is the introduction highlighted the background to the research, the statement of the problem, research questions, research objectives, the study's significance and its scope , the second chapter deal with the review of related literatures; the next Chapter consisted of the employed methodology; the last but one Chapter devoted to the data analysis while the last Chapter highlighted the conclusion of the findings and recommendations.

1.2 Back ground

Development is an evolution of a financial system and of society as an entire, and a rise in income and wealth is merely one aspect of it. Even when considering "a one-dimensional perspective on development based on economic characteristics," the investigation "shows a

mildly favourable influence of electricity on productivity, which appears to differ between countries."

The successful and fruitful made policies has resulted with considerable outputs of being industrialised rapidly and the country has been seen as an economic boom since 2000s with standards of living which were improved.

As of (MININFRA, 2015a): The government's progressive goals were to accelerating the economy but specifically there we mission of energy sector for the purpose of policies allocated to the sector and were the following:

a) Ensuring that sufficient, reliable, and affordable energy supplies are available to all or any of Rwanda's population,
b) Creating and promoting an enabling environment for increased private sector participation in energy supply and service provision,
c) Encouraging and incentivizing more rational, efficient energy use by government institutions, industry, and household end-users,
d) Ensuring the long-term viability of energy exploration, extraction, supply, and consumption to avoid environmental and habitat damage;
e) Promoting safe, efficient, and competitive energy production, procurement, transportation, and distribution; and
f) Developing the institutional, organizational, and human capacity to extend accountability, transparency, and national ownership and decentralized implementation capacity for sustainable energy service delivery."

By mid-2021, Rwanda has a total installed capacity of 235.6 MW generated by various power facilities, the majority of which are hydroelectric; Only 11% of the available capacity is imported, with the balance coming from native sources. Hydrological resources account for 50.6 percent of the generation technology mix, followed by thermal sources (43.4 percent) and solar sources (5%). (https://www.reg.rw, June 2021)

Economic growth is a symbol of progress; it refers to an increase in a country's economic capability. Electricity is seen as a common intermediate and a production boosting element. Energy is both essential to the economy and crucial to the economic process. It is essential to human survival and economic development, as well as the foundation of contemporary

communities. It is the lifeblood and foundation of economic growth. It is playing an important role in encouraging trade and expanding the economy. Trade, according to the research, boosts economic growth.

Electricity is a critical prime mover in driving economic growth and improving human well-being. To reduce poverty, improve living standards, and develop wealth in a sustainable manner, it is critical to provide safe, reliable, inexpensive, and environmentally friendly electricity.

Energy is required by all sectors of the economy (agricultural, commerce, industry, public administration, transportation, and so on) to produce things and deliver services that are both important for people's survival and economic progress.
Appropriate decisions by governments, energy companies, and customers are required for energy to play such a large role in a sustainable manner.
These judgments must be founded on a comprehensive understanding of the elements that influence or affect various aspects of the energy industry in order to be effective.
Théoneste, (2016).

The state would experience significant levels of economic process if its energy potentials were properly utilized to meet demand.

The Rwandan government understands the critical role that electricity plays in advancing economic development by boosting health and living conditions. The government's top goal is energy, particularly access to electricity.

The aim of Rwanda to become a middle income country by 2035 and high income country by 3050 shall be achieved through a series of seven-year National Transformation Strategies (NST1), which will be backed up by sector-specific strategies aimed at fulfilling the Social Development Goals (SDGs).

Following the implementation of two successive five-year program of Economic Development and Poverty Reduction Strategies—EDPRS (2008-12) and EDPRS-2 (2013-18), great social and economic results have been achieved.

Clear policies have been made for diversifying sources of electricity that were beyond the traditional and dominant grid including off grid connections under development of EDPRS 2.

As a result, with the purpose of alleviating the constraints of and limited government subsidies , the residential that were located far from national grids coverage have been advised to use the cheapest electricity sources known as mini grids and solar photovoltaics (PVs).

As of May 2021, 63 percent of Rwandan households had access to the electricity, with 47 percent connected to the national grid and 16 percent using off-grid alternatives (mainly solar). (https://www.reg.rw, June 2021)

1.3 Statement of the Problem

When Rwanda's generation capacity couldn't keep up with demand in 2004, the country faced acute power outages;
Generation capacity has increased dramatically since the crisis, although they remain low in comparison to the size of the country's developing economy;
In May 2010, time of use fees for industrial consumers were introduced as part of efficiency initiatives to enhance the system load factor;
These tariffs were put in place to encourage businesses to shift production from peak to off-peak hours (17.00-23.00). (23.00-7.00).
Economic growth, population, and technology are the three most basic drivers of power consumption;
According to (USEIA, 2011), population growth, labour force participation rate, productivity growth, national savings rate, and capital accumulation have underlying demographic and productivity trends which in turn influenced Longer-term economic growth trends.

Rwanda is enhancing all sectors that have high rate of its contribution to the gross domestic product which has been increased dramatically since 1995 one year after genocide against the Tutsi in 1994.

The government of Rwanda's efforts and high investment throughout its Vision 2020, which has been segmented into two successive development initiatives known as Economic

Development and Poverty Reduction Strategies one and two, have propelled the substantial increase (EDPRS1&2).

Following significant achievements, such as annual increases in GDP, electricity accessibility, capital accumulation, labour force participation rate, vibrant private sector, world-class physical infrastructure, and modern agriculture and livestock, all geared toward prospering in national, regional, and global markets where the results integrated SDGs into the long-term Vision 2050, which has been translated into small-scale strategies under the National Transformation Strategy (NST1).

The NST 1 reflects the Three elements of sustainable development known as economic, social, and environmental were reflected by NST1 which technologically transformed SDGs' aspirational character in the modern agriculture, service, and industrial sectors.

The study was driven by curiosity of knowing the causal association that exist between Is economic growth and power usage in Rwanda from 1995 to 2019?

The association between power usage and progress of the economy has been investigated by a number of researchers, with varying results depending on the country. Surprisingly, growth analysts in Rwanda have paid little attention to the same study.
Rwanda's goal is to transform its agrarian-based economy into a more industrialized, diversified, and knowledge-based economy at the same time a higher income country by 2035 and 2050 respectively.
In the medium-term plans and sector programs, economic transformation is a crucial strategic pillar.
To achieve this goal, major infrastructural expansion will be required to move the economy towards higher-value sectors.
A strategic policy framework approach has helped Rwanda to pursue a green economy throughout a hard and soft investment in infrastructure development for priority sectors, which resulted with an increment in domestic and external connectivity, boosting exports, facilitating urbanization and promote secondary cities.

Recognizing that, economically, the achievement indicator will be found in a significant increase in gross domestic product.

Because of the aforementioned factors, electricity is the lifeblood of the global economy, serving as a critical input to nearly all of the modern world's goods and services. Stable, reasonably priced electricity supplies are critical to maintaining and improving billions of people's living standards.

Electricity is known as "The Economy's Oxygen" because without heat, light, and electricity, companies and cities that supply commodities, services, employment, and homes cannot be built or run, nor can people enjoy the amenities that make life more pleasant and joyful (Yergin, 2012).

The researcher was inspired to look at the causal relationship between economic growth and electricity consumption, as well as other elements that may influence economic growth in Rwanda, as this will help with proper policy selection.

