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Presented by

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TITLE: ASSESSMENT OF SOCIO ECONOMIC IMPACT OF RWANDA RURAL ELECTRIFICATION STRATEGY ON LIVELIHOOD TRANSFORMATION
A CASE STUDY OF BUSORO, RULINDO DISTRICT

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ASSESSMENT OF SOCIO ECONOMIC IMPACT OF RWANDA RURAL ELECTRIFICATION STRATEGY, ON LIVELIHOOD TRANSFORMATION:

A CASE STUDY OF BUSORO, RULINDO DISTRICT.

BY

Alexis MUTABARUKA

A Research Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Science in Energy Policy of Pan African University Institute of Water and Energy Science (including climate change) Tlemcen, Algeria

September, 2018

DECLARATION

I, **MUTABARUKA Alexis**, hereby declare that this thesis represents my personal work, realized to the best of my knowledge and has never been presented for a degree in any other University. I also declare that all information, material and results from other works presented herein, have been fully cited and referenced in accordance with the academic rules and ethics.

Signature:  Date: **15th September, 2018**

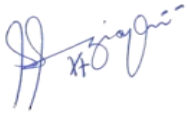
Alexis MUTABARUKA

Energy Policy

Reg no: PAUWES/2016/MEP12

CERTIFICATION

This thesis has been submitted for examination with my approval as the university supervisor

Signature:  **Date:15th September, 2018**

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DEDICATION

This work is dedicated to my family and friends, you are my rays of hope and without your guiding hands, financial and moral assistance I would be lost. Above all, to the Almighty God for the gift of life.

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ABSTRACT

This study aimed to assess the socio-economic impact of Rwanda rural electrification strategy on livelihood transformation; using a case study of Busoro cell- Rulindo District. The main goals of Rwanda rural electrification strategy have been; Ensuring access to affordable, reliable, sustainable and modern energy for all as part of the sustainable development goals and also affiliated to the African Union agenda 2063. In June 2016 government of Rwanda established Rural electrification strategy with the objectives of the provision of basic solar systems, increase private sector participation, development of mini-grids in suitable locations and the expansion of the Electricity Access Rollout Programme (EARP). The objectives of this study were to assess the social effect of rural electrification on livelihood transformation; to assess the economic effect of rural electrification on livelihood transformation; the implementation and progress of the program, analyze the barriers and sustainability of the program in Busoro cell of Rulindo District. The study used both qualitative and quantitative approaches in data collection. The Stratified random sampling design was used for filling 255 questionnaires from beneficiaries of the program in Busoro cell, 80 for on- grid connection beneficiaries and 175 for off-grid PV solar home system. Purposive interviews were conducted with different local leaders and rural electrification patterns which are REG representatives and PV solar home system supplier companies, and direct observation during data collection was done. This study found out that the program has a positive impact on education, health, security and entertainment for people's livelihood. This study found out that electricity has improved economic activities in Busoro cell though it has neglecting Impact on irrigation. This study further reveals that people are aware of use and interest of electricity for their household transformation though they still have some challenges for proper use of electricity. This study revealed that the program is well Implemented in Busoro cell with PV solar home system reliable sources of energy in the rural isolated area. However, the study showed some challenges like poverty of peoples, the low voltage of electricity supplied and stealing the transmission equipment. The study recommended that the government should strengthen the infrastructure, promote the housing of peoples in villages and decentralize technological electronic appliances. In addition, the full economic benefits of rural electrification should be exploited in order to have meaningful development. By doing so, the study forecasted stability and guarantee of the rural

electrification strategy, and the government target of 100% electricity access of all Rwandan by 2024 may be achieved.

RÉSUMÉ

Cette étude visait à évaluer l'impact socio-économique de la stratégie d'électrification rurale du Rwanda sur la transformation des moyens de subsistance; en utilisant une étude de cas de la cellule de Busoro - District de Rulindo. Les principaux objectifs de la stratégie d'électrification rurale du Rwanda ont été: Assurer l'accès à une énergie abordable, fiable, durable et moderne pour tous dans le cadre des objectifs de développement durable et également affiliés à l'agenda Africaine 2063. En juin 2016, le gouvernement Rwandais a établi une stratégie d'électrification rurale visant à fournir des systèmes solaires de base, accroître la participation du secteur privé, le développement de mini-réseaux dans des endroits appropriés et l'expansion du Programme de déploiement de l'accès à l'électricité (EARP). Les objectifs de cette étude étaient d'évaluer l'effet social de l'électrification rurale sur la transformation des moyens de subsistance; évaluer l'effet économique de l'électrification rurale sur la transformation des moyens de subsistance; la mise en œuvre ou le progrès, analyser les barrières et la durabilité du programme dans la cellule Busoro du district de Rulindo. L'étude a utilisé des approches qualitatives et quantitatives dans la collecte de données. Un plan d'échantillonnage aléatoire stratifié a été utilisé pour remplir 255 questionnaires des bénéficiaires du programme dans la cellule de Busoro, 80 pour les bénéficiaires de la connexion au réseau et 175 pour le système de la maison solaire photovoltaïque hors réseau. Des entretiens ciblés ont été menés par différents dirigeants locaux et des schémas d'électrification rurale, qui sont des représentants de REG et des fournisseurs de systèmes de maison solaire PV et une observation directe pendant la collecte de données a été effectuée. Cette étude a révélé que le programme a un impact positif sur l'éducation, la santé, la sécurité et le divertissement pour les moyens de subsistance des populations. Cette étude a révélé que l'électricité a amélioré les activités économiques dans la cellule de Busoro, bien qu'elle ait négligé l'impact sur l'irrigation.

Cette étude révèle en outre que les gens sont conscients de l'utilisation et de l'intérêt de l'électricité pour la transformation de leur foyer, bien qu'ils aient encore des difficultés à utiliser correctement l'électricité. Cette étude a révélé que le programme est bien mis en œuvre dans la cellule de Busoro avec système solaire PV maison sources d'énergie fiables dans les zones rurales isolées. Cependant, l'étude a montré quelques défis comme la pauvreté des populations, la basse tension de l'électricité fournie et le vol de l'équipement

de transmission. L’étude a recommandé que le gouvernement renforce l'infrastructure, encourage l'installation des populations dans les villages et décentralise les appareils électroniques technologiques. En outre, tous les avantages économiques de l'électrification rurale devraient être exploités afin d'avoir un développement significatif. Ce faisant, l'étude a prédit la stabilité et la garantie de la stratégie d'électrification rurale, et l'objectif gouvernemental de 100% d'accès à l'électricité de tous les Rwandais d'ici 2024 pourrait être atteint.

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LIST OF SYMBOLS, ACRONYMS, ABBREVIATIONS

AU: African Union

EARP: Electricity Access Rollout Programme

EDPRS: Development and poverty Reduction Strategy

EDCL: Energy Development Corporation Ltd

ESSP: Rwanda Energy Sector Strategic Plan

EUCL: Energy Utility Corporation Limited

GDP: Gross Domestic Product

GoR: Government of Rwanda

ICT: Information and Communication Technology

IEA: International Energy Agency

LV: low voltage

MINECOFIN: Ministry of Finance

MININFRA: Ministry of Infrastructure

MoUs: Memorandum of Understand

MV: Medium voltage

MW: Mega Watt

NISR: National Institute of Statistics of Rwanda

PAUWES: Pan African University Institute of Water and Energy Sciences

PV: Photovoltaic Solar

REG: Rwanda Energy Group

REP: Rwanda Energy Policy

RETS: Renewable Technologies

Rwf: Rwandan Francs

SDGs: Sustainable development goals

SHS: Solar Home System

SME: Small and medium enterprises

SEIA: Socio Economic impact assessment

SPSS: Statistical Package for Social Scientists

%: percentage

DEFINITION OF OPERATIONAL CONCEPTS

Socio Economic impact

According to Mackenzie (2007). SEIA is the systematic analysis used during Environment Impact Assessment to identify and evaluate the potential socio-economic and cultural impacts of a proposed development on the lives and circumstances of people, their families, and their communities.

The Review Board definition of SEIA recognizes the importance of relationships between people, culture, Economic activities and the biophysical environment. While SEIA tends to focus on the avoidance of adverse impacts, SEIA also provides a forum for planning how to maximize the beneficial impacts of a proposed development. Beneficial impacts can include: a better standard of living due to increased access to employment, business opportunities, training, and education greater access to and from a community and increased funding to improve social infrastructure and cultural maintenance. Rutz and Janssen (2014).

Barrio (2010) shown socio-economic variables which are:

Population and density, Population growth forecasts, Population age and sex, Educational attainment, Per capita income, Median household income, Households below the poverty level, Households receiving public assistance funds. Households with Social Security income, Employment variables: Labor force, Employment situation, and Housing variables**:** Housing occupancy, Value of housing units

And Environment Impact Assessment(EIA) Valued Socio-Economic Component which are Health and well-being, Sustainable wildlife harvesting, land access and use, Protecting heritage and cultural Resources, Equitable business and employment Opportunities, Population sustainability, Adequate services and infrastructure, Adequate sustainable income and lifestyle

Rural Electrification

This implies expanding the electricity network to the rural areas by connecting to the electrification grid or through off -grid.

Livelihood Transformation

Different researchers and gatherings have been characterized Livelihood in various ways, Conway and Chambers, (1991) characterizes livelihood as a method for picking up a living. Also, (Elis, 2000) considers Livelihoods to be those strategies and courses through which the general population gain admittance to the assets or resources which are basic for

the survival .The survival technique might be short term or long term which relies on the objectives and requirements of the general population.

