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TITLE OF THE PROJECT: IMPACT OF ENERGY ACCESSIBILITY TO HOUSEHOLD WELFARE IN RWANDA

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November, 2021

DECLARATION

I, the do hereby, hereby declare that this research is my original work and that it has not been previously submitted for a degree from the University of Rwanda or any other university. All sources of information used in the thesis will be properly cited.

NAMES

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Signature

Date : 18 November 2021

APPROVAL

I prove that the candidate completed the project described in this research thesis under my supervision and with my approval.

Name

Dr. Johnson Bosco RUKUNDO

Signature: 

Date: 19th November 2021

NOTE OF GRATITUDE

This work would have not been possible without the moral, financial, and technical assistance of many people. First and foremost, I want to express my gratitude to Almighty God, with whom I owe my life and all good faith. I am grateful to Him for empowering me throughout my academic career, particularly for allowing me to complete this research project.

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List of abbreviations

Terms	meaning
EDPRS:	Economic Development and Poverty Reduction Strategy
PPP:	Purchasing Power Party
GDP:	Gross Domestic Product
EAC:	East African countries
KWH:	Kilowatt hour
REG:	Rwanda Energy Group ltd
MW:	Megawatt
IEA:	International Energy Agency
USAID:	United States Agency for International Development
EICV:	Integrated Household Living Conditions Survey
NISR:	National Institute of statistics
OLS:	Ordinary Least Square
%:	Percentage
MININFRA:	Ministry of Infrastructure

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ABSTRACT

Nowadays, the world socioeconomic development and wellbeing of society is based on the energy accessibility. As the number of energy accessors increase some problems have been highlighted global like the climate change and global warming. Those problems lead the developing countries including Rwanda to the food insecurity and poverty. Easily accessible energy in Rwanda is biomass energy which occupy above 83% of the total energy consumption. Electrification and green energy like solar and gas energy is considerably increasingly accessed by Rwandans which define the country's development and civilization. Those clean energy are mostly available in the cities compare to the rural villages which causes a negative impact of the people development in rural area. However, the industries and other businesses are located in the city due to the clean energy accessibility, and youth are shifting from rural area to the cities to look for jobs and civilized way of living.

However, in this study we used to asses and analyze the impact of energy accessibility to the household's welfare. The econometric approach method with Integrated Household Living Conditions Survey 5 (EICV5) has been used to assessing the country's level of energy access and the impact of energy accessibility to the households 'welfare is identified. During analysis those impacts, we used the ordinary least squares test (OLS) of simple regression analysis. The data from National institute of statistics Rwanda treated using STATA software show that the access to electricity affect household's welfare in different expenses is 68%. It is significantly implying that when household has access to electricity the way of living improved in rural areas. With good clean energy accessibility, the non-farm business increasing due to from the small to the large industries need electricity to operate and they impacted by 68.4% from the coefficient estimates. In the education sector, there is an impact of clean energy accessibility which has 52.6%. More available of access to electricity cause the trending technology and research or browsing the world publication works and data in education being possible and hours of a student used to study per day increased. The different required equipment used in the Science, Technology, Engineering, and Mathematics are electrified for useful outcomes in education. Therefore, the general consideration of the impact of the energy accessibility impact to the household's welfare play an important role at a rate of 68% in people' way of living in both rural areas and cities of Rwanda.

CHAPTER 1: INTRODUCTION

1.1 Background of the study

Energy is necessary for the socioeconomic development and well-being of a society. Many of today's global issues, such as climate change, poverty, and food security, necessitate the provision of low-cost, dependable, long-term energy services. Electrification and clean energy has become both a requirement for any society's development and a symbol of civilization. Access to clean energy is essential for economic activity as well as community health and well-being. (Mainali, 2014)

Despite the fact that global access to electricity increased from 78 percent to 89 percent between 2000 and 2017, an estimated 800 million people remained without access in 2017. Low-income countries (especially those in Sub-Saharan Africa) and rural communities continue to face access issues. Concurrently, the quality of connections, such as electricity generation capacity, affordability, durability, safety and health, and convenience, are other factors that may influence an end user's ability to use electricity when needed. (Nicholas Moore D. G., august,2020).

In developing countries, a major impediment to rural economic growth and development is a lack of access to electricity. Along with a result, the World Bank and other development organizations have made modern energy access, particularly access to electricity, one of their top priorities. It is widely acknowledged that electrification improves household quality of life and stimulates the economy as a whole. The immediate benefit of electrification is improved lighting, which encourages longer hours of study for students and, as a result, contributes to higher educational achievement. Other household activities, such as sewing by women, social gatherings after dark, and so on, can benefit from lighting as well (Khandker, march, 2009).