1.4 General Objective

The study's objective is to look into the correlations between power usage and progress of economy in Rwanda from 1995 to 2019.

1.4.1 Specific Objective

- To test the causation association between power demand and Rwandan progress of economy from 1995 to 2019.

1.5. Questions and Hypotheses to Consider

1.5.1 Research questions

Do there exist a relationship between electricity use and Rwandan economic development from 1995 to 2019?

1.5.2 Research Hypotheses

- **The first hypothesis has been set on relationship among variables**

H_0= Electricity Consumption is positively related to the Real GDP.

H_1= There is a negative relationship between electricity use and Real GDP.

- **The second hypotheses have been set on the causality relationship between variables**

H_2= Between 1995 and 2019, there was no direct association between electricity usage and economic growth in Rwanda.

H_3= Between 1995 and 2019, there is a one-way causation relationship between electricity usage and economic growth in Rwanda.

The literature of causality association from either progress of economy to electricity demand and vice versa is underpinned by four testable hypotheses known as conservation, feedback, and neutrality .
Energy consumption has a critical role in economic growth, either directly or as a supplement to capital and labour, according to the growth hypothesis.
Economic growth, according to the conservation theory, determines power use.
The feedback hypothesis is based on the fact that power consumption and economic growth are inextricably linked.
The neutrality hypothesis is based on the notion that energy consumption plays a minor impact in the process of economic growth. (Apergis and Payne, 2012).

1.6 Significance of the Study

This research will be useful to the general population in observing the impact of power prices on their electricity use and, of course, outputs.
The findings and analysis will be useful in formulating future energy policies because they will include the key conditions and requirements for utilities in setting end-user electricity tariffs and the impact of electricity prices on consumption, as well as how these elements affect utility customer categories and, ultimately, their impact on utility revenues.

The study could potentially be used by the power sector and government regulatory agencies as part of other supporting study materials in establishing which class of customers is affected. This study will help both regulator and utility to know how the electricity market is in the

country by knowing at which level of price that can lead a customer to left electricity supplier by consuming single off grid electricity supplier.

It will help academic students and institutions to know the electricity sector functioning and issues related too. Researchers will use it as reference on electricity consumption and GDP growth rate.

1.7 Scope of the Study

The scope of this study encompasses the many types of power generation available as well as how Rwanda's electrical supply system is designed.

It will also investigate the quality of energy delivery as well as the electricity pricing charged to various customer groups in Rwanda.

The research will be defined by the accuracy of data available on the direct influence of power usage on economic growth. The research will span the years 1995 through 2019.

CHAPTER II: LITERATURE REVIEW

2.1. Introduction

In Rwanda, the energy market is run by the national utility, which is state-owned and vertically integrated, while certain Independent Power Producers (IPPs) participate in the generation of electricity.

Rwanda Energy Group (REG) Ltd manages the national utility and has two subsidiaries: Energy Utility Corporation Limited (EUCL), which is responsible for producing and distributing electricity across the country and managing grid operations, and Energy Development Corporation Limited (EDCL), which is responsible for energy infrastructure planning and development.

IPPs sell bulk electricity to EUCL, which has a monopoly on electricity transmission, distribution, and sale to customers linked to the national grid as well as international electricity commerce. There is also a list of mini-grids and standalone systems run by private developers in addition to the grid system.

Rwanda is on pace to increase access to power; nonetheless, the cost of energy delivery is among the highest in the area, and it remains a barrier to the country's economic and industrial development, according to the research. Understanding the behaviour of demand of electricity in connection with economy is very crucial for empowering a strong economic progress in Rwanda.

2.2. Definition of Key terms

This study used a number of terms that are specific to or have specific definitions when used in the context of the above topic.

Term	Definition
Average end-user tariff	The average of tariffs for all customer classes weighted by consumption
Energy costs	Costs that vary with each unit of energy (kWh) generated; These costs are also considered variable cost
Lifeline tariffs	In many countries, **lifeline tariffs** are used for household consumers. **Lifeline tariffs** entail giving a block of electricity use at a reduced rate, calculated to allow people to meet their essential needs.
Non-residential customers	Shops, hospitals (government or private), nursing homes, clinics, dispensaries, restaurants, hotels, clubs, and guest houses all utilize electrical energy for light, fan, and power loads for non-domestic purposes.
National grid	An electrical grid is a network of linked power lines that transport electricity from generators to consumers and come in a variety of sizes and can span entire countries or continents.
Mini-grids	A mini grid, also known as a "micro grid" or "isolated grid," is a collection of electricity producers and possibly energy storage systems connected to a distribution network that provides power to a small number of clients.
The Off-Grids	These are compact, self-contained solar PV-powered power units. Mini-grids are small power plants that power local low-voltage distribution grids that serve individual towns. They can be off-grid or connected to the main grid.
The difference between mini grid and micro grid	The grid's key differentiating feature is that it generates power from its own sources and serves a small number of consumers. Distribution lines are used in the mini-grid. Micro-grids are comparable to mini-grids, but their size and generation capacity are smaller (1 to 50 kW).
Bulk supply	A large supply for resale to other clients also known as a single point of supply to an intermediate distributor or reseller. NOTE: The term "single point of supply" is also used.
Consumer	A person who uses electricity in anyway of consumption, either has a business that consume electricity at the final stage of consumption.
Consumption	Quantity of energy consumed in the unit of kWh.

Customer	A person or legal entity that has agreed to provide distribution services to the Distributor under a contract. Embedded generators, other distributors, end-use customers, foreign customers, retailers, and resellers are among these entities.
Electricity generation	Is the process of producing electric power from primary energy sources, usually at power plants? Typically, electromechanical generators powered by heat engines or the kinetic energy of water or wind are used. Solar photovoltaics and geothermal power are two alternative energy sources.
Transmission of electric power	Is the bulk transportation of electrical energy from a generating site to an electrical substation, from whence it is connected to the distribution system, via a web of interconnecting lines? Local wiring between high-voltage substations and customers is not part of this networked system of connections.
Independent power producer (IPPs)	Private entrepreneurs who build, own, or run electric power plants powered by alternative energy sources such as biomass, cogeneration, small hydro, waste-energy, and wind facilities — all while vying for profit against other state-owned and privately owned generators.
off-peak	Periods of relatively low system demands.
Peak	Periods of relatively high system demands.
Tariff	Combination of charging parameters applied to recover measured quantities such as consumption and capacity costs, as well as unmeasured quantities such as service costs.
Tariff structure	Contains all the components of price and the relationship to consumption and demand.
Utility	Regulated entity that supplies services.
Non -residential tariffs	These are tariffs computed for non - residential customers (Commercial , public or Private institutions , schools, hospitals,
Industrial tariffs	These are tariff computed for All industries as per their industry category.(Small, Medium and Large industry)
Residential tariffs	These are tariffs computed for residential household’s customers.

2.3. Theoretical review

2.3.1. Gross Capital Formation

Capital accumulation is seen as a critical component of economic development. this claim is supported by both theoretical and empirical research. Indeed, since Solow's (1957) analysis, physical capital accumulation has helped to raise the level of productivity.

The word "capital formation" refers to a country's net capital accumulation over a given accounting period. It refers to the addition of capital goods such as equipment, tools, transportation assets, and electricity that are required to replace older ones with new for the continued production of goods and services in order to avoid production decline.