In this research, the purpose was to assess the socio -economic impacts of Rwanda rural electrification strategy which is based on electrification by grid connection and off -grid PV solar system connection for livelihood transformation. In this study and in the conceptual framework the linkages between the effect of rural electrification by on grid and solar home system are developed for livelihood transformation in Busoro cell

CHAPTER ONE: GENERAL INTRODUCTION

1.1Background of study

Energy is an essential driver of economic growth, promotion of social equity, and national stability. The secure and sustainable energy is needed to achieve the country development goal and livelihood transformation. Africa continent is currently intensively engulfed developing its sectors, like infrastructure, while at the same time strengthen its economic with emphasis on energy as a major catalyst of economic development (MINECOFIN,2007),Electrification and other sources of modern energy have been putted on fundamental place to achieves the long-time goals the governments took: Substantial improvement in modern energy that the poor have access to was needed to meet MDGs (Millennium Development Goals) (GNESD ,2007).The sustainable development goal (SDGs,7) set energy in priority to the sustainable development of world future through 2030 by Ensure access to affordable ,reliable, sustainable and modern energy for all, this has been set as the 7among 17 goals to transform our world by ensuring sustainable development. Given its substantial benefits, Africa agenda 2063 has been identified as essential the role of energy for prosperous continent based on inclusive growth and sustainable development as the one in -house as the basic necessity of life (Africa union, 2015), Rwanda government also recognized the important role of Energy to drive into a middle-income country by 2020 through EDPRS II by setting "the provision of appropriate, reliable and affordable energy supplies for all Rwandans" (MINECOFIN, 2013).

Although the programs and long-time goals have been elaborated by the governments, the access to electricity in rural area still low especially in sub-Sahara countries ,according to International Energy Agency more than 588 million people lacked access to electricity in sub-Sahara Africa in 2015 and 846 million people lacked access to clean cooking (IEA.2017), according to world bank (2017) 62% of the populations live in rural areas in sub-Africa and 70% in Rwanda in 2016 and access to electricity in the rural area in 2014 was 18.0% in sub-Africa and 9.1% in Rwanda.

1.1.2 Rwanda electrification policies and programs

Rwanda, is one of the African countries, in Central/East Africa and on the African mainland and is landlocked. It is one of the smallest countries with an area of 26,338 km^2. The country is divided into 5 provinces which are subdivided into 30 districts, further

divided into 416 sectors, 2,148 cells and 14,837 villages at the lower level (Clgf, 2017). It is a rural country, statistics show that 70% of the Rwandan population lived in rural areas in 2016 (World Bank, 2017). With 8% economic growth rate per year, is one of the fastest growing in the world, improvement of business regulations and reform in government have been key drivers for country economic growth (Gemma et al, 2017).With the mountain and population settlement character of the rural country makes the provision of energy to rural areas difficult and expensive though Rwanda considers energy sector as a key driver of economic growth (MININFRA, 2016).To strengthen the access of energy for all Rwandan population, the short, medium and the long term goals have been assessed and divided according to the needs and priorities, Power generation, transmission, distribution, region integration efforts and prioritize investors are a central to satisfying demand and supply of energy in Rwanda,(Gemma et al ,2017).Rwanda has critical low level of the power supply, with an introduced limit of 208.5 MW contrasted with Finland with a populace of around 5.5 Million yet with vitality supply of 400,000 MW (Abdulla and Markandya, 2007). The inadequacy of power can be made with California which has a populace of 38 million yet utilizes more electric vitality than any mix of 35 Sub-Saharan Africa nations, excluding South Africa, the significance of positive attitude and approaches of government is appeared by South Africa whose entrance to power expanded exponentially from 35% of families in 1990 to 84% of in 2011 this is done by looking on the needy individuals' the place Connection charges for their family units are insignificant and can be paid in portions, also in 2004 south Africa government presented Free fundamental power (FBE) after understood that poor family units couldn't bear to utilize power. Government of Rwanda as the country with visible development in Africa defined several objectives and targets in order to tackle the persistent problem of rural energy poverty in the country, including increased access to grid electricity and access to off -grid, (MINICOFIN, 2000), Variety activities in cooperation with the international community has addressed those problems, in all the program like South Africa there is government support for poor peoples. The Electricity Access Rollout Programme2009 helped to attain national electrification rate of 19 % by 2014; 21% by 2015and 24.17% by 2016 with a total of 586 229 households connected to the grid (EDCL, 2016). Rwanda Energy Sector Strategic Plan (ESSP) of 2013 and Rwanda Energy Policy of 2015were elaborated and reciprocally reinforcing, policy outlines a long-term vision by providing high-level goals, and recommends clear and coordinated approaches for achieving that vision and ESSP outlines targets and an implementation structure against which to measure progress towards the

realization of the policy, (MININFRA, 2016). Rwanda energy policy (2015) recognize that energy is a critical productive sector that can strengthen economic growth and contribute considerably to facilitating the achievement of the country's socio-economic transformation agenda (MININFRA, 2015). Rwanda rural penetration for electrification has also shown many challenges like Rwanda settlement household which are not compact (MININFRA, 2015). Given those barriers ,in order to meet the country's development aspirations, and to strengthen the access to electricity especially in rural area, Rwanda government approved in June 2016 program of Rural electrification strategy to accelerate economic development through improving health and standards of living in rural area ,with this program government combine the solutions focus on the location, income and consumption level in addition to connection to the grid which is not possible for all households(MININFRA,2016)

1.1.3 EARP and off- grid PV solar home system programs

The Rwanda EARP programme development objective is to improve access to reliable and cost-effective electricity services for households, priority public institutions and productive use. The EARP was established within REG/EDCL to facilitate the program implementation. The EARP bears the implementation oversight responsibility for the full program. It has the primary responsibility for facilitating, monitoring, evaluating and reporting on program activities and progress. EARP objective is planned to be achieved through the construction of several MV& LV electrical lines as well as different substations. The electricity access roll-out program aims at increasing connections, boost economic activities all over the country, direct and indirect creation of jobs and raise off-farm activities,(EARP, 2017),in additional to EARP the Energy Development Corporation Ltd (EDCL) signed MoUs with some 24 private companies to increase the supply of off-grid solar home system and country's supply chain, the 24 companies are 3EPOWER ltd&Rahimafrooz solar ltd, BBOXX, Dassy Enterprises ,Electricom Ltd, Elerai Global Services Ltd, Energy Resources Power Ltd, ERF,GECO Ltd, GLAS Ltd, Global Evolution Energy, Great Lakes Energy Ltd. Ignite power Ltd, Innotech consulting Ltd, INTERTECH Ltd ,Mobisol Rwanda Ltd, Munyax ECO, NESELTEC, Nguvu Utilities Rwanda, NOTS SOLAR LAMP ltd& Barefoot Power (Rwanda)Ltd, NURU EAST AFRICA ltd, Off grid Electric, Serve and Smile ltd ,SOLAR KIOSK, and Vision technologies (EDCL,2017).The programs have contributed a lot on electrification access sector in Rwanda, the electricity

access (December, 2017) was 41.5%,with 30.5% Rwandan households have access to electrically connected to the national grid and 11% through off-grid.

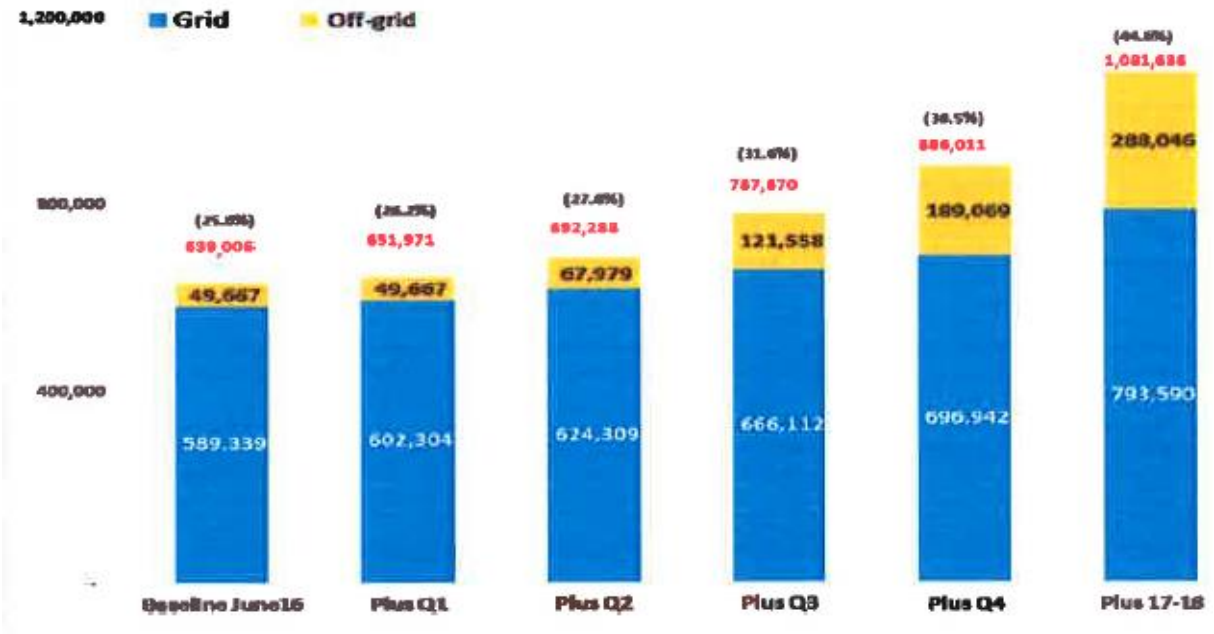

Figure1. 1 Total household access to electricity

Source: EDCL Annual performance report, August 2018

The rural electrification strategy should be strengthened together with other plans as the target is 100% access to electricity in 7 years by 2024, (REG, 2017)

This rural electrification strategy transformed livelihood socially and economically, hence the major purpose of this thesis work for assessing socio- economic impact brought by this program in Busoro cell of Rulindo District rural livelihood transformation, it is progress , Barriers ,and sustainability of the program.