Rwanda's total power supply has grown by 10% since 2008, to 502,053 MWh. Year after year, total consumption has increased in a logarithmic trend. The seasonal variations in power demand are negligible. The total installed capacity of electricity generation is currently 119.6MW, with

hydrological resources accounting for roughly 60% and diesel-powered generators accounting for 40%. Rwanda has a significant peak demand load between 6 and 9 p.m., which, on an annual basis, was recorded at 87.9 MW in 2013. This is because household lighting is the most common use of electricity.

1.2. Problem statement

According to Rwanda's energy balance, biomass accounts for approximately 85% of total primary energy consumption (99% of all households use biomass for cooking), petroleum products account for 11% (transport, electricity production, and industrial use), and hydro sources account for 4%. In April 2011, approximately 14% of the total population had grid access, and the government has started a roll-out program to quickly increase this to 16% (350 000 connections) by 2012, and 60% by 2020.

Until 2004, Rwanda relied on a single energy source – hydropower – whose limited capacity was dependent on a dilapidated network with technical and commercial losses of around 30%, much of which could be attributed to a lack of investment in the sector over the previous 25 years. Rwanda has experienced severe load shedding and acute electricity supply shortages in recent years (2004-2006). Drought in the region has severely limited installed generation capacity (primarily hydropower), resulting in rapid reservoir depletion. Drought has also struck Kenya, Tanzania, and Uganda, making it impossible for Rwanda to obtain power from its neighbor.

Late in 2004, the government was forced to make a difficult choice: cheaper energy or no energy at all. Private companies rented diesel generators at a high cost, and this, combined with high fuel costs, increased tariffs by more than 100 percent to around US$ 0.22/kWh. Average retail tariffs in the rest of the region are around US$ 0.10-0.12/kWh; in 2017, average tariffs (life line tariffs) are around 0.12 $c/kWh for industries and 0.17 $c/kWh for consumers. To achieve its goal of becoming a middle-income country, Rwanda will require strong, sustained economic growth with an annual GDP growth rate of 8-9 percent (information as of 2007),

Rwanda's government will collaborate with the private sector to increase energy production and distribution in order to boost the sub-energy region's sector's competitiveness. By implementing

the Second Generation Poverty Reduction Strategy Program, the Rwandan government is investigating mechanisms to improve modern energy services in rural areas (EDPRS).

The program focuses on promising rural energy supply options such as solar, wind, and rural grid extension. Energy issues are both serious and widespread in the developing world. Up to 90% of the population in many developing countries lacks access to adequate and sustainable energy supplies. (Floor, 2012).

1.3. The objectives

The general and specific objectives of this study are outlined below.

1.3.1. Major Objectives

This study's primary goal is to assess and analyze the impact of energy accessibility to the Households' welfare

1.3.2. The Specific Goals

The following specific objectives will be pursued in addition to the main goal:

- To assess the country's level of energy access
- To assess the impact of energy accessibility to the Households' welfare;

1.4. Research Questions

In relation to the research objectives, the following research questions were developed**:**

- What is the level of energy access in Rwanda?
- Is there an impact of energy accessibility to the Households' welfare?

1.5. Scope of the Study

The extent of the research will focus on the households in Rwanda, with an ambition of becoming a middle income by 2050.

The findings of the research study will provide insights on energy access to the households' welfare and wellbeing of the population of Rwanda. Actually, in this research there is a deep

analysis of how energy accessibility could improve the households' welfare such as income, expenditure, and education

The main objective of this project is to investigate an impact of energy access on household welfare in Rwanda by using the survey conducted between 2016 and 2017. This time period was chosen due to data availability, and the variables to be considered in the model have their respective data during this time period.

The expected outcome and importance of the study will benefit households, policymakers, stakeholders in the energy sector, and private sector actors.

It anticipated that the research study findings will portray the potentialities of accessing clean energy towards households, thus increasing the welfare on individuals. This research shall provide guidance on how energy accessibility can be increased in efficient ways so that its utilization can aid in the improvement of the population well-being and country's economic in general as energy accessibility and usage is the primary driver of economic growth for other sectors and a source of revenue for the country. The results of the study will inform policy makers on the appropriate measures to be undertaken to increase energy accessibility mostly in rural areas of Rwanda

CHAPTER 2: ENERGY ACCESS AND HOUSEHOLD WELFARE

This Chapter contains a brief overview on energy access especially access to electricity in Rwanda and compare with the global level and how it impacts the household welfare. Moreover, the household welfare trends in factors such as; income, education, household expenditure, which will be briefly explained in this chapter

2.1. Energy access situation

Energy has a huge impact on people's lives and is a driving force behind social and economic development. Energy has aided in the transformation of societies and the advancement of human civilization over the centuries. Energy contributes to the fulfillment of some of the most fundamental human needs, such as nutrition, warmth, and light. Furthermore, there is ample evidence that having reliable, efficient, cost-effective, and safe energy carriers can directly impact productivity, income, and health, as well as improving gender equity, education, and access to other infrastructure services. The immediate applications of electricity in newly electrified households are lighting and appliances, communications, and entertainment. Public/street lighting, refrigeration, health centers and schools, piped water, communication, and the like are among the most frequently mentioned public needs.