Globally, the greater the capital formation of an economy, the better the aggregate income is increase in improved manner.

Outlays on additions to the economy's fixed assets and net changes in the degree of inventories make up gross domestic investment.
Land improvement, plant, machinery, and equipment purchases, as well as the construction of roads, trains, schools, offices, hospitals, private residential homes, and commercial and industrial buildings, are all examples of fixed assets.
Firms keep inventories of items to meet transitory or unforeseen swings in production or sales, as well as 'work in progress.

2.3.2. Definition of tariff

The price unit that an electricity end user or consumer pays to the supplier in any type of currency per kilowatt hour is defined as a Tariff.

Economically as well as Politically, electricity has been often considered as a public good and thus it has been obliged to be priced for their consumers whether residential or non-residential customers.

Specifically, tariff setting could be driven by the principles of (a) Revenue adequacy to the Utility, (b) equity, (c) economic efficiency, (d) transparency, (e) simplicity, (f) stability, (g) Uniformity of regulatory framework, and (i) increments of costs.

2.3.3. Electricity generation

Electricity could be generated from fossil fuels namely coal, natural gas and Petroleum; nuclear energy and renewable energy sources.

The steam turbines using biomass, thermal, , solar ,hydro turbines, and solar photovoltaics are used to generate electricity in Rwanda.

2.3.4. Electricity generation mix

Various types of energy are used to produce electricity worldwide and among those forms of energy they are hydro, peat, solar heavy and light fuel and methane gas.

The cheapest and most advised to be used is the hydropower but due to its scarcity and challenges in the dry season, the Rwandan system shift to the expansive diesel that contributes with a highest share of the installed capacity regardless to its presented high costs.

2.3.5. Accessibility of electricity in Rwanda (kWh)

By May 2021, 47 percent of Rwandans were connected to the national grid while 16 percent of them were connected to off grids system and this give a total of 63% Rwandans who were accessing electricity countrywide.

The country development in all sectors caused a high demand of electricity which in turn pushed Policy makers to take and struggle with the problematic of availing electricity so that it could be accessible at affordable price and this is the reason why the government of Rwanda took a favourable policy commitment to expand the sources of electricity from traditional ruling grid to incorporate even off-grid connections.

2.3.6. Electricity Consumption (Kwh) in Rwanda

Up to date, electricity is still vital input for all manufacturing systems and an essential for all households today. Electricity consumption may be the source of not only an improved living style but also put out effect on the environment due to inappropriate use.

What if electricity consumption is growing around the world? If there is an excessive of electricity use this shall push more power plants be built to produce enough electricity to meet demand.

Socio-economic development is assessed as a measure of electricity consumption level worldwide and this has been proven in the east African countries that have indicated an increase in production and energy consumption which was significantly raised since last decade.

Due to that electricity is the best and foremost preferable form of energy in developed countries with modern economies where it was used in all area of final consumption like light, heat, electrical and electronic devices, it has been considered as a fundamental factors of a country's development in both economic and human capitals at either regional and international level.

2.3.7 Trade Accessibility

Assuming the expansion process regarding electricity and trade has oriented many investigators to discover both short and long term association (Sadorsky, 2012). Variety of the investigations have indicated that both electricity and trade are useful to influence economic improvement.

Even so, (Gries, 2012) found that trade and economic growth were negatively related and perceive that huge exporters have a positive empowered growth while less exporters discourage growth. The degree of importation and exportation as registered in national economy as impex rate affect the level of a country behaviour whether politically and economically.

2.3.8. Gross Domestic Product

Progress of economic has been much investigated by various number of researchers. According to Phan (2006), increase of economic growth is a growth of overall achievement of an economy within any period. Thus, it can be taken as an increase in GDP or individual earnings in a given period. Globally, electricity contributes in the economic growth process. Electricity utilization

is either the driver or the facilitator of economic growth. The literature also explains that the causality association between electricity and economic progress varies from country to another. A favourable connection between electricity utilization and progress of economic, as indicated by earing levels or by some wide measure such as the Human Development Index (HDI), has long been perceived.

This connection give rise to an exposed question on causality. Does electricity consumption a mere outcome of increasing GDP or is it a crucial component in the overall growth of income and welfare, along with other determinants such as capital formation, employment, trade openness.

According to Mann (2004) and (UNECA, 2015), due to that all countries don't have a competitive advantage in manufacturing, the expansion of services is significantly quick and the service sector is taken as a pillar of economic development.

2.3.9. Employment in Rwanda

The most discussed concern in national strategies is the connection between Employment and economic progress. Growth of Economic should result from a suitable combination of employment growth and productivity growth.

The concept of Economic and practice progressively illustrate that the main contemporary global issues such as economy progress, advanced human capital, healthy and hopeful lives have been challenged by permanent conflicts of natural resources scarcity and various individual and or general human needs and this involves all types of active natural resources and factors of outputs that may contribute to the economic progress.

2.3.10. Principles links between electricity consumption and employment

Various economic effects are identified when we focus on the link between electricity consumption and employment. Six of them have been highlighted depending on demographic, income, price, and substitution, technological and structural effect.

The demographic change related effects which can affect directly either electricity consumption or employment. The needs in matter of electricity are increasing in some countries

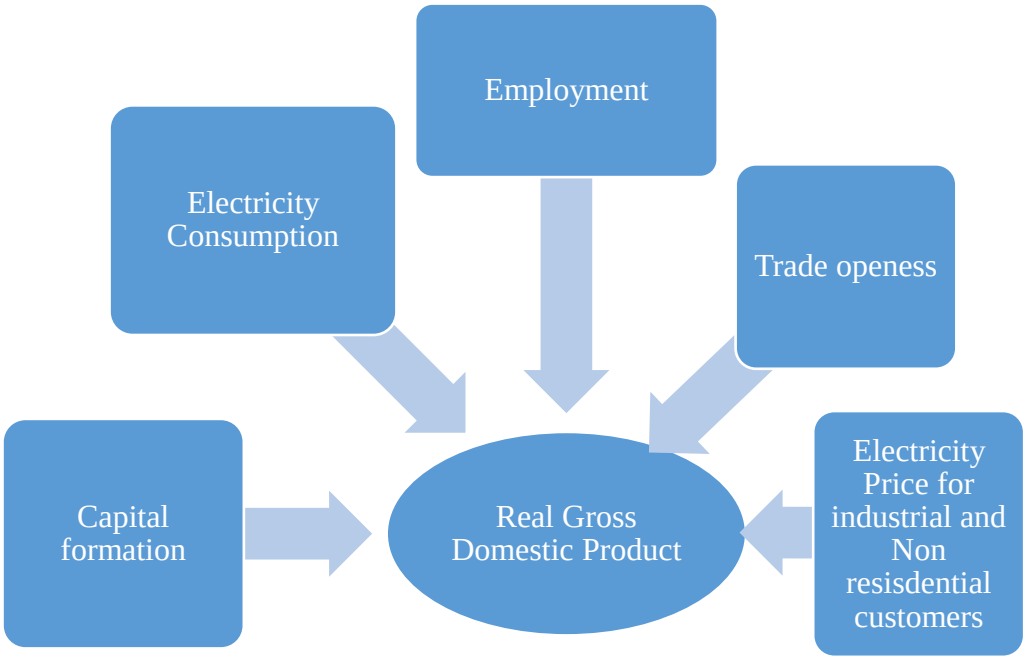
due to both baby booms have risen their populations and its use in health care, education services, foods, domestic needs services without need in matter of employment. The situation becomes more complex when this population enters to the employment market. Employment and electricity consumption are growing all together.