1.2Statement of the Problem

Rwanda government recognize the role played by energy especially electricity in the country development for that reason different policies, laws, Regulations, strategies have been established in the different period by the government through the ministry of infrastructure (MININFRA) in collaboration with Energy institutional and energy partners. Due to the challenges facing the power generation transmission in Rwanda especially in the rural area in June 2016 government of Rwanda through the Ministry of Infrastructure (MININFRA) established rural electrification strategy. "The Government developed this strategy with the objective of ensuring that Rwanda's households have access to electricity

through the most cost-effective means by developing programmes that will facilitate both the end users to access less costly technologies and increase private sector participation in the provision of these solutions. The four distinct programmes in the strategy include; the provision of basic solar systems as a basic necessity to the less privileged population under Ubudehe 1, the establishment of a risk mitigation facility that will support the private sector mechanisms that will increase, the development of mini-grids in suitable locations and the continued of the Electricity Access Rollout Programme (EARP)", (MININFRA, 2016)

Although Different study has been done on rural electrification effect before the establishment of program, and annually Imihigo Districts evaluation but none have shown the impact played by this program on socio-economic Impact in the rural community livelihood transformation by showing the advantages the rural areas have got out of it basing on the material gain, health, economic and social livelihood improvement, the implementation or progress and the Barriers of program, Feedback peoples' sense of awareness and /or acceptability, interest and readiness on the program transfer and their understanding of the benefits of such program in their livelihood transformation process. It was the aim of this study to assess socio-economic impact of the program and it is sustainability in Busoro cell, Rulindo District set the basis upon which the stability of the rural electrification can be guaranteed. It is important to gain feedback from target population and implementers partners about ways in which program might be improved to accelerate program implementation in order to meet the government target of 100% of electricity access of all Rwandan by 2024.

1.3 Objectives of the Study

1.3.1 General Objective of the Study

The general objective of the study was to assess socio-economic impact of Rwanda rural electrifications Strategy2016 on livelihood transformation in Busoro cell-Rulindo District

1.3.2 Specific Objectives of the Study

1. To identify the social effects of rural electrification strategy on livelihood transformation in Busoro- Rulindo District.

2. To identify the economic effects of rural electrification strategy on livelihood transformation in Busoro-Rulindo District

3. To examine awareness of program on livelihood transformation in Busoro- Rulindo District.

4. To examine the program implementation, it is progress, it is barriers and it is sustainability on livelihood transformation in Busoro-Rulindo District

1.4. Research Questions

1. What are the social effects of rural electrification strategy on livelihood transformation in Busoro- Rulindo District?

2. What are the economic effects and/ or activities brought by rural electrification strategy on livelihood transformation in Busoro-Rulindo District?

3. What is the awareness of people for rural electrification strategy on livelihood transformation in Busoro- Rulindo district?

4. What are the program implementation strategy, progress, partners, barriers and it is sustainability for livelihood transformation in Busoro- Rulindo district?

1.5 Significance of the Study

The study serves as a reference material by Rwanda government, and other stakeholders, institutional bodies of knowledge and all other Ministries and Development Agencies on feedback on the planning process, implementation and it is the impact of rural electrification strategy on livelihood transformation. It provides proper feedback on the planning process for the rural electrification strategy in the country.

The study will also help the policymakers to improve program and stakeholders mainly solar home system private company suppliers to improve the capacity, marketing, and use of their product in order to satisfy the need of rural area population, this means that findings from the study are of great benefits to the project planners and implementers and may be used further for policy intervention and policy development.

It is also important to the researchers and academicians as it will be a useful guide for future researcher's interested in undertaking a study on the socio-economic effects of rural electrification in other parts of Rwanda.

1.7 Scope of the Study

The study was carried out in the Northern Province of Rwanda, Rulindo district, Buyoga sector; Busoro Cell, according to EARP 2015-2016 the district electricity access was

15.66% and according to the Rulindo District substation leader, the connectivity was 37% at the end of the fiscal year 2017-2018(igihe, 2018).

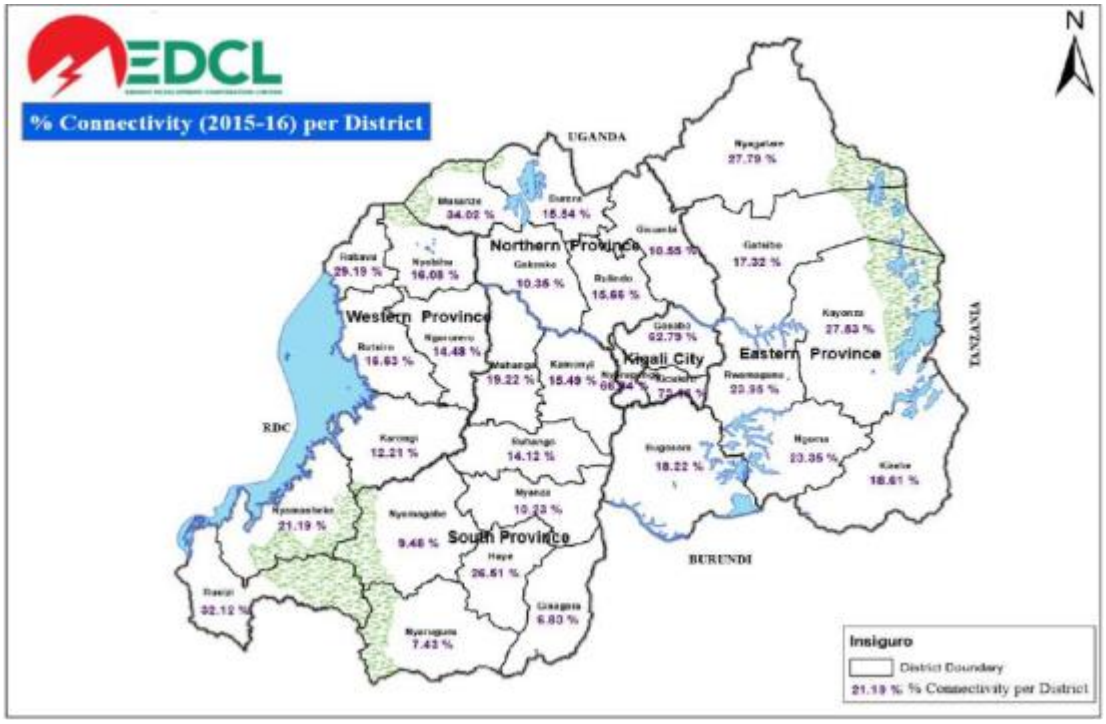

Figure1. 2 National grid access provision

Source: EARP 2015-2016.

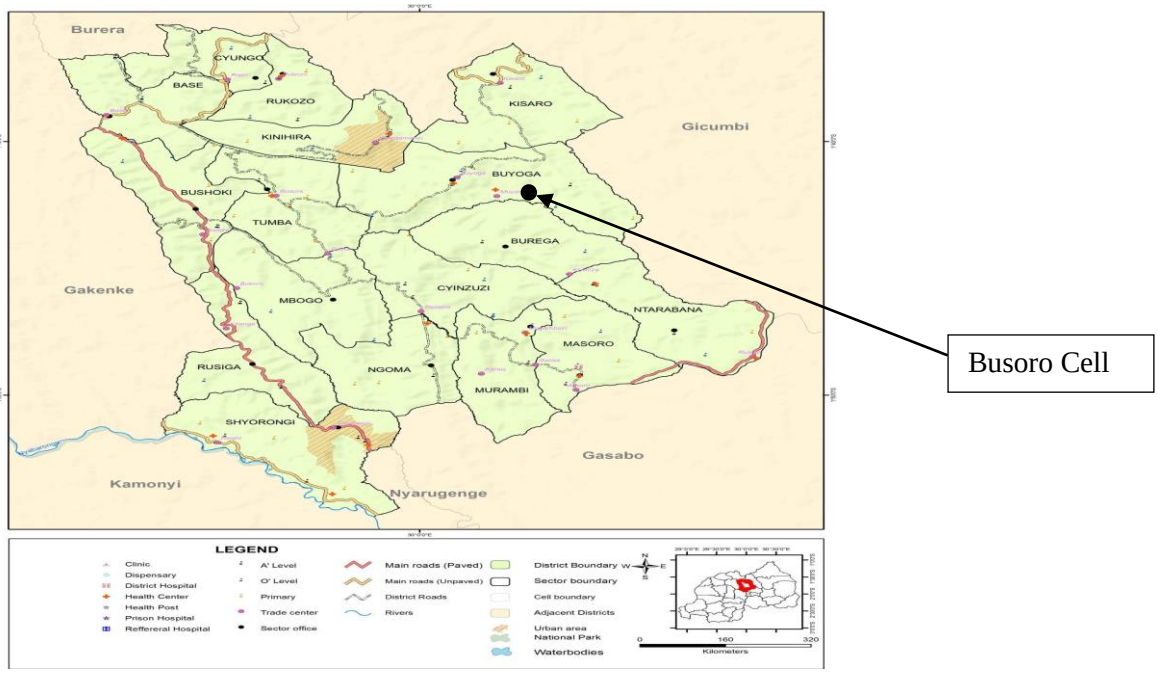

Figure1. 3 Administrative Map of Rulindo District

Source: NISR, 2012

This case study was chosen because it is the District rural area dominated by hills and with the settlement which is not close and many households are not connected to the national electricity grid; According to 2012 Rwanda national Institute of statistic census Shyorongi, Buyoga, Masoro ,and Kisaro are the most populated sectors with more than 19, 000 residents each. They represent 8.2%, 7.7%, 7.2% and 6.9% of the total population of Rulindo district, respectively. (NISR, 2012)