The use of a variety of electricity-powered appliances benefits households. There is a clear progression in the energy services available to those with electricity access. The initial applications are in lighting and entertainment. Following that, thanks to appliances such as electric lamps, radios, televisions, computers, refrigerators, fans, stoves, and electric pumps, a wide range of benefits are potentially available, ranging from security, comfort, and convenience to education, health, and home productivity. (Shonali Pachauri, 17 Mar 2014).

(Bhattacharyya, 2012) Higher levels of income are normally associated with higher levels of energy access, as expected; however, rapid improvement in access level occurs within an income

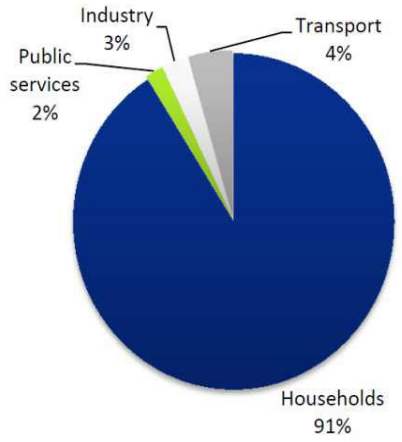
band bounded by a lower threshold income level of around $1000 per person in PPP terms 2005 and an upper saturation level of around $15,000 per person in PPP terms. Those below the lower threshold clearly do not have access to clean energy, whereas those above the upper threshold do.

Rwanda is a small country in East Africa with a population of 12,089,721 people and a land area of 26,338 square kilometers. It is located between the latitudes of 1.050 and 2.840 degrees S and the longitudes of 28.860 and 30.900 degrees E. Rwanda's economy has expanded rapidly in recent decades, and the country has substantial energy resources that have yet to be fully utilized (REG; RDB, 2018). Despite having abundant natural energy resources such as hydro, solar, peat, gas, and biomass, Rwanda currently has only about 216 MW of installed electricity capacity to serve the entire country. (Bimenyimana, 2018).

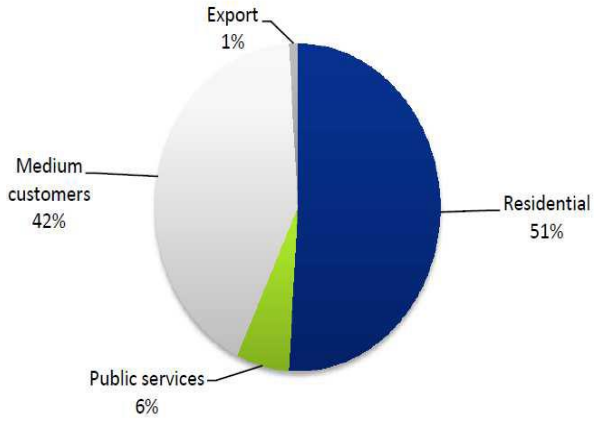
Despite encouraging economic growth, the country has a low per capita GDP of $696 and a low per capita electricity consumption (30 kWh) when compared to Uganda (66 kWh), Kenya (140 kWh), and Tanzania (85 kWh). Furthermore, when the highest regional electricity tariff of US$0.12 to US$0.18/kWh is compared to the local Rwandan electricity tariff of US$0.22/kWh, the local Rwandan electricity tariff wins (REG, 2018c). According to the research, Rwanda's electricity price is approximately 22.2 percent higher than the EAC's highest electricity tariff. (Hakizimana, 2016).

In 2008, total primary energy supply was 111 PJ2, with traditional biomass accounting for the vast majority. Households consume the most energy (91%) followed by transportation (4%), industry (3%) and public services (3%) 2 percent. Households are also the largest users of electricity for lighting (51 percent). The industrial sector is the second largest consumer (42 percent of total consumption), owing primarily to motor-drivers and lighting. The public sector's consumption (6 percent of total consumption) is primarily driven by public buildings, street lighting, and water pumping. (MINIFRA, 2014)

Figure 1: Energy and Electricity Consumption by Sector, 2009 and 2012



Energy Consumption by Sector (2009)



Electricity Consumption by Sector (2012)

The energy sector is critical to the Rwandan economy because it is interconnected with almost every other sector, including transportation, housing and urbanization, manufacturing, agro-processing, mining, and information and technology services. The supply and transmission of electricity remains a top priority.

Electricity can be generated in Rwanda using a variety of technologies and natural resources, such as petroleum-based fuels, hydro, solar, methane gas, peat, geothermal, biomass, waste, and wind. Energy efficiency and conservation measures, which include both demand-side and supply-side components, are also gaining popularity. (Minifra, 2016).