2.4. Conceptual Review

Each and every researcher ‘s expectations via his/her research would be illustrated by a conceptual framework which identifies the variables relevant on his or her study by describing how they might relate to each other. It maps out visually in a layout as indicated below.

The study has the regression model equation comprising the Dependent variable known as real gross domestic product, the independent variables known as Electricity consumption, Trade openness, Employment, capital formation and electricity price for industrial customers.

$$\mathbf{LOG\_R\_GDP} = \mathbf{C1}\,\mathrm{LOGEC} + \mathbf{C2}\,\mathrm{LOGEM} + \mathbf{C3}\,\mathrm{LOGEPI} + \mathbf{C4}\,\mathrm{LOGEPNR} + \mathbf{C5}\,\mathrm{LOGK} + \mathbf{C6}\,\mathrm{TO} + \mathbf{C7}$$



2.5. Empirical review

Electricity is amongst production inputs and is considered as an engine of the economic progress at national level (REG, June 2019). According to (El-Sakka, (2004)) energy is a "Barrier to economic growth". (Chang, 2008) Also agree with this conclusion because economic activities depend on energy within production process.

The best and fruitful decision taken by policy makers could be leaded by the different findings from investigation aiming to know the causality direction between electricity demand and the progress of the economy within a country whereby based on factual research made, there might be evidence to encourage conservative, feedback, neutrality or growth hypothesis depending on the country policy orientation.

According to (**Ferguson** et **al.,** 2000), during the past two decades, empirical research has been carried out on the related topic of the causal association between use of electricity with progress economy where most of the researchers discovered that there is relationship between them. is a close concluded that there is a strong relationship between them.

Researchers have much focused on the association between Use of electricity and the progress of economics with some assumptions that on one hand economic progress promotes electricity use but also on the other way growth in economy can be affected. Researchers shall serve to further investigation on use of electricity where the economic progress should be impacted by the allocation of price subsidization.

The causation could be the important metric rather than correlation due to it gives all information about use of electricity which help to improves the economic growth movements forecasts.

Below are sample outputs of the empirical examination on causal association between economic progress and electricity use in various countries.

There have been various investigations on the causality relationship between electricity demand and economic progress in different countries which ended by different findings whereby Kepler (2006), Adom (2011), Kourbali (2012), for India, Ghana and Algeria respectively found that there was causality relationship running from economic growth to electricity use and it confirm with conservative hypothesis. While, Kepler (2006), Karagöl et al. (2007), for chine, Turkey respectively discovered that a causal association run from electricity use to the economic progress and confirms with growth hypothesis.

Majority of authors who tested the relation between electricity use and growth of economic with inclusion of electricity prices as an intermittent variable (George, 2002). Various works on the topic differ from each other where some studies found bi-directional causality. (Oh, 2004), (Soytas, 2003) and others discovered a unidirectional causality from electricity use to GDP. Strong evidence found (Altinay, 2005) (Lee, 2005), while (Fatai, 2004) , (Hatemi, 2005) found unidirectional causality running from economic growth to electricity demand were found for New Zealand and Australia , Sweden respectively and Lastly, (Yemane., 2006) discovered the absence of causal relationships between use of electricity and growth of economics.

Many authors found empirically that macroeconomic production function may consider energy and employment as substitute inputs because of that the lack or absence of one of them may lead to more use of another and vice versa and then this is called substitute effect.

Shifting to a tertiary based economy from an industrial based economy is usually followed by less demand of electricity use whereby a transition from manufacturing to the service sector is expected to take into consideration a dematerialization of economic activity and an improvement in eco-efficiency without increasing unemployment and this is called the structural effect (Arouri et al, 2014).

Therefore, the above effects lead to various complex relationship between employment and electricity consumption. However, regarding economic concepts on the connection between economic progress and employment; many economists acknowledge capital, employment, natural resource and technology as four main driver of economic growth.. (Phạm et all....,

2014). Study identifies an immense body of evidence, which indicate that growth in manufacturing, and services have particularly positive effect on employment.

Progress in economics has been much debated by analysts. According to Phan (2006), economic growth is a growth in overall output of an economy in a given period. Thus, it can be understood as an increase in GDP for a given period. Economic growth reflects a quantitative variation in an economy. Employment is a special commodity that can be traded in the market like other services (Phạm et all...., 2014).

According to Kapos (2005) and Dopke (2001), economic growth is positively related to employment by generating new opportunities that could create many more jobs.

CHAPTER III: RESEARCH METHODOLOGY

3.1. Introduction

Comprehension of the behaviour of electricity consumption in connection with the economy is a key and significant to enhance a stable economic growth with consideration of electricity consumption, Gross capital formation, Employment, trade openness and Price volatility impact on the development of the country. The models employed to test for stationary, co-integration and causality of the variables in the Model.

The research started by curiosity of knowing the economic impact of electricity end user price to the progress of economic in Rwanda for the years of from 1995 to 2019. Economically understanding, there was an expectation of negative relationship between them in Rwanda.

The electricity consumption has been increased highly due to the high electricity use Demand side such as population increase, infrastructure development, new businesses entries, industrial sector consumption increased due to the national policy on subsidization of industries sector, high increase in Service sector.

3.2. Source of data

This research applies the statistical data from national institution of statistics of Rwanda, World Development Indicators, Regulatory Authority, electric utility from 1995 to 2019, which comprise Real Gross Domestic Products, electricity consumption, capital formation, electricity end user tariffs (Industrial and non-residential customers) and employment.

The covered data were real GDP (Rwf), Trade Openness (%), consumed electricity (kWh), employment, capital formation and electricity end user tariff (Frw/kwh).

This research explores the causal association between electricity demand and economic growth in Rwanda. The long term relationship among the parameters have been determined by ARDL bounds test.

The results of the ARDL model has confirmed a long term link between electricity demand, economic progress, electricity prices and trade openness, capital formation and employment. These findings have brought a fresh perspective for creating electricity policies that has enhanced economic progress in Rwanda with regard to the electricity end user tariffs that could promote electricity consumption.

3.3. Model specification

The factual examination of the link connecting electricity use and progress of economic bring in three stage. The stage of employing:

a) Unit root tests investigating the stationarity,
b) Co-integration test investing existence of long term relationship among parameters and
c) Granger causality test for causality relationship between them.

Therefore, the stability test of time series data will be needed whereby experts and analysts insist that electricity contributes a vital role in production process.

The production function is composed by employment and capital.

$$Y = f(K, L) \qquad (1)$$

The equation define production of Y as output variable that depend on capital formation and employment as function's inputs that are substitutes for each other.

As per neoclassical models, production function does not consider electricity as an input. Contrary, nowadays it become key resource of production.

In this context, the Cobb- Douglas production function generally is used to define the link between input and product.

According to Pokrovski, V. (2003) there is an additional production tool known as electricity and equation 1 can be expressed as;

$$\boldsymbol{Y = f(K, L, E)} \qquad (2)$$

Y, K and L represent Output, capital and employment respectively while Ec is used for electricity consumption. The necessity of employment and electricity in production process is determined by the level of technology whereby electricity is attracted by the capital. (Chang, 2008).