Table 1. 1 Distribution of the resident population in Rulindo district by sector and area of Residence

Sectors	Count			%		
	Total	Urban	Rural	Total	Urban	Rural
Rwanda	**10,515,973**	**1,737,684**	**8,778,289**	**100.0**	**16.5**	**83.5**
Northern Province	**1,726,370**	**160,808**	**1,565,562**	**100.0**	**9.3**	**90.7**
Rulindo District	**287,681**	**8,630**	**279,051**	**100.0**	**3.0**	**97.0**
Base	17,341	0	17,341	100.0	0.0	100.0
Burega	12,730	0	12,730	100.0	0.0	100.0
Bushoki	19,970	0	19,970	100.0	0.0	100.0
Buyoga	22,171	0	22,171	100.0	0.0	100.0
Cyinzuzi	13,662	0	13,662	100.0	0.0	100.0
Cyungo	13,489	0	13,489	100.0	0.0	100.0
Kinihira	15,344	4,222	11,122	100.0	27.5	72.5
Kisaro	19,868	0	19,868	100.0	0.0	100.0
Masoro	20,733	0	20,733	100.0	0.0	100.0
Mbogo	16,795	0	16,795	100.0	0.0	100.0
Murambi	17,892	0	17,892	100.0	0.0	100.0
Ngoma	10,881	0	10,881	100.0	0.0	100.0
Ntarabana	18,065	0	18,065	100.0	0.0	100.0
Rukozo	15,023	0	15,023	100.0	0.0	100.0
Rusiga	10,888	0	10,888	100.0	0.0	100.0
Shyorongi	23,545	4,408	19,137	100.0	18.7	81.3
Tumba	19,284	0	19,284	100.0	0.0	100.0

Source: Rwanda 4th Population and Housing Census, 2012 (NISR)

Table 1. 2 Distribution of the private households in Rulindo district by main source of energy for lighting and by Sector

Sectors	Total number of private households	Total (%)	Electricity	Kerosene lamp	Candle	Firewood	Other	Not stated
Rwanda	**2,424,898**	**100**	**17.4**	**39.6**	**9.7**	**7.9**	**24.9**	**0.5**
Northern Province	**391,668**	**100**	**9.1**	**29.8**	**14.4**	**8.2**	**38**	**0.5**
Rulindo District	**67,453**	**100**	**6.1**	**19.2**	**20.9**	**5.8**	**47.6**	**0.5**
Base	4,049	100	11.4	24.1	15.3	8	40.8	0.4
Burega	3,045	100	0.5	11	18.5	7.1	62.6	0.2
Bushoki	4,702	100	15.5	30.8	14.3	5.7	33.3	0.3
Buyoga	5,070	100	2.8	4.1	11.9	10	70.7	0.5
Cyinzuzi	3,261	100	2.6	20.7	15.5	4	56.8	0.3
Cyungo	3,017	100	5.1	21.6	13	7.1	53	0.1
Kinihira	3,473	100	9.5	8.4	16.9	10.3	54.3	0.5
Kisaro	4,452	100	3.2	15.1	17.4	12.1	51.3	0.7
Masoro	5,068	100	11.3	23.5	43.6	0.9	20.3	0.4
Mbogo	3,834	100	6.1	15.2	11.6	6.1	60.1	0.8
Murambi	4,312	100	5.2	24.2	29.5	2.1	37.4	1.6
Ngoma	2,605	100	4	21.9	20.6	4.3	48.8	0.3
Ntarabana	4,383	100	1.2	14.2	42.1	2.6	39.4	0.3
Rukozo	3,421	100	5.3	15.3	15.6	8.1	55.1	0.6
Rusiga	2,596	100	3	15.7	19.5	1.5	60.1	0.1
Shyorongi	5,774	100	6	37.6	22	0.8	33.1	0.4
Tumba	4,391	100	5.5	12.7	17	8.5	56	0.3

Source: Rwanda 4th Population and Housing Census, 2012 (NISR)

According also to the 2012 Rwanda national Institute of statistic census; Buyoga sector was the first populated sector with 100% rural areas in Rulindo District, and it was the most populated sector in Rulindo District with a low level of electrification rate. The Busoro cell with 3.028 peoples which form 701 houses, has been chosen because it has been beneficiary both on grid electrification and off -grid with PV solar home system, according to the cell report 98 households got on grid electricity and 308 households got electricity from PV solar home system as a results of rural electrification strategy program (Busoro, 2018), and ties in very well with the operationalization of the research question under study.

1.7 Limitation and delimitation of study

During this study same limitations have come across like minimal understanding of the questions asked by data collectors to the respondents as most of them have no education, same English electrical technical terms become challenges to translate them into Kinyarwanda language which was spoken local language ,short time for research , rain season period, same household members who for the first time refused to give full information, and the remoteness of the area was also a limitation of the study .To deal with these limitations different solutions were taken; like explaining what the study meant and informing them that confidentiality on every information given was to be maintained, restructuring the questions when asking to make them easily understood by the informants and explaining them in easy manner and understandable , about the rain season period researcher and assistant in data collection worked hard even during rain and worked during evening or night in order to reach everyone from the sample size in short period .

CHAPTER TWO: LITERATURE REVIEW

2.0. Introduction

This chapter looked at the theoretical review, conceptual framework, Empirical review, and chapter summary Literature were reviewed according to the topic of the study. The purpose here was to find out socio- economic impact of rural electrification on livelihood transformation process. The objective here is to reveal the contributions made by earlier researchers, identify the weaknesses and gaps in the existing knowledge and highlight the lessons learned from their studies. Literature was obtained from textbooks, reports, journals, internet and documents from Ministry of infrastructure, Rwanda Energy group and Rulindo District and Busoro cell office.

2.1 Theoretical review

This research was guided by Anthony Giddens' Structuration Theory, Development as freedom and capability approach by Armatya Sen and the user value of rural electrification theory.

2.1.1 Anthony Giddens' Structuration Theory

Giddens structuration theory state an affirmation of both the roles of structures of society and individual agency in bringing about change**,** Giddens wrote this in his book '*New Rules of Sociological Method*' (1976), where he outlines the Structuration theory.

Giddens sees desired change as a result of the complement of structures and actions, relating with this research rural electrification strategy in Busoro provides opportunity but are not enough to bring socio-economic effects on livelihood transformation without good leadership, socio-economic program on rural peoples and the good mindset of individually. This can be seen by the example of rural electrified before Rwanda genocide 1994 though the percentage it was low but the one beneficiated by the rural electrification they didn't have an extensive socio-economic development as a result of bad leadership.

2.1.2 Development as freedom and capability approach by Armatya Sen Theories

Sen in his book 'Development as Freedom' (1999) he outlines what he sees to be freedoms, which entail rights such as education, life ,and public participation. Armatya Sen argues that individual agency is not real if the freedom is absent or in other words constrained freedom cannot realize desired development trajectories.

The theories helped to see if Busoro people are free to use the opportunities that come worth the rural electrification strategy and have all the enabling components such as

political goodwill, positive knowledge enough and in support of the developmental initiatives influenced by rural electrification strategy.

The capability approach by Sen's 1980s was also applied to guide this study, this approach was established in the 1980s and it challenges the use of the gross national product, individual personal incomes, industrialization and social modernization. Capability approach sees human life as a set of "beings" and "doing" which some time are called *"functioning"* and it relates the evaluation of the quality of life to the assessment of the capability to function (Sen, 1990). Basing on Sen's capability approach, development requires the removal of major sources of un-freedom, poverty , poor economic opportunities as well as systematic social deprivation, neglect of public facilities as well as intolerance or over-activity of depressive stated (Sen,1999)

Capability approach was relevant to this study in exploring the impact of Rwanda rural electrification strategy on livelihood transformation. This approach helped in understanding how on grid connection and off-grid connection in Busoro has impacted the lives of the people at the household level and the community at large in terms of expanding their socio-economic effect and the way it has helped them to live the kind of life they want to live and the way it has helped in expanding people's freedom.

2.1.2 The user – value of rural electrification Theory

In his book 'Analysis and adaptation of existing models theories' Stephanie (2014) emphasized that for success of any project including rural electrification the project makers and implementers must take attention to the end user value among others criteria and output projected from it .

On relevance to the study end user-value explain why Creating value for the end- user for rural electrification strategy in Busoro is particularly important for livelihood transformation and the acceptance and the sustainability of a program after the installation of the electricity connection and PV solar system to the homes of the Busoro communities.