In terms Households (91 percent) consume the most energy, primarily using traditional fuels such as wood, followed by the transportation sector (4%), industry (3 percent), and public services (3 percent) (3%). 2% Households are also the largest consumers of electricity (51%), with lighting accounting for the majority of demand. The industrial sector (42%) consumes the most energy, with motor-drivers and lighting being the primary sources. Cement, mining, textile, and agricultural companies are among the largest industrial consumers. (including tea estates).

Energy is required for the majority of industrial and commercial wealth creation and is essential for increased social and economic well-being. It is critical for alleviating poverty, enhancing human welfare, and raising living standards. However, as important as energy is for development,

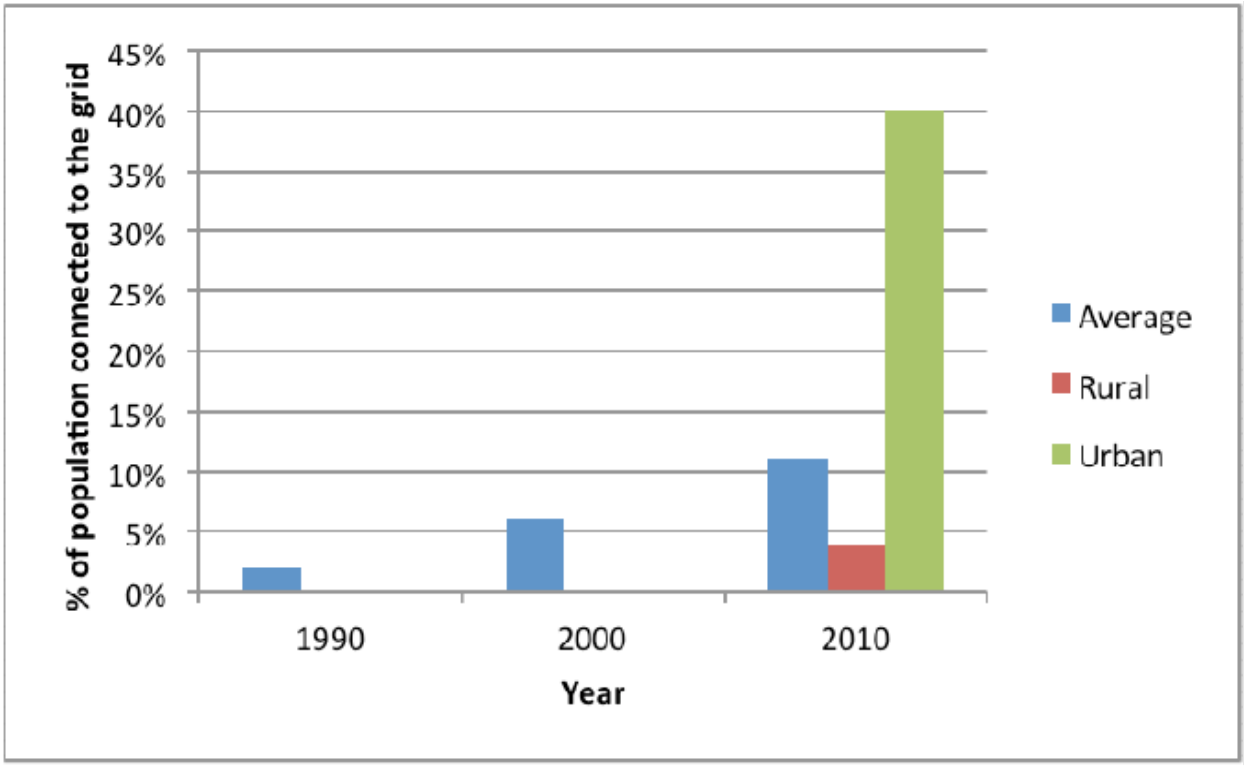
it is only a means to an end. The goals are good health, a high standard of living, a sustainable economy, and a clean environment.

The Rwandan government made a clear policy decision throughout the development of the EDPRS to diversify electricity sources away from the traditional dominant grid and include off-grid connections. As a result, households outside of the planned national grid coverage have been encouraged to use alternatively cheaper connections, such as Mini-grids and Solar Photovoltaics (PVs), to lower the cost of access to electricity while relieving constraints on previous government subsidies. Household well-being is commonly expressed in terms of real income. A rise in real output and real incomes implies that people are doing better, and thus household welfare rises. (Shahidur R. Khandker, 2009)

Economic activity is dependent on reliable supply – not just access – because reliability affects the economic realm through income-generating activities, the ability of business operations to remain open for longer periods of time during the day, and thus increasing utilization of installed capacity. Electricity reduces the burden and time required for household work, which may influence labor supply decisions. Electricity availability has an impact on capacity utilization and employment rates. (Abbas & Choudhury, 2013).