Additionally, trade openness and electricity price are also key drivers with significant contribution to the growth of the economy and have been used by many of investigators; therefore, being considered the production function become as below:

$$\boldsymbol{Yit} = \boldsymbol{f}(\boldsymbol{Kit}, \boldsymbol{Lit}, \boldsymbol{Ecit}, \boldsymbol{Toit}, \boldsymbol{Epit}) \quad (3)$$

Considering the function in exponential form as per Cobb-Douglas experiment, equation 3 will presented as follow;

$$Yit = \boldsymbol{AL}_{\boldsymbol{it}}^{\propto \boldsymbol{it}} \boldsymbol{Ec}_{\boldsymbol{it}}^{\propto \boldsymbol{it}} \boldsymbol{To}_{\boldsymbol{it}}^{\propto \boldsymbol{it}} \boldsymbol{K}_{\boldsymbol{it}}^{\propto \boldsymbol{it}} \boldsymbol{Epi}_{\boldsymbol{it}}^{\propto \boldsymbol{it}} \boldsymbol{Epnr}_{\boldsymbol{it}}^{\propto \boldsymbol{it}} \quad (4)$$

In order to avoid disequilibrium and skedasticity, the equation has been transformed into natural logarithms form so that it became linearized equation.

$$Ln(Yit) = \propto_{\boldsymbol{0}} + \propto_{\boldsymbol{1}} \boldsymbol{ln}(\boldsymbol{L_t}) + \propto_{\boldsymbol{2}} \boldsymbol{ln}(\boldsymbol{Ec_t}) + \propto_{\boldsymbol{3}} \boldsymbol{ln}(\boldsymbol{To_t}) + \propto_{\boldsymbol{4}} \boldsymbol{ln}(\boldsymbol{K_t}) + + \propto_{\boldsymbol{5}} \boldsymbol{ln}(\boldsymbol{Ep_{it}}) + \boldsymbol{\alpha_6 lnE_{pnrt}} + \mu it \quad (5)$$

With ln = Natural logarithm; Y = Economic growth measured in Real GDP; Ec = Electricity consumption; To = Trade openness; L = Employment; K=Gross capital formation; $\alpha 0$ = Intercepts; $\alpha 1$ = elasticity of employment force with respect to growth of economy; $\alpha 2$ = elasticity of electricity demand with respect to economic growth; $\alpha 3$ = coefficients of trade openness; $\alpha 4$ = coefficients of capital formation;

α5= elasticity of industrial electricity price with respect to the economic growth; α6=elasticity of non-residential electricity price in connection with advancement of economic. t = 1, 2 ….. 25 periods; and μ = error term.

The analysis is focusing on how to detect a link of economic growth with regard to the electricity consumption with other variables.

The applicable processes, approaches and estimation procedure for time series statistics are debated in this part.

The purpose of tracing out the long term relationship, short term variability with reconciliation of its contribution to the short and long term connection between parameters could be done by applying Johansen test procedure.

The fact that the parameters have the same order of integration is demonstrated by Co-integration test and show how variables are stationary. While the Unit root test is used for testing the non –stationarity of the variables.

Apart from conversation on the co-integration mechanism, there has been a debate about granger causality test between variables.

3.4. Tools of data analysis

As per the aim of the empirical examination of both how the variables are related and their causality relations in long term, the analysis tools have been structured as below:

3.4.1 Augmented Dickey Fuller Test

Apart from stationary test, there have been adoption of examining and to defining with or without intercept the variables non-stationary is augmented dickey fuller test as shown below:

$$\Delta \boldsymbol{lnY_{it}} = \boldsymbol{\mu} + \propto^{*} \ \boldsymbol{lnY_{t-1}} + \sum_{i=1}^{\alpha-1} \boldsymbol{\beta_i \Delta lnY_{t-i}} + \mu_t \ (6)$$

3.4.2 Co-integration

To discover the causal relationship among variables, the test for Johansen procedure is needed by applying the methodology developed in Johansen (1991, 1995).

3.4.3 Granger causality Test

The granger causality test has been employed to evaluate the nature of causal relationship.

For conducting the granger causality examination, the series need to be stationary. Therefore, the unit root tests are applied to test the stationary of both series.

This test is used to determine causal relationship between two variables. There is a relationship between variables X & Y if the Probity values of X significantly influence the prediction of the value of the other variables Y (Sabihuddin, 2001).

$$\mathbf{\Delta Y_t}=\sum_{\mathbf{i=1}}^{\boldsymbol{\alpha}}\boldsymbol{\alpha_i}\mathbf{\Delta Y_{t-i}}+\sum_{\mathbf{j=1}}^{\boldsymbol{\alpha}}\boldsymbol{\beta_j}\mathbf{\Delta X}+\mu_{\mathbf{1t}} \quad (07)$$

$$\Delta X=\sum_{\mathbf{i=1}}^{\boldsymbol{\alpha}}\boldsymbol{\Upsilon_i}\mathbf{X_{t-1}}+\sum_{\mathbf{j=1}}^{\boldsymbol{\alpha}}\boldsymbol{\delta_j}\,\mathbf{\Delta Y_{t-j}}+\mu_{\mathbf{2t}} \quad (08)$$

CHAPTER IV: FINDINGS FROM EMPIRICAL ANALYSIS

4.1. Unit root Test

Expecting that the parameters would have the same order of integration for measuring co-integration, the stationary test as Johansen technique has been employed to check the absence of stationary.

It checks the data series of stationary level. Below are the findings of ADF and PP stationary test of the variables with 2 hypotheses of H0 = absence of stationary, H1 = existence of stationary.

Table 1: Results for Stationarity test.

	ADF		PP	
Variables	Level	1st Diff	LEVEL	1st Diff
log(R_GDP)	-2.298	-4.717	-4.150	-5.195
logEc	-0.161	-8.005	-0.412	-10.292
logK	-1.591	-3.360	-1.550	-3.392
logEm	-0.161	-5.887	-2.477	-1.920
To	0.789	-4.201	0.419	-7.168
LogEpi	-2.498	-4.303	-2.522	-4.316
logEpnr	-1.716	-4.733	-1.748	-4.737
1% Critical Value	-3.788	-3.753	-3.738	-3.753
5% Critical value	-3.012	-2.998	-2.992	-2.998
10%Critical Value	-2.646	-2.640	-2.640	-2.640

Sources: Computed using E-views 9

The ADF test and Stationarity test have been used to demonstrate whether data has stationary or has a unit root and their order of integration where after the findings indicated that there was non-stationary at level for ADF & Philipp Perron tests in the model.

However, except capital which is stationary in the first difference at 5 % level of significance, Real economic growth, Trade openness and Electricity consumption become stationary in the first difference at 1 % level of significance.

Meanwhile, employment is not stationary at their level neither 1st difference for PP test but only stationary at 1st difference for ADF test at 1% level of significance.

4.2 Co-integration experiment

Johansen techniques has been used in the model for long term association between parameters in Rwanda with the hypotheses of H0: Rank = 0, H1: Rank = 1 whereby the existence of long term relationship could be confirmed by the rejection of hypothesis H0 and the findings are presented in the table below.