2.2. Conceptual Framework

This study is based on socio-economic impact of rural electrification strategy as independent variables and livelihood transformation as a dependent variable

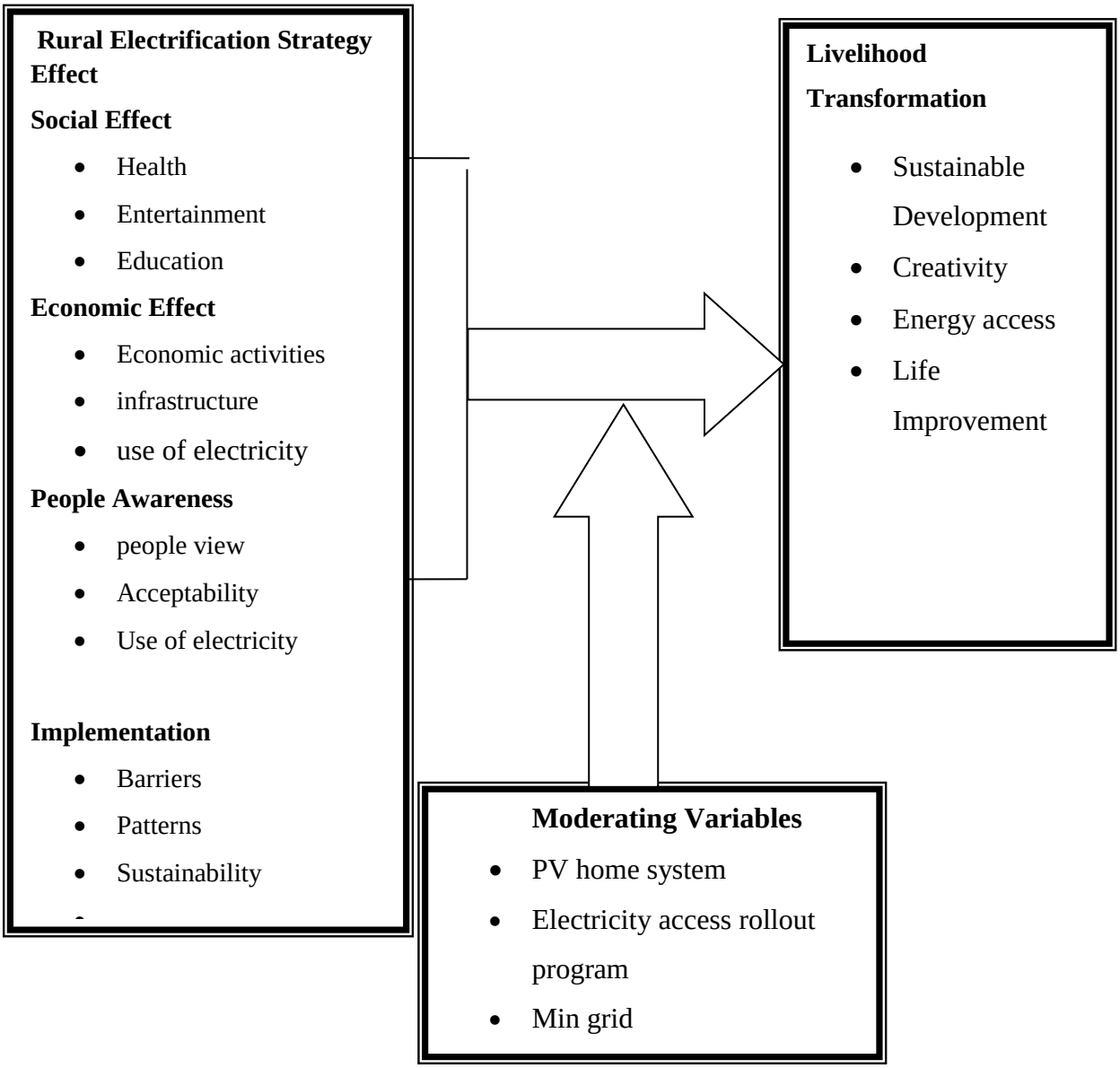

Figure2. 1Conceptual framework on the relationship between rural electrification strategy Effect and livelihood transformation

To achieve rural electrification effect for livelihood transformation the PV Home system, Electricity access rollout program and Mini grid are moderating variables as indicated by rural electrification strategy.2016.

2.3. Empirical Review

2.3.1 Social effect of rural electrification on livelihood transformation

Different studies have proven that rural electrification has different social impact on livelihood transformation in rural areas in different sectors like health, education, security and entertainment .World Bank (2008) argued that rural electrification has numerous benefits in the contribution of improving quality of life in rural areas like lighting which is the most dominant use of electricity which improves the study environment for school children, access to information, and different entertainment activities like by helping people to own televisions. A study of the World Bank for 11 countries indicated that rural electrification is useful in a number of ways; it works for better health because the people will not use those energy sources for cooking, lighting and heating, which emit CO2 and create indoor pollution(Zilles, 2007).This argument also has been emphases by Raul (2017) on development effect of rural electrification by suggests that rural electrification have three main outcomes: decreased indoor pollution, increased electricity use, and changes in time allocation. Firstly, he argued that access to electricity produce improvements in health outcomes , mainly respiratory illness, especially among household members who spend more time inside the dwelling (women and children) this is done by reduces the consumption of Low-quality, dirty fuels for lighting (such as kerosene or candles), thereby reducing intrahouse emissions of polluting gases. Karekezi and Sihag (2004) argued that without sufficient energy supplies the education and health condition cannot be desirably improved because in many rural areas kerosene oil and candles are used for lighting. According, to Kaplin (2007) burning of candles in a closed room create a lot of pollution and may cause a mental problem or fatal damages to the kids and adults. Wamukonya (1999) on his study on socio-economic impact in Namibia found that Electrification by off- grid solar or grid connection modified social development, standard and way of living and also results in crime reduction. According to Raul (2017) in rural areas students do their study and homework at 2 day time only because they do not have light to study at night if there is little electricity available at night it may improve students' performance by investing more time in their studies. So, that's why rural electrification plays a key role to improve the social condition of the people in rural areas.

2.3.2 Economic effect of rural electrification on livelihood transformation

The economic effect of rural electrification was emphasized by many researchers and scholars, According to Rutangengwa (2013) Energy is an essential need for the economic

development of the country and to provide services to its citizens through schools, health facilities, job creation through establishment of small-scale industries towards a better life for a sustainable development. Manas and Satyabrat (2013) recognize that energy affects all the dimensions and support pillars of sustainability and that it raises economic, social and health conditions. Tarujyot (2012) by looking at rural electrifications sees the modern energy in the development of societies more important as a basic human in the same way as water and food. FAO, (2000) by looking that energy improves different socio-economic activities at the household level such as agriculture, health care, and education argue that can be taken as a catalyst which can spur peoples' livelihood transformation. As qualitative communication with many villagers in different African countries has shown, Bensch, G. and . Peters,(2010) emphasize that run electric lighting can be expected to change life in newly electrified communities profoundly and sustainably also argue that lighting forms the major application of electricity for rural people .

World Bank (2008) say that rural electrification contributes to poverty reduction by improving business, providing employment opportunity. Samanta and Sundaram (1983) did a study on the socio-economic impact of rural electrification in India and they found that rural electrification has made a major contribution to rural development, it found to be positively associated with the two most critical inputs irrigation and innovation in the agricultural sector ,it is also found to have positive effects on the development of rural industry and services on another hand in the social sectors, the effects were less pronounced though still consequential.

Erin (2017) on his study on assessment of the impacts of rural electrification in the kingdom of Bhutan he looked at survey data from three rounds of the Bhutan Living Standards Survey by Applying linear and non-linear regression methods as well as propensity score matching, he find that the Renewable energy program led to improvements in education and reduced fuelwood consumption, he found inconclusive evidence of the effects of renewable energy on non-agricultural employment and found no effect on health.

Dinkleman (2011) evaluated grid electrification in South Africa and found positive impacts on female employment, likely due to less time spent doing housework but found no increase in wages due to no change in labor demand. In Peru, Dasso and Fernandez (2015) find that electrification led to economic improvements for both men and women after electrification men work more hours but are less likely to have a second job. For women,

electrification leads to improvements in both employment status and income and also increases the probability that a woman is employed outside of the agricultural sector.

The argument that the rural electrification has socio-economic effect was argued also by Kembo,(2013) in the study in tala division, Machakos county, Kenya who seems that electrification enhances quality of life at the household level and motivates the economy at a broader level, according to him electricity extended hours of study and reading and other household responsibilities, and in turn contributes to better educational activities, also argue that household activities, like sewing by women, social gatherings after dark, Communication devices ,access to information , entertainment to family are results of lighting.

The role of modern energy in poverty reduction has been documented also by study of Ondari (2010) emphasizes that no country in the developing world has ever achieved 8 – 10 percent annual growth that is required to reduce poverty without modern energy. (Kirubi, 2006; Tuntivate,2011) on a research, study outcomes have given evidence indicating the positive relationship between electricity consumption and gross domestic production and this correlation has been reflected by the relationship existing between the electrification rate in a country and the percent of households who are living above the poverty line of two dollars per day.

Matungwa, (2014**)** on his study in Tanzania having conducted in the village that had two sub-villages where one village is electrified and the other one not electrified, he found that there is the difference in socio and economic between two villages.

The effect of PV was also given by World Bank (2009) by reveals that Solar Home Systems (SHS) increases economic activities inside and outside households because business activities operate long hours in the evening. The study also conducted by Singh (2009) found that businesses in rural areas of developing countries with access to electricity such as home businesses, small commercial shops, grain mills, sawmills, coffee and tea processing, brick kilns and other small-scale enterprises can benefit from rural electrification programmes.