Rwanda's government plans to transition the country from developing to middle-income status. To that end, the government intends to achieve 100 percent electricity access by 2024. Rwanda is rich in natural energy resources such as hydropower, solar power, and methane gas. It has only 218 MW of installed capacity at the moment. Rwanda's national electrification rate is estimated to be 30% by the International Energy Agency (IEA). (12%) in rural areas and 72 percent in urban areas.(USAID, 2020).

Figure 2: percentage of Rwandan households has access to electricity (connected on grid)



Data Source: REG (2021)

At the moment, 1.5 billion people in developing countries lack access to electricity, and 3 billion rely on solid fuels for cooking. A comparable number of people in Sub-Saharan Africa do not have access to electricity or modern fuels (respectively 560 and 625millionpeople). People in Asian countries may have access to electricity, but they frequently do not have access to modern fuels. Less than 200 million people in East Asia and the Pacific lack access to electricity, but nearly 1.1 billion rely on solid fuels for cooking. (Gwénaëlle Legros, 2009).

An estimated 1.64 billion people lack access to electricity worldwide, with roughly 80% living in rural South Asia and Sub-Saharan Africa. (IEA, 2002). According to the 2001 Census of India, roughly 44% of rural Indians have access to electricity. (Akanksha Chaureya, 2004).

Lack of access to electricity is inextricably linked to rural poverty. This is because electricity is not only necessary for raising living standards, but it is also a necessary input for productive and economic activities. Because of the bundling of socioeconomic benefits, the positive impacts of electricity inputs for basic activities such as pumping water for drinking and irrigation; lighting for

extending working and learning hours; and powering small-scale rural industry are significantly greater for vulnerable rural populations.

(Shonali Pachauri)**,** According to his book, energy has a significant impact on people's lives and serves as a catalyst for social and economic development. Energy has aided in the transformation of societies and the advancement of human civilization over the centuries. Energy helps to meet some of the most basic human needs, such as nutrition, warmth, and light. Furthermore, there is ample evidence that having access to reliable, efficient, cost-effective, and safe energy carriers can have a direct impact on productivity, income, and health, in addition to improving gender equity, education, and access to other infrastructure services.

Energy issues are both serious and widespread in the developing world. Up to 90% of the population in many developing countries lacks access to adequate and sustainable energy supplies. Some 2 billion people lack access to electricity, and a similar number cook their meals with fuels such as animal dung, crop residues, wood, and charcoal. People's efforts to engage in productive activities or improve their quality of life are hampered in the absence of efficient, clean energy. People cannot farm or produce goods efficiently if they must spend a significant portion of their time traveling further and further afield in search of diminishing wood fuel. (Floor 1996).

(Grzegorz Slusarz, 2021) stated that as civilization progresses, more and more energy resources are required to meet basic social needs as well as production. Inconsistent strategies and inefficient resource use result from a lack of integration in resource assessment and policy making. Electricity access has been linked to increased productivity, business creation, and employment. Businesses that are newly established and rely solely on electricity access may have the potential to improve the overall economic situation and business environment.

Electricity is a critical driver of modern technology and socioeconomic development, enabling industrial processing activities, value addition, export growth, and job creation for both low-consumption devices like lights and mobile phones and large users like industries. Despite accounting for only about 4% of Rwanda's primary energy consumption, Electricity consumption

is expected to skyrocket in the coming years. Rwanda currently has one of the world's lowest per capita electricity consumption rates. Despite Rwanda's dense population, which should make network expansion and access to electricity easier, only 19% of Rwandan households are currently connected to the grid.

Human development and modern societies are propelled forward by energy. Access to energy promotes economic and human development, as well as the transition of agrarian societies to industrial societies. As a result, industrialization increases household income, eliminates many contagious diseases, lowers child mortality rates, and extends life expectancy. Many healthcare facilities in developing countries are unable to function due to a lack of energy access, which is required for storing vaccines and performing life-saving procedures. Improved energy access in healthcare facilities will help to increase life expectancy by ensuring timely service delivery. (ChristineW. Njiru, 2018)

According to current discourses of developmental studies, which conclude that income inequality affects educational opportunities, education is widely recognized as one of the most important components for poverty reduction. Furthermore, primary education yields the highest return on investment. Poor families enroll and complete fewer students because direct and indirect educational costs are significant burdens on them. As a result, these households have a noticeably lower literacy rate than middle or upper income households. Poor households face a lack of employment opportunities as a result of their low educational attainment (Makoto Kanagawa, April, 2008).