Table 2: Test of Unrestricted co-integration test (Trace)

Hypothesized		Trace	5%	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.99	334.80	125.62	0.000
At most 1 *	0.98	206.15	95.75	0.00
At most 2 *	0.92	113.21	69.82	0.00
At most 3 *	0.77	54.66	47.86	0.01
At most 4	0.40	20.49	29.80	0.39
At most 5	0.31	8.69	15.49	0.4
At most 6	0.00	0.02	3.84	0.89
Trace test indicates 4 co-integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

Source: Computed using E-views 9

Table 3: Test Unrestricted co-integration (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.996	128.647	46.231	0.000
At most 1 *	0.982	92.939	40.077	0.000
At most 2 *	0.922	58.554	33.876	0.000
At most 3 *	0.774	34.162	27.584	0.006
At most 4	0.402	11.809	21.131	0.567
At most 5	0.314	8.667	14.264	0.315
At most 6	0.000	0.021	3.841	0.885
Max-eigenvalue test indicates 4 co-integrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

Source: Computed using E-views 9

The outcomes of both the trace and Maximum-Eigen investigation indicates imply that there are four co-integrating equations exits at the 1% level of significance.

Taking into consideration of Maximum-Eigen experiment, the findings indicate that Max-Eigen values all are higher than the critical values, and they are of values. Consequently, the model's variables are co-integrated.

Table 4: Long-run relationship of variables

Dependent Variable: LOG_R_GDP_				
Method: Least Squares				
Sample: 1995 2019				
Included observations: 25				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.810	0.844	3.327	0.004
LOGEC	0.107	0.026	4.146	0.0006
LOGEM	0.840	0.207	4.056	0.0007
LOGK	0.268	0.058	4.570	0.0002
LOGEPNR	0.001	0.051	0.026	0.978
LOGEPI	0.023	0.041	0.560	0.581
TO	0.002	0.0001	2.141	0.046
R-squared	0.998107	Mean dependent var		12.58149
Adjusted R-squared	0.997475	S.D. dependent var		0.241444
S.E. of regression	0.012131	Akaike info criterion		-5.754571
Sum squared resid	0.002649	Schwarz criterion		-5.413286
Log likelihood	78.93214	Hannan-Quinn criter.		-5.659913
F-statistic	1581.460	Durbin-Watson stat		1.929055
Prob(F-statistic)	0.000000			

Source: Computed using E-views 9

Estimation Equation

- $\mathbf{LOG\_R\_GDP = C1LOGEC + C2LOGEM + C3LOGEPI + C4\,LOGEPNR + C5LOGK + C6\,TO + C7}$

Substituting Coefficients in the above equations:

- $\mathbf{LOG\_R\_GDP = 0.108LOGEC + 0.840LOGEM + 0.023LOGEPI + 0.001LOGEPNR + 0.268LOGK + 0.002TO + 2.810}$

The model explains that among dependent variables; employment, electricity consumption, capital and trade openness are statistically significant and have positive long term connection to the GDP in Rwanda whereas electricity price for both industrial and non- residential are positively but not statistically associated to the growth domestic products in Rwanda. These results revealed that end user electricity price of non-residential and for industrial's impact to the GDP is meaningless. The positive relationship between variables is confirmed by the values of goodness-of-fit and adjusted the strength of the relationship at 99% which shows the fitness and closer relationship between variables and it is represented by R^2= 99% of variable fitness from independent variables to dependent one in the model.

So, other factors remaining constant, the increase of 1% to the electricity consumption, Real GDP shall increase by 11% in long run and in the same condition of keeping other factors constant, a 1% increase to the employment and capital could rise GDP by 84% and 27% respectively while 1% increase in Trade openness, implies a GDP increase by 0.002 Unit other things remain constant.

Table 5: Short-Run Relationship

Dependent Variable: D(LOG_R_GDP_)				
Method: Least Squares				
Sample (adjusted): 1996 2019				
Included observations: 24 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.022	0.005	3.837	0.0013
D(LOGEC)	0.047	0.015	3.186	0.0054
D(LOGEM)	-0.188	0.395	-0.478	0.6396
D(LOGK)	0.195	0.068	2.852	0.0110
D(LOGEPNR)	0.022	0.056	0.397	0.6957
D(LOGEPI)	0.0197	0.054	0.363	0.7208
ECM(-1)	**-0.591**	0.214	-2.752	0.0136
R-squared	0.619	Mean dependent var		0.033752
Adjusted R-squared	0.484	S.D. dependent var		0.011440
S.E. of regression	0.008	Akaike info criterion		-6.526242

Sum squared resid	0.001148	Schwarz criterion	-6.182643
Log likelihood	85.31490	Hannan-Quinn criter.	-6.435085
F-statistic	4.593651	Durbin-Watson stat	1.730964
Prob(F-statistic)	0.006014		

Source: Computed using E-views 9

The above results are evaluation results of the associated short and long term between electricity use and the progress of economy. There were expected a negative and significant error correction factor and the value was (0.591) which was large and demonstrated that the correction rate for long-term equilibrium and short-term disequilibrium is 59.1%. This shows that the moderated speed of convergence to long-term equilibrium after the shock.

The results also show that there is a negative correlation between employment and economic progress in the short term and there is no statistically significant relationship. Trade liberalization and tariffs for non-residential and industrial energy end-users are not significant, but have a beneficial impact on economic growth.

The negative signs of the short-run variables are stable with the long-run coefficients and the significance levels are also kept for both capital and electricity use to economic progress in Rwanda in between 1995 to 2019.

4.3. Test of Parameter stability.

H0: Parameters are stable (Desirable)

H1: Parameters are unstable (not Desirable)

In order to check whether regression's coefficients vary systematically, the research use Cumulative Sum test and when they investigators want to know if regression's coefficients are suddenly changing, they always used Cumulative Sum of square test.

The stability test results from Cusum and Cusum square test confirmed that variable were stable for short and long term with specification that all of the values lie within critical boundaries at a significance level of 5%.