Raul, (2017) argue also that new access to electricity in addition to offering an equivalent and cheaper lighting source could also reduce copying costs and energy expenditures and increase disposable income at the household level, access to and use of electricity also tend to imply an extension of usable hours during the night, potentially allowing for increased leisure and/or productive activities.

2.3.3 Peoples and government awareness on rural electrification

Government and groups of peoples are aware of the importance of rural electrification on livelihood transformation, this has been highlighted by different studies and scholars and by the different government policies.

In his book "*Rural Electrification and Rural Development*" Cook (2012) points out that the effect of rural electrification on small businesses should be determined by the nature of the local community, the complimentary programs and the ability of rural entrepreneurs. He further emphasizes that although electricity is an important and essential input that can spur and help in the development of small industries, the other complementary conditions such as access to good rural markets and adequate credit should also be considered

Anton (2017) on his study on Rural Electrification and Societal Impacts on Future Energy Demand in Bolivia revealed that energy access especially accesses to electricity is an essential condition for the development of rural communities. However, it does not guarantee an increase in productivity or effectiveness in social institutions in the absence of other development programs. The study also concludes that well-planned carefully implemented rural electrification programs provide enormous benefits to rural people and once an area has reached a certain level of development further improvement of societal institutions depends on the availability of a secure and stable energy supply.

Most developing countries include rural electrification policies in their socio-political development efforts, the existing economic inequalities between urban and rural populations and these countries' social equity objectives tend to be the main drivers of providing electricity access to isolated populations by doing this governments of developing countries seek to improve the living standards of their rural populations and help them economically in order to help level out rural/urban disparities. In developing countries the subsidization policies vary according to governments objectives with regard to renewable energy project targets In Uganda, rural electrification is carried out through the utility private providers who are faced with insufficient supply of generation that is not equal to demand.in the case of South Africa, the National rural electrification project aims to meet the needs of households, institutions of learning and health centers, based on the impact analysis of the rural electrification in various sectors in rural areas (Thom, 1998).

Dufe (2015) on his study on factors influencing accessibility of rural electrification in Kenya: a case of Naivasha constituency he found that the peoples are aware that benefits of

rural electrification range from lighting, access to information, improved study environment for school children as well as improved businesses which in turn create employment opportunities and contribute to development and poverty reduction., the study recommends that the Rural Electrification Authority endeavours to include community participation in their projects to enhance community ownership and ensure sustainability, in addition, the Rural Electrification Authority needs to ensure they have the skills needed for community mobilisation and public relations ,it is also recommended that the Rural Electrification Authority builds in continuous monitoring as an integral part of their projects and that lessons learnt are properly documented and used to inform future projects.

2.3.4 Rural electrification Implementation, barriers, and sustainability

Rwanda has a small-sized economy but with one of the fastest rates of development in East and Central Africa, according to Rutangengwa ;(2013) the government of Rwanda recognizes the key role of the private sector in accelerating growth and eradicating poverty and it has undertaken reforms to improve the energy business to protect the environment and harness economic growth. Rwanda have a huge potential of energy resources for electricity generation include: hydropower ,geothermal, methane gas ,peat, solar, wind , and waste energy yet most of these resources remain untapped, the country's energy mix is dominated by renewable energy like hydro, solar and biomass, Gemma et al,(2017).

The Rwanda Energy Policy (MININFRA, 2015) sees and recognises energy as important for development and an element which can determine either success or failure of any society depending on the status of availability and quality, by looking on how solar energy is clean, climate-friendly, with abundant and inexhaustible energy source of mankind seems PV solar electricity as a good option to the off-grid rural areas where there is a limited supply of modern energy (electricity) for communities' development. With the low rate of electrification in rural area ,the government took the solution of lighting ICT schools, clinics, hospitals ,administration offices, households far away from the planned national grid and other productive sector in remote area by solar lighting (AFDBG,2015) because solar energy has a huge potentiality in Rwanda with a potential of 4.5 kWh per m^2 per day and approximately 5 peak sun hours with this good solar irradiation in Rwanda on-grid installed energy is 12.08 MW and 189,069 households are accessing electricity through off-grid system (REG,2017) .A part of solar energy, Rutangengwa ;J (2013) argue that Small hydropower potentials are also the most significant and economically viable in solving electricity scarcity and improvement of access to electricity in rural electrification

based on the project target he said this based on that technology is comparatively simple and environmentally friend relative to other technologies for different sources of energy, on other hand Electricity Access Roll-out Programme (EARP I and EARP II) program have played important role in Rwanda under which access to grid has increased from 364,000 households in June 2012 to 665,815 households (29% of the total households) in March 2017(EARP, 2017)

According to world bank (2017) access to electricity in rural area was 18.0% in sub Africa and 9.1% in Rwanda in 2014,this means that the African country must put electricity in their priority plan given that the rural electrification is essential and is the base of Rural economic development but Rural electrification in the world and Africa is still encountered with different challenges: Forcano, (2003), on his study in Chile argue that rural area is very unlikely to be reached by the extension of the electricity grid due to remoteness and isolation of many rural communities and usually low demand for electricity this lead to the rural areas frequently lack the safe and liable electricity supply that is needed for the development of numerous economic activities. Rwanda national policy (2015) said that the Rwanda settlements in rural areas are not compact, the Rwandan culture of not living together in villages and a Rwandan household structure and dispositions as a giant challenges because it takes time and materials to connect different households and it delays the speed to connect people (MININFRA, 2015).According to the (Urwego bank, 2016) Rwandan off-grid solar market access to finance, high costs of financing, increased taxation, an unclear implementation of the RES and other policies are among the problem faced by Rwanda off-grid market also found that the Rwandan market of mini-grids on the other hand ,is still in its early stages due to that the mini-grid sector is much more dependent on government policies due to its characterisation as infrastructure and predicted increase of private sector and further growth of Rwandan of–grid solar Market in Rwanda once the challenges above are eradicated. Mwihava,(2002) argued also that financial support is needed for rural households to afford renewable energy technologies expenses for rural electrification due to the fact that the majority are poor. On their book Darce et al (2015) entitle Sustainable rural electrification said that mostly non-urbanized lowly populated rural areas with a lower educated and poor population represent a big challenge in the expansion of electrification through renewable energy, they provided three main problems for financing renewable energy infrastructure and the provision of services which are level-playing field for all types of energy, easy market, and political and

regulatory investment risk, they concluded by saying that no one mechanism to finance rural electrification via solar in Africa is truly the best across all criteria, Governments must therefore take into account their Own rural electrification, environmental and development goals and solvency capacities to support the finance mechanism that will satisfy these goals

2.4 Summary of Literature

Literature above present different view on the effect of rural electrification on livelihood transformation , some studies shown that rural electrification have impact on socio-economic transformation in rural area like education, health ,security ,improving business activities ,job creation ,agriculture but due to the fact that the majority of population of rural areas are poor and many of them are not aware of the energy resources utilization, it is difficult to maximize all benefit of rural electrification ,this is shown on the way that in different studies, not every way all effect of rural electrification have been found at the same time, the literature also found that peoples and government are aware on importance's of rural electrification on socio-economic transformation of rural livelihood, it is found also that rural electrification has different barriers in its implementation and socio economic impact on livelihood transformation live peoples settlement, poverty and lack of education and information.

CHAPTER THREE: RESEACH METHODOLOGY

3.1 Introduction

This chapter indicates how data for the study were collected, analyzed and interpreted in order to answer the research questions. It describes how the research objectives were reached and achieved under this study. This chapter, therefore, comprises of research design, study population, determination of sample size, sampling techniques, data collection methods, data collection instruments, data analysis, and ethical considerations.

3.2 Research design

In this study, numerical figures and descriptive information were obtained, giving it both a quantitative and qualitative research dimension. The study hence used both qualitative and quantitative approaches in data collection and analysis. At data collection stage, a qualitative approach was involved at beneficiary of rural electrification strategies households. According to Mugenda and Mugenda (2003), this method is used in studies that cover large population by selecting and studying the sample from the population to discover their characteristics, most information on the households was collected using this method. Whilst the quantitative approach was involved in administering closed-ended interview to Rwanda energy group (REG), local leaders, and electricity supplier's private companies.

3.3 Study Population

This study was conducted in Busoro cell of Rulindo District, Northern Province of Rwanda. The study population consisted of Busoro701 households and the target population was household's beneficiary by rural electrification strategy 2016 both on grid and off-grid through PV solar home system, the local leaders, and the government and private electricity suppliers were part of this study. The local leaders were be chosen because they have the responsibility of overseeing the people livelihood transformation and plan for future budget and Imihigo plan in which rural electrification included. The electricity suppliers companies and private sector were chosen in this study because they had that absolute role to implement rural electrification strategy. The households 'members were chosen because they had a direct role to play in this study as they are beneficiary of the program and the one which demonstrates the impact of the program on their everyday livelihood transformation.

3.4 Sample size and Sampling Technique

Simple random sampling technique was used to choose beneficiary of electrification to ensure that each member of the target population has an equal and independent chance of being included in the sample this is because the electrified households are not equally distributed in all cell. The table in appendix B from a study by Morgan and Krejcie (1970) was used to determine the sample size from the target population of the household beneficiary of on grid and off-grid PV home system to be taken. Purposive sampling was employed to select local leaders and electricity suppliers' company agents who were the target for an interview due to their perceived knowledge arising out of know experience that they have. This technique was employed following the postulate that if sampling has to be done from smaller groups of key informants, there is need to collect very informative data and thus the researcher needs to select the sample purposively at one's own discretion (Sekaran, 2003).