Literacy levels are influenced by electricity access. Improved boarding school provision of clean water, sanitation, lighting, and cooking energy is facilitated by cleaner and more affordable energy. Rural electrification attracts qualified teachers due to the improved quality of life that comes with having access to electricity. Electricity enables learning to be digitized through the use of electronic equipment such as computers and overhead projectors for learning. The availability of modern fuels also reduces the time spent searching for fuel wood, giving rural children more time

to learn. Children raised in electrified homes have higher educational attainment and more study time than those rose in non-electrified homes. (Letema, 2018).

(Squires, march 16, 2015) Demonstrates that the effect of access to electricity on educational attainment is theoretically unclear due to the possibility of multiple mechanisms at work. As one possible mechanism, increased access to electricity may increase demand for low-skilled labor. This would increase the opportunity cost for students to stay in school, resulting in lower educational attainment. Another possibility is that manufacturing jobs are attracted by access to electricity. More highly skilled labor would be required, raising the returns on human capital and increasing the likelihood of students remaining in school. There are numerous other mechanisms that could influence educational attainment, complicating the impact of electricity on educational attainment uncertain.

Economic activity is dependent on reliable supply – not just access – because reliability affects the economic realm via income-generating activities, the ability of business operations to remain open for longer periods of time during the day, and thus increased utilization of installed capacity. Electricity lessens the burden and time required for household chores, which may have an impact on labor supply decisions. The availability of electricity has an impact on capacity utilization and employment rates. The ability to access and use available capital resources has an impact on wages and household income. If electrification is the foundation for inclusive development, a reliable and consistent supply of electricity reduces the amount of time spent on home production, potentially increasing the labor supply of adults, particularly women, in the household. The time saved by not having to go out and buy cooking fuel can be put to better use, increasing household consumption, income, and assets.

CHAPTER 3: METHODOLOGY

This section discusses the methods and tools used in gathering and analysing data on energy access and household welfare in Rwanda. It entails the data used, research design, econometric approach, description of variables and methods of analysis

3.2. Data and Variable description

This study's data is derived from the NISR's EICV5, which was conducted between 2016 and 2017. This data source contains information on population well-being changes Poverty, inequality, employment, living standards, education, health and housing conditions, household consumption, and so on are examples of such factors. The research framework is made up of the following components: Household income, household expenditure, household education, access to electricity, and nonfarm business. Table below shows the description of variables;

Table 1: Descriptive of variables

Variables	Description
Household age	Household age indicates the age of family members
Household size	Household size indicates the numbers of person living as economic unit means that they indicate the population growth
Household expenditure (hhexp),	Household expenditure stands for the expenses that spend on electricity, aggregate consumption, food consumption and non-food consumption of the sample household
Household salary	Household salary is the salary gained by the household as it discussed in the literature the energy access impacts the household salary
Household Education(hhed),	Household education stands for the general number of household head and spouse who have primary up to university education, education an access to energy have relationship
Electricity accessibility	Electricity access stands for all total population that connected to the national grid and other source as the main focus how it affects the household welfare

Non-farm business	Non-farm business stand for all business done by the household other than agriculture in previous chapter discussion state that electricity access should affect the nonfarm business done by households

Source: compilation of author

The main question to be examined in this research is to analyze how energy access through access to electricity impacts household welfare, in order to analyze those impacts we need to use simple regression analysis to justify the Ordinary lest Squares test (OLS)

3.3. Econometric Approach

This section describes the general econometric methods used in this study with EICV5 data. To avoid spurious regression, the properties of the variables must be examined in the empirical analysis.

The hypothesis demonstrated that energy access has a significant impact on household welfare, including household expenditure, education, nonfarm business, and household member salary. We create an equation to investigate the relationship between energy access and household welfare. The independent variable is on the right side of the equation. "electricity access" is explicitly used because it affects household welfare. As a result, the model specification can be written in regression model as follows:

$$\boldsymbol{log_{hhexp} = \beta o + \beta 1 hhage + \beta 2 hhsize + \beta 3 electricityaccess +}$$
$$\boldsymbol{\beta 4 nonfarmbusiness + \beta 5 hhed + \beta_6 salary + \varepsilon_t}$$

Data exploration and regression analysis of variables of interest in this study were performed to draw conclusions about the impact of energy accessibility on household well-being. The data used in the study is cross-section data which looks at information from a group of people at a single point in time. The data for this study were derived from the NISR EICV5 survey, which is

conducted every three years and polled 14,580 families across the country between late October 2016 and early October 2017.

CHAPTER 4: FINDINGS AND DISCUSSION

The purpose of this chapter is to conduct an empirical study of the relationship between electricity access and household welfare in Rwanda in order to determine the impact of energy access on household welfare. As previously discussed, achieving this goal would necessitate running a regression analysis on the previous chapter's economic model. To explain the study's overall goal, this section presented and discussed regression analysis in order to present experimental evidence of electricity access and household welfare in Rwanda.