Figure 1: Cusum of Square test

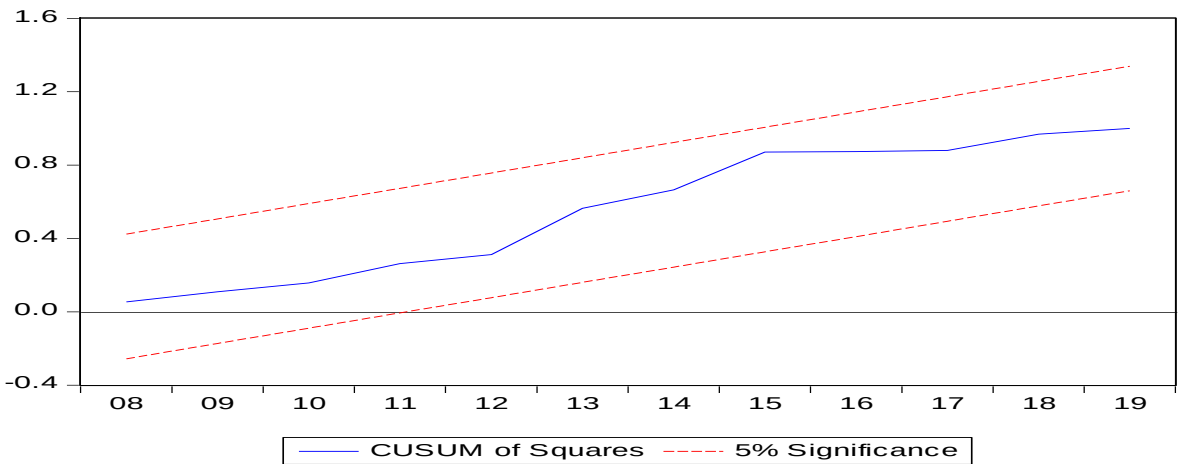
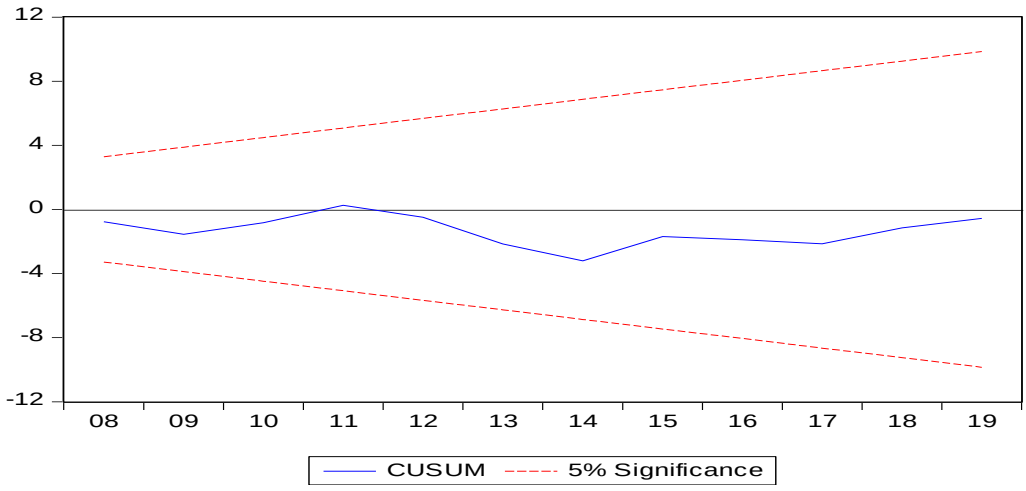


Figure 2: Cusum test



The coefficients' short and long run stability is confirmed by the fact that the blue line lies between the two red lines at 5% significance level.

4.4. Granger Causality experiment

Granger causality investigation is to analyse the forerunner-lag link between GDP and Electricity use in this study. If economic progress give rise to the electricity consumption, GDP could vary before Electricity demand in time series, contrary, Electricity consumption will vary before GDP.

Test Hypothesis	Lags	Observation	F Value	P Value	Results	Interpretation
EC does Not Cause RGDP	2	23	0.01077	0.9893	Not rejected	**RGDP→EC**
RGDP does Not Cause EC			3.70965	0.0448	**Rejected**	
EM does Not Cause RGDP	2	23	0.81215	0.4595	Not rejected	**RGDP—EM**
RGDP Does Not Cause EM			26.2087	5.E-06	Not rejected	
EPI does Not Cause RGDP	2	23	0.56505	0.5781	Not rejected	**RGDP—EPI**
RGDP does Not Cause EPI			0.97202	0.3973	Not rejected	
EPNR does Not Cause RGDP	2	23	0.28401	0.7561	Not rejected	**RGDP →EPNR**
RGDP does Not Cause EPNR			5.18459	0.0167	**Rejected**	
K does not Cause RGDP	2	23	1.13526	0.3433	Not rejected	**RGDP →K**
RGDP does not Cause K			6.22056	0.0088	**Rejected**	
TO does not Cause RGDP	2	23	2.79507	0.0877	**Rejected**	**TO→RGDP**
RGDP does not Cause TO			2.00338	0.1639	Not rejected	

Table 6: Granger Causality Experiment for the data from 1995-2019.

—: Neutral causality or not granger causality between variables

→: Unidirectional causality from one variable to another

↔: Bidirectional causality between variables.

This study period of between 1995 and 2019 on the table used gross domestic product, electricity consumption, employment, gross capital formation, trade openness and electricity price for non-residential with industrial tariff within this investigation. The above findings explain the pairwise causality between Real GDP in Rwanda and electricity consumption, employment, gross capital formation, and Trade openness, electricity price for both non-residential and industrial tariff within the above period.

The Granger Causality test found that within the whole period of from 1995 to 2019 , a unidirectional causality from real GDP to both use of electricity and gross capital formation in Rwanda which is contrary to the trade openness that has a unidirectional causality to the Real

GDP in Rwanda, there is no causality relationship between RGDP and employment as well as industrial end user electricity price, meanwhile the increase in real gross domestic product push non -residential end user tariff to be increased due to the high consumption rate from commercials customers categorized in non -residential categories.

Foregoing to the causality investigation, the Augmented Dickey Fuller and Phillip Peron stationary tests and co-integration test applied to investigate for unit roots and co-integration. Factors that parameters have a unidirectional or bidirectional long run relationship between them is confirmed that they were found co-integrated.

The direction of short-run and long-run Granger causality was discovered by applying vector error correction model. The experiment findings of co-integration examination show that electricity use and progress of economy are connected. Moreover, causality investigation findings give out that in the long run, economic progress push electricity consumption in Rwanda. This study confirm the conservation hypothesis which proved that economic growth has caused electricity demand in Rwanda within the period of from 1995 to 2019.

Taking into considerations the electricity end user tariff that was flat from 1995 up to 2010 and categorised customer tariff from 2010 to above. This study tried to spread into two period for further conclusion on the flat and differentiated tariffs.

Curiously, in from 1995 to 2010, it was found that Real GDP is positively related to the electricity consumption and confirm to the neutrality hypothesis indicating that there is no link between electricity demand and economic progress, meanwhile, use of electricity was negatively related to the Non-residential end user electricity tariff while in from 2010 to 2019, they are also positively but non -significantly related with no causality relationship too.

However, the results from the two separated period could not been trusted even not believable due to the limited time period which couldn’t allow this study to make a conclusion.

Therefore, it has been recommended a deep and particular research on the impact of electricity end user tariff to the economic growth and their relationship in Rwanda.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.0. Introduction

Using stationary, Johansen and causality test, the connection between electricity utilization and progress of economic in Rwanda have been investigated. The results show that there was a long term trend with a unidirectional relationship from the growth of economic to the demand of electricity.

Basing on statistical data above in this thesis concerning logarithm of electricity and real economic growth, capital, Trade openness, employment and end user electricity price by the unit root, co-integration and Granger causality investigations, applying OLS method to determine the model, and finally come to the results conclusions and proper guidelines recommendations:

5.1. Major findings

Due to that Rwanda has experienced a considerable economy development, electricity demand has been increased through all sectors driving the growth of country's economy. Therefore, economic growth which takes place greatly in sectors driving economy, intensify electricity demand in Rwanda.

The experiment findings of this research give government a great comprehension of electricity use via economic growth nexus to draw up Rwanda energy sector's policies which could be executed without adverse effect on economic development.