Table 3. 1The sampling frame for questionnaire

Study population or Target population	**Total population**	**Sample size**	**Sampling technique**
Household beneficiary by rural electrification on grid	98	80	randomly
Household beneficiary by rural electrification off grid	308	175	randomly
Total	406	255	

Table 3. 2 The sampling frame for interviews

Title	**Sample size**	**Sampling Technique**
PV supply company representative	3	purposive
REG representative	2	purposive
Local leaders	3	Purposive
Total	8	

3.5 Data Collection Methods and Instrument

3.5.1 Survey

This was used to collect primary data from rural electrified households connected both on grid and off grid through PV solar home system, the survey involved use of a semi-structured questionnaire indicated in Appendix A: 1 and 2 ,the method of survey using a semi-structured questionnaire was considered appropriate since part of the questionnaire offers the households a choice of picking their answers from a given set of alternatives while the other part of the questionnaire allows them to qualify their responses (Amin, 2005).The questionnaires were filled house by the house from the selected sample size.

3.5.2 Interview

This method has been used to collect primary data from suppliers companies' representative, local leaders and Rwanda energy group (REG) representative involved the use of a semi-structured interview guide indicated in Appendix A: 3,4 and 5.

3.5.3 Direct Observation

Direct observation was important and it has proven to be helpful in this research area. Through direct observation different events and activities, people were engaged in and the way they are utilizing electricity within and outside their households were observed and captured, these were moreover helped in capturing different activities people doing during the night, the socialization levels in the villages in different ways were also observed. All these observations has driven further questions and the need of asking and understand from the people concerned.

3.5.4 Documentary Review

Various documents on impact of rural electrification strategy and other information about Rulindo District were reviewed, some of them were obtained from Rulindo District office, Rwanda energy group (REG), PV solar home system supplier offices, textbooks, journals, magazines, thesis, conference papers, newspaper articles, government reports, internet, and dissertations with literature relevant to the research topic were analysed as secondary sources of data to supplement primary data.

3.6 Data processing and analysis

Data were analyzed both quantitatively and qualitatively, the data collected were carefully arranged and analyzed. The data analysis used both descriptive and inferential statistics in

the Statistical Package for Social Scientists (SPSS). All the information were analyzed according to the research question and the information available.

3.7 Ethical Considerations

The research process must ensure the participants' dignity, privacy and safety Scheyvens, et al (2003). In this study, social research ethics were assured. To be able to conduct this study, the permission and the introduction letter from University were processed, after getting in the research area which in this case Busoro cell, self-introduction to the cell authorities were done and the introduction letter from the PAUWES was hand in. After identifying the households and the groups which were involved in the study, the information was sent prior the visiting house by house, the research participants were fully informed about the procedures involved in the research and were kindly asked to give their permission to participate, they were all assured of confidentiality, dignity. To ensure confidentiality, the participants were guaranteed that the identifying information would not be made available to anyone who was not involved in the study and it would remain confidential for the purposes it was intended for.

CHAPITER FOUR: RESULTS AND DISCUSSION

4.1: Introduction

The study main objective was to assess socio-economic impact of Rwanda rural electrification strategy on livelihood transformation, this chapter presents the response from respondent in Busoro cell, Buyoga district. The respondents were the people connected on grid through EARP and the people connected on off grid through PV home solar system, local leaders, REG representative and suppliers company representative. The chapter puts the data in perspective with the research questions asked and seeks to interpret it according to the topic, the chapter is arranged in thematic form starting with a presentation of results followed by interpretation of the finding. The data analysis was done using both descriptive and inferential statistics.

4.2Results

4.2.1 General Information

Table 4. 1 Sex of on grid respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Male	48	60.0	60.0	60.0
	Female	32	40.0	40.0	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 2 Sex of off grid PV home system Respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Male	109	62.3	62.3	62.3
	Female	66	37.7	37.7	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The questionnaires were targeted at 255 households, 80 connected through on grid and 175 connected through off-grid PV solar home system as a result of rural electrification strategy in Busoro cell. The questionnaires were filled house by house to ensure 100% of the response of target sample size.

Among the household member asked, those connected on grid 60% were Male and 40% female. And the one with off-grid was 63.3%, Male and 37.7 female as presented in the table above 4.1 and 4.2.

It clear that all the respondent in all cases were dominated by Males.

Table 4. 3 Age group of on grid Respondents

		Frequency	Percentage	valid Percentage	cumulative percentage
Valid	14-24	3	3.8	3.8	3.8
	25-35	39	48.8	48.8	52.5
	36-44	31	38.8	38.8	91.3
	45-54	5	6.3	6.3	97.5
	Over 55 years	2	2.5	2.5	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 4 Age group of off grid Respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	14-24	12	6.9	6.9	6.9
	25-35	86	49.1	49.1	56.0
	36-46	46	26.3	26.3	82.3
	47-57	14	8.0	8.0	90.3
	58 years old and above	17	9.7	9.7	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

For the table 4.3 and 4.4 above the respondents' age group are dominated by 25-35, with 48.8% on grid and 49.1% on off grid, and less headed respondent are in the age over 55 years for on grid and aged between 17and 24 for off grid PV home system. This shows that the majority of the respondents are in the youth generation which is the age of working and improvement of well-being.

Table 4. 5 On grid Respondents High level of education

		Frequency	Percentage	Valid percentage	Cumulative Percentage
Valid	Never been to school	11	13.8	13.8	13.8
	Primary	60	75.0	75.0	88.8
	Secondary	8	10.0	10.0	98.8
	University	1	1.3	1.3	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 6 Off grid PV system respondent's education

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Never been to school	21	12.0	12.0	12.0
	Primary	109	62.3	62.3	74.3
	Secondary	39	22.3	22.3	96.6
	Post-secondary	6	3.4	3.4	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

As presented in Table 4.5 and 4.6, the majority of the respondent education is a primary school with 75.0% for on grid and 62.3% for off-grid respondents and in both cases, the number of respondents who attained university is low with 1.3% for on grid connection and 3.4 for off grid connection. The dominance of the respondents attained only primary education it can be a barrier to rural electrification strategy transmission and program profitable because many uneducated peoples are not aware of the use of electricity and high consumption equipment.

Table 4. 7 Household members of on grid respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	1	1	1.3	1.3	1.3
	2-3	24	30.0	30.0	31.3
	4-7	42	52.5	52.5	83.8
	More than 7	13	16.3	16.3	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 8 Household members of off grid respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	1	2	1.1	1.1	1.1
	2-3	72	41.1	41.1	42.3
	4-7	67	38.3	38.3	80.6
	More than 7	34	19.4	19.4	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The Busoro houses visited are majority inhabited by4-7 persons represent 52.5% for on grid and 2-3 persons which represent 41.1% for those with off-grid system as presented in table 4.7 and 4.8.On both cases, the inhabitant living as individually in the house are few with 1.3 % for grid connection and 1.1 % for off-grid connection.

Table 4. 9 Roof of house of Respondents connected on grid

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Tiles	53	66.3	66.3	66.3
	Iron sheets	27	33.8	33.8	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 10 Roof of house of respondents connected off grid by PV solar

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Tiles	123	70.3	70.3	70.3
	Iron sheets	52	29.7	29.7	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The study looked at the roof of the households of respondents and found that the majority of respondents house have Tiles with 66.3% of those connected on grid and 70.3% of those connected off-grid and the iron sheets houses are few with 33.8% on grid and 29.7 off grid PV solar as presented on table 4.9 and4.10 .The tiles roof is one of the obstacles of PV system panel installation, in the same cases, they can protect the solar radiation from reaching the cells because of their form.

Table 4. 11 Respondents monthly net Income for on grid connection

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Less than 100,000 Rwf	62	77.5	77.5	77.5
	More than 100,000Rwf	18	22.5	22.5	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 12 Respondents monthly net Income for off grid connection

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Less than 100,000 FRW	153	87.4	87.4	87.4
	More than 100,000 FRW	22	12.6	12.6	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

From the study as presented in table 4.11 and 4.12, majority of Busoro respondents have monthly net income less than 100000 Rwf with 77.5 %of those connected on grid and 87.5% of the household having PV solar system .the household with net income more than 100000 Rwf are 22.5% for on grid and 12.6% off grid PV solar connection. This low monthly net income is among the barriers of extending profitability of all of the electricity effect for socio-economic development and also it is difficult for them to afford high-cost pv solar home system which can increase their social economic effects.

4.2.2 Results on electricity use, connection and Distribution

Table 4. 13 Connection Time of on grid respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Less than 15 months	66	82.5	82.5	82.5
	More than 15 months	14	17.5	17.5	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

Table 4. 14 Connection Time of off grid PV system respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	less than 5 months ago	17	9.7	9.7	9.7
	6-10 months	38	21.7	21.7	31.4
	11-15 months	73	41.7	41.7	73.1
	16-20 moths	27	15.4	15.4	88.6
	over 20 months	20	11.4	11.4	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

Findings from The table 4.12 and 4.13 above shown that the majority of Busoro Cell have received electricity connection in the time less than 15 months with 82.5% and 17.5% who

have electricity in the time more than 15 months for on grid and for off grid majority got the system in the range of 11-15 months ago with 41.7%, followed 6-10 months 21.7%, 16-20 months with 15.4% over than 20 months represent 11.4% and less than 5months 9.7%. The majority of respondents are beneficiary of rural electrification in the time less than 15 years, this is lead to the high speed of rural electrification strategy implementation and also can explain why some effects of rural electrification have not yet attained.