4.1. Descriptive statistics

Before analyzing regression results, consider the following summary statistics for the variables of interest in the above-described economic model, which provide a clear picture of those variables and their implications for the inference made.

Table 2: descriptive statistics

	Mean	Standard deviation	Minimum	Maximum
Household size	4.41	2.12	1	22
Age of household head	45.2	15.6	14	109
Salary	12.0	1.44	2.08	18.4
Household use of electricity	0.25	0.43	0	1
Household expenditure	14.5	0.79	10.9	18.9
Non-farm business	0.52	0.50	0	1
Education	0.45	0.50	0	1
Observations	14580			

Source: author's computation

Table above shows the descriptive statistics for the variables used in this. The binary and discrete variables are included in the table. The binary variables have two responses (0 and 1), whereas the discrete variables have numbers such as household head age, household size, salary, and household expenditure, with the exception that the binary response variables include all of the other variables mentioned.

The table shows that, among the 14,580 observations, the size of the household varies from 1 to

22, and its average of 4.41, which is similar to 1, indicates that households have an average of 4 individuals, which appears to be small compared to 22. The findings show that the age of the head of households is an average of 45.2, with most heads of households appearing to approach 14 years of age than the household head who have 109. The people who have salary are likely to be higher than those who do not have wage and salary the mean is 12.0 with the minimum salary of 2.08 and maximum of 18.4

household access to electricity have an average of about 0.25, tending to value between 0 and 1 total use of electricity, the degree of variability shows that the standard deviation of household access to electricity is 0.43 which indicates that the data is not scattered away of mean value this means that the people who are access to electricity are likely to be low than those who are not access. The results show that Household expenditure average value is 14.5 which means that the expenditure of household is likely to be high value of minimum average of 10.9 spending and maximum spending of 18.9

Non-farm business: individuals who practice non-firm business have an average of 0.52 which means that there are more people who involves in nonfarm business. The findings show that the number of household who attend the class from primary to university are likely to be low means that the more household have formal education among households under consideration, the household with who have formal education have an average of 0.45.

4.2. Empirical Findings

4.2.1. Regression Analysis

With the aim of this thesis of examining impact of energy access on household welfare, the regression analysis is used in order to justify the economic model built in chapter three, so the following is the results;

Impact of Electricity access on household expenditure

Table 3: Regression analysis of household expenditure

Simple OLS

Variables	Household expenditure
Household size	0.123***
	(0.00277)
Salary	0.130***
	(0.00551)
Household use of electricity	0.687***
	(0.0159)
nonfarm business	0.119***
	(0.0119)
Education	0.261***
	(0.0111)
Constant	12.00***
	(0.0624)
Observations	11,253
R-squared	0.518

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The findings show that access to electricity can affect household welfare through expenditure 68.7 percent and acceptable at 1%, with all coefficients examined being significantly positive, implying that when the household has access to electricity, the other activities improve. Other household and community characteristics that influence household expenditure, such as nonfarm business and education spending, The size of a household, for example, has a direct impact on expenditure at 12 percent, education at 26.1 percent, salary at 13 percent, and nonfarm business at 13 percent.(Kimura, october,2019) The size of a household, for example, has a direct impact on expenditure (12%), education (26.1%), salary (13%), and nonfarm

business (13%): The size of a household, among other things, has a direct impact on food consumption and children's education. Community characteristics, such as rural households, appear to have a negative impact on food consumption and education spending. This finding implies that rural or remote households spend less on food and education for their children. The findings also suggest that rural households live in a subsistence economy in which their labor is not valued and they produce their own food.

b) Impact of Electricity access on non-farm business

Table 4: Regression analysis of non-farm business

Simple OLS

Variables	Nonfarm business
Hhid	-1.58e-05***
	(2.67e-06)
Household size	-0.00926
	(0.00627)
Age of household head	-0.0111***
	(0.000815)
Household use of electricity	0.526***
	(0.0352)
Household expenditure	0.587***
	(0.0216)

Non-farm business	0.684***
	(0.0247)
Education	0.118***
	(0.0247)
Constant	6.661***
	(0.621)
Observations	11,253
R-squared	0.359

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Coefficient estimates of non-farm business shows that the increasing of access to electricity by 1% will impact non-farm business 52.6% means that when the electricity is more accessible will increase the investment of business other than farm business for the people because the small and big industries their production needs electricity.