A period of from 1995 to 2019 in Rwanda, time series of logarithm of electricity consumption and Gross Domestic Products with additional of gross capital formation, trade openness, employment and end user electricity tariffs were non-stationary at level but at first differences, they are stable and have co-integration, showing that they have stable link of long-term trend and are statistically significance with exceptional of end user electricity tariffs that are positively related to the GDP but not statistically significance.

- This research of analysing the relationship between Electricity Consumption and Economic growth in Rwanda 1995 – 2019' found a one way causality relationship from economic growth to the electricity consumption in Rwanda and it confirm and agree with studies done by Kepler (2006), Adom (2011) and Kourbali (2012) for Indian, Ghana and Algeria that concluded that economic growth has an effect to electricity consumption without reciprocity causality this has kept the conservation hypothesis.
- Among other factors, Trade openness which is the ratio of net export to the real GDP has a one- way causal relationship to the real GDP in Rwanda.
- The spreaded period, the investigation results were not trusted due to the limited period, therefore, the deep analysis has been recommended on the link between electricity end user tariff and GDP in Rwanda for further findings.

The findings confirm the results from the studies done by Ghosh (2002), Jumbo et all (2004), Narayan and Smyth (2005), studied the causality relationship between use of electricity and growth of economy and found that electricity demand is favoured by the growth of economy.

5.2. Conclusion

In Rwanda, from 1995 to 2019, both developed economic and demand of electricity were positively related and have increased together with a considerable speed. However, the electricity consumption is driven by high economic growth dispatched in at least all sectors, this means that higher economic growth, greater electricity consumption in the country which confirm the hypothesis of the conservation where economic growth lead electricity consumption.

The study explained the researcher that despite the importance, function and prioritization of electricity consumption in Rwanda, we have concluded that electricity consumption could be enhanced in industries production, capital formations in service sector, agriculture development such as irrigation and machinery uses but itself couldn't not be classified together with capital and labour forces as Production input.

5.3. Policy Recommendations

Economic progress in Rwanda has been depended mostly on mainly three sectors including agriculture, service and industrial sector which are the main electricity consumers in Rwanda

and that boost Gross capital formation and trade openness which is the ratio of Net export to the growth domestic product and consequently they increase employment. In order to be a middle and high income country, Rwanda should act as Bellow:

- First, to adjust the industrial category for the purpose of favouring them to work in a productive environment.
- Due to the contribution of 49 %, 24% and 19% by service sector, Agriculture sector and Industry sector respectively to GDP; the higher proportion, the higher electricity consumption. Therefore, industrial restructuring should be accelerated and backward production with high electricity consumption and be elimination of serious environmental pollution.
- Increase investment in science and technology, to improve service sector efficiency.
- The investigation found that among other factors of economic growth in Rwanda, there is trade openness which has a one -way causal relationship to the Real GDP, this gave a call to the government to improve exportation by investing much in most exported products and enhance in Foreigner direct investment.
    - ❖ According to Barro et all (1997), trade openness has enhanced long term growth economy throughout diffusion of technology and knowledge dissemination by allocating all resources , improving total factor productivity efficiently and access to all goods and services.
    - ❖ The government is recommended to invest more in human capital and physical capital, while maintaining the protection of natural resources of the country.

References

Altinay, G. &. (2005). Electricity consumption and economic growth: evidence from Turkey. *Energy economics, 27(6),*, 849-856.

Arouri et al. (2014). Exploring the Causality Links between Energy and Employment in African Countries. *IZA Discussion Papers, No. 8296, Institute for the Study of Labor (IZA), Bonn*, 5-6.

Chandran, V. G. (2010). Electricity consumption–growth nexus: the case of Malaysia. *Energy Policy, 38(1)*, 606-612.

Chang, C.-C. L.-P. (2008). Energy consumption and economic growth in Asian economies: A more comprehensive analysis using panel data. *Resource and Energy Economics, vol. 30, issue 1,*, 50-65 .

El-Sakka, K. H. ((2004)). Energy use and output growth in Canada: a multivariate cointegration analysis. *Energy Economics, vol. 26, issue 2,* , 225-238 .

Fatai, K. O. (2004). Modelling the causal relationship between energy consumption and GDP in New Zealand, Australia, India, Indonesia, The Philippines and Thailand. *Mathematics and Computers in Simulation, 64(3-4)*, 431-445.

Ferguson et all, ,. (2000). Electricity use and economic development. *Energy Policy, 28, issue 13,*, 923-934.

Fezzi, C. (2007). ECONOMETRIC MODELS FOR THE ANALYSIS OF ELECTRICITY MARKETS. *Disciplinary sector: SECS-P/05 ; STATISTICAL METHODOLOGY FOR SCIENTIFIC RESEARCH XIX Cycle*, 13 (2.1).

George. (2002). Energy consumption and economic growth: Assessing the evidence from Greece. *Energy Economics 24 (4); DOI: 10.1016/S0140-9883(02)00006-3*, 319-336.

Gries, T. a. (2012). Foreign Direct Investment, Trade Openness and Economic Growth: Evidence from Ghana. *Trade Openness and Economic Growth: A Panel Causality Analysis.*

Hatemi, A. a. (2005). "Energy consumption and economic growth in Sweden: a leveraged bootstrap approach, 1965–2000.". *International Journal of Applied Econometrics and Quantitative Studies, 2(4),* 87-98.

IOB. (August 2014). Access to Energy in Rwanda. *Impact evaluation of activities supported by the Dutch Promoting Renewable Energy Programme*, 29-35.

Lawrence. (2012). Energy Vision Update 2012. *Putting Energy Back to Work, Energy for economic growth*, 5 & 26.

Lee, C.-C. (2005). Structural breaks, energy consumption, and economic growth revisited: Evidence from Taiwan. *Energy Economics, Volume 27, Issue 6,*, Pages 857-872.

Nicholas Apergis, J. E. (2010). Energy consumption and growth in South America: Evidence from a panel errorcorrection model. *Energy Economics 32 (2010) 1421–1426*, 2-6.

Oh, W. a. (2004). *Energy consumption and economic growth in Korea: testing the causality relation,*.

Phạm et all.... (2014). Relationship between Economic Growth and Employment in Vietnam. *JED No.222October2014|41/DOI: 10.24311/jed/2014.222.07*, 4-5.

REG. (June 2019). Least Cost Power Development Plan: June 2019. *MPRA Paper*, 10-14.

Sabihuddin. (2001). THE RELATIONSHIP BETWEEN ENERGY CONSUMPTIONAND ECONOMIC GROWTH IN PAKISTAN. *Asia-Pacific Development Journal , Vol. 8, No. 2, December 2001*, 103 (3).

Soytas, U. a. (2003). Energy consumption and GDP: causality relationship in G-7 countries and emerging markets,. *Energy Economics, 25, issue 1*, p. 33-37.

Théoneste. (2016). Modelling electricity supply options for Rwanda in the face of climate change , chapter 5.1. *Dissertation submitted to attain the academic degree of "Doctor of Economics (Dr. rer. pol.)" at Europa-Universität Flensburg*, 108.

USEIA. (2011). Energy and Economy. *o define the nature and magnitude of the demands on local and global energy systems arising from economic activity*.

Yemane., W. a. (2006). "Electricity consumption and economic growth: a time series experience for 17 African countries.". *Energy policy 34.10*, 1106-1114.

Yergin. (2012). Energy for Economic Growth;. *Energy Vision Update 2012*, 6.

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