Access to electricity is supposed to improve socioeconomic well-being and, ultimately, poverty reduction. These benefits are expected to be realized through a variety of mechanisms. Domestic and economic productivity has increased, as well as the creation of new economic opportunities, many of which are not related to agriculture, are expected as a result of new and/or improved access. Positive externalities could result from potential increases in household and corporate wealth.

c) The effect of access to electricity on household education

The result shows that access to electricity can impact education at 52.6% this means that more the people access on electricity it encourages the people to study through expanding the hour of study

which may yield the desired results, Electricity is frequently assumed to improve educational outcomes, and there are several potential and theorized causal pathways by which this may occur. The main mechanism highlighted in the studies included was new and/or improved lighting, which would allow for an extended effective school day and flexible home study. The primary point is that having access to electricity leads to improved educational outcomes, which implies more and better human capital accumulation, which translates into increased labor supply and household incomes. Access to electricity, in particular, appears to promote women's economic participation by relieving them of tasks such as biomass collection and, more broadly, by allowing them to make better use of their time. In this vein, increases in female employment are primarily the result of increased small-scale self-employment.

(YE, 2017), According to his research, access to electricity has a significant impact on educational attainment. Increased nighttime light intensity, In terms of mechanism, in addition to overall electricity access, does not contribute to increased average years of schooling. This finding implies that having access to electricity during the day, rather than just at night, benefits household cluster educational attainment. This discovery implies that the impact of electricity on education may have occurred through channels other than illumination, such as labor savings.

Table 5: Regression analysis of household salary

Simple OLS

Variables	Salary
Hhid	-1.58e-05***
	(2.67e-06)
Household size	-0.00926
	(0.00627)
Age of household head	-0.0111***
	(0.000815)

Household use of electricity	0.526***
	(0.0352)
Household expenditure	0.587***
	(0.0216)
Non-farm business	0.684***
	(0.0247)
Education	0.118***
	(0.0247)
Constant	6.661***
	(0.621)
Observations	11,253
R-squared	0.359

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

According to the coefficient estimates of electricity access on salary, the household is likely to increase their salary by 52.6% for every 1% increase on access to electricity. This indicates that every percentage point of electricity access has an effect on household earnings, same as non-farm business and education also can impact the household salary by 68.4% and 11.8%

Household income increased as access to electricity improved, Non-farm income has a larger effect size, as reported. Despite the fact that separating farm and non-farm income produced no statistically significant effect sizes for either source of employment, farm employment increased only marginally. (Nicholas Moore D. G., august, 2020).

Chapter 5. CONCLUSION AND RECOMMENDATION

Economics is the study of the distribution of scarce resources. Particularly, Developing countries are struggling to meet economic targets while working with limited resources. Using microdata, this thesis investigates the impact of energy access on household expenditure, salary, non-farm business, and education, all of which are indicators of household welfare. The findings may be useful to policymakers in Rwanda and other countries facing similar development challenges.

5.1. Conclusion on Results

As the main goal of this research, I was able to use EICV5 data from Rwanda's national institute of statistics to conduct a more detailed assessment of the impact of energy access on household expenditure, salary, non-farm business, and education. In this study, the regression analysis of simple Ordinary Square was used to investigate the impact of electricity on household expenditure, salary, education, and nonfarm business. The findings revealed that access to electricity has a direct impact on expenditure via various channels such as salary generated from non-farm business and increasing the level of study up to university level.

Firstly, the findings indicate that access to electricity has a positive and statistically significant impact on household expenditure, which plays a critical role in household welfare at a rate of 68%. This means that access to electricity has a significant impact on household life.

Secondly, the findings shows that electricity access continue to play vital role in the household welfare where positively impact on the salary, education and non-farm business at the significantly level, means that as the government continue to increase the level of energy connectivity especially rural electrification will increase the well-being of people as well as the economic growth occurs.

5.2. Recommendation

Governments must pay closer attention to the most important factors discovered in order to achieve a long-term solution to electricity access as the government aims for 100 percent access by 2024. In a nutshell, governments could also: boost economic conditions; prioritize financial sector development and provide easier access to finance; improve education; integrate rural electrification into larger rural development schemes to allow for synergy among various

initiatives; maintain strong government commitment and political will to invest in public services and infrastructure; and encourage private sector participation.

It is the responsibility of the governments to provide education and employment to the citizens, as well as to improve the citizens' living standards The study confirmed the importance of human capital formation in influencing welfare, such as the household head's educational level and accessibility of information via media and television, which will have a positive impact on the country's economic development... In a briefly, the policies listed below are recommended:

To begin, governments should promote renewable energy technologies at the national level, which will have an impact on country’s economic development. Renewable energy mostly off grid like solar panel is critical to alleviating energy accessibility to the country especially in rural area. Renewable energy generates clean energy, which is important for human well-being, while also assisting in resolving the issue of insufficient energy access in developing countries' remote areas.

Second, Access to electricity and other infrastructure is critical for increasing household income and opportunities. As a result, policymakers must devise appropriate policies to connect households to the electrical grid as soon as possible. While investment patterns will slow power grid and distribution development, other measures, such as rooftop solar photovoltaics, solar farms, and hold small generators, will improve access to remote areas. Policies to attract investment in spread energy systems will need to be developed by the government..

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