Table 4. 15 Types of lamps using by on grid connection respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Incandescent	12	15.0	15.0	15.0
	Leds	45	56.3	56.3	71.3
	CFLs	23	28.7	28.7	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

The table 4.15 presented the finding son type of lamps of household connected to the grid, it showed that majority of the house have compact fluorescent lamps (CFLs) with the percentage of 56.3% followed by lighting emission diodes (Led) and with a minority of inefficiency incandescent lamps. The user of electricity are using LEDs and CFLS lamps which are the efficient lamps , the respondents which are using inefficient lamps might lead to the high consumption of electricity bill which at the end they are feeling that the electricity is expensive.

Table 4. 16 Others Energy sources using by respondents of on grid connection

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Wood Product	75	93.8	93.8	93.8
	Biogaz	3	3.8	3.8	97.5
	1 and 2	2	2.5	2.5	100.0
	Total	80	100,0	100,0	

Source: Primary Data, 2018

Table 4. 17 Others Energy sources using by respondents with off grid connection

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	wood products	170	97.1	97.1	97.1
	Biogaz	3	1.7	1.7	98.9
	1 and 2	2	1.1	1.1	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The finding in the table 4.16 and 4.17 above shown wood products as dominated of others energy sources using by Busoro cell households for both the house with on grid electricity and off grid connection, with 93.8% and 97.1 respectively. Followed by biogas and a little number of houses using both wood product and biogas.

Because of availability of the wood product at the low price in rural areas, the use of the electricity for cooking is neglected.

Table 4. 18 Appliances using electricity for on grid connection Respondents

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Bulbs, phones, radio	59	73.8	73.8	73.8
	Bulbs ,phones, radios, television	4	5.0	5.0	78.8
	Others(refrigerators ,iron, mills, cookers)+1and2	17	21.3	21.3	100.0
	Total	80	100,0	100,0	

Source: Primary Data, 2018

Table 4. 19 Appliances using electricity for off grid respondent's connection

		Frequency	Percentage	Valid Percentage	Cumulative percentage
Valid	Lighting bulbs and phones	81	46.3	46.3	46.3
	Bulbs, phone and radio	93	53.1	53.1	99.4
	bulbs, phones, radio and television	1	0.6	0.6	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The study investigated the appliances in the houses that use electricity and the results in table 4.18and 4. 19 above show that for both cases the dominated appliances are the households with both bulbs, phones and radio. For on grid houses the percentage is 73.8% and for off grid the percentage is 53.1%.In common for both cases the houses that use bulbs; phones; radio, and television are few with 5.0% for grid electricity and 0.6% for off grid PV home system. For the houses connected on grid have others appliances that use high consumption of electricity for house members wellbeing like refrigerators, iron, mills and, cookers with percentage of 21.3% and the house with off grid PV system with appliances bulbs and phones only have 46.3% it is clear that all household connected use at least radio, and phones which is the evidence of effect of electricity in social and economic effect.

Table 4. 20 Electricity monthly bills for household connected on grid

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Less than 500 RWF	11	13.8	13.8	13.8
	500-1000RWF	40	50.0	50.0	63.7
	1000-2000RWF	18	22.5	22.5	86.3
	Over 2000	11	13.8	13.8	100.0
	Total	80	100.0	100.0	

Source: Primary Data, 2018

The study looked on the electricity bill payment monthly for those on grid connection and found that majority pays electricity bill monthly between 100-2000Rwf with total of 50.0%, followed by 1000-2000Rwf which is 22.5%, those over 2000rwf are 13.8% and less than 500 Rwf are 13.8%.Those who pay much money are the one who use high consumption appliances and inefficient lamps such as incandescent but are for both cases at low percentages.

4.2.3 PV Solar system Distribution

Table 4. 21 Distance between household with PV solar and grid connected household

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	less than 500 meters	23	13.1	13.1	13.1
	500m-1km	71	40.6	40.6	53.7
	1-2km	53	30.3	30.3	84.0
	2-5km	19	10.9	10.9	94.9
	more than 5km	9	5.1	5.1	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The study looked on the distance between electricity grid and the house with PV solar home system and found that majority are in the distance between 500m-1km with 40.6%,followed by 1-2 km with 30.3%,less than 500 m with 13.1% ,2-5 Km with 10.9% and more than 5 km with 5.1% respectively. This table shows that majority are in the distance less than 2 km which means that as the economics of the peoples will increase they could pay money and ask electricity transmission for their homes to complement their PV stability.

Table 4. 22 Where did you get PV solar system information?

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	friends	30	17.1	17.1	17.1
	advitersiment	26	14.9	14.9	32.0
	company representative	98	56.0	56.0	88.0
	local leaders	21	12.0	12.0	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

Another feature of the households surveyed is where the house member got the information about PV solar, the finding in the table 4.22 show that majority with 56.0% got the information from companies representative, 17.1% from friends, 14.9 %from advitersiment, and 12.0 % from local leaders. The majority got information from companies' representative, this show how suppliers companies are working hard to approach peoples and at the same times accelerate rural electrification strategy.

Table 4. 23 Monthly saving by using PV solar home system

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	less than 500Rwf	12	6.9	6.9	6.9
	500-1000 Rwf	57	32.6	32.6	39.4
	1000-2000 Rwf	44	25.1	25.1	64.6
	Over 2000 Rwf	62	35.4	35.4	10000
	Total	175	100.0	100.0	

Source: Primary Data, 2018

This table 4.23 show the approximation of the saving from house which are using PV solar home system monthly, the finding shown that 35.4% they save over 2000 Rwf, 32.6 % save between 500 and 1000Rwf, 25.1 % have a saving range from 1000 to 2000 Rwf and

6.9 % save less than 500Rwf this means that all respondent have got effect to their economic income as results of use electricity

Table 4. 24 How have you got the PV solar home system?

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Government	12	6.9	6.9	6.9
	self payment	163	93.1	93.1	100.0
	Total	175	100.0	100.0	

Source: Primary Data, 2018

The study looked on the way the house received the PV solar home system and the finding in the table 4.24 indicated that majority have paid the system them self with 93.1% and 6.9% they got the system by government institution offers. The offers are the ministry of health which gave the PV solar system to the local health helpers.

Table 4. 25 PV solar system payment method

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Direct	62	38.0	38.0	38.0
	Monthly	98	60.1	60.1	98.2
	bank loan	3	1.8	1.8	100.0
	Total	163	100.0	100.0	

Source: Primary Data, 2018

Apart from the way the household got the system ,the study sought on the way the peoples who paid the system them self they did and the finding in the table 4.25 indicated that 60.1% paid the system monthly,38.0% direct payment and 1.8 % they paid the system from a bank loan. Payment monthly of the system helped the peoples because many of them they cannot manage to pay for once as results of poverty and their monthly income.

4.2.4 Socio Impact of rural electrification strategy

In this study the social impact of rural electrification strategy both on grid connection and off grid connection in Busoro cell livelihood transformation was investigated, using questionnaire on a likert scale of 1-5 with 5 - Extremely a lot, 4- A lot, 3- Moderate, 2- Just a little, 1 Not at all .The finding from respondents are presented in table 4. 26 and 4.27.

Table 4.26 Social effects of rural electrification strategy for on grid connected in livelihood transformation

	N		Mean	Standard Deviation
	Valid	Missing		
I know a lot happening around me and government program because of listening to the radio and using phone	80	0	4.3750	0.95963
There is more security in the village because of the lights	80	0	3.8500	0.95599
I am participating in the entertainment as results of electricity	80	0	3.4375	1.16753
My health has been improved due to the access to electricity	80	0	3.4250	0.88267
I am connected with friends and family by using phone	80	0	3.8625	0.65107
My children perform better in class because they have more time to read at home	80	0	3.8500	0.82830

Source: Primary Data, 2018

Table 4. 27 Social effects of rural electrification strategy for off grid connected in livelihood transformation

		I know a lot happening around me because of listening radio and phone	I have more security at home as result of using solar	My children perform better in class because they have more time to read at home	I have good health because of PV solar	I do entertainment as result of PV solar
N	Valid	175	175	175	175	175
	Missing	0	0	0	0	0
Mean		4.0914	3.4400	3.0971	3.7657	3.1029
Standard deviation		0.94849	0.91325	0.98070	1.05970	0.87805

Source: Primary Data, 2018

From the tables 4.26 and 4.27 above for both peoples beneficiary both on grid and off grid through PV solar home system they results show that they got important improvements on their everyday lives. This is shown by mean which is above 3.0 for all social areas of lives and a little variation with the answers of all respondent which is shown by standard variation which doesn't reach 1.5, By having access to electricity peoples are using information tools like television, radio, and phones, for exchanging news and information, which have high mean for all respondents more than 4. The security and crime in the cell have also improved by using electricity during night ,Health and education also have improved as shown by respondent and the interview with local leaders which explained that the children have time to do their homework and courses revision during night ,The local readers also indicated that the incident of people resulting from darkness and using kerosene and candle for lighting has been reduced, entertainment activities was developed as results of electricity as shown by respondents mean also by direct observation during the data collections the Busoro cell peoples was watching world cup games even during night which wasn't impossible before availability of electricity.

4.2.5 Economic impact of rural electrification strategy

The study sought on the economic impact of rural electrification strategy on livelihood transformation in Busoro as one of the objectives of the study. This is based on the hypothesis that rural electrification leads to improved economic conditions, the questionnaire had a set of questions for which respondents were expected to rate the effect level on a likert scale of 1-5 with 5 - Extremely a lot, 4- A lot,3- Moderate, 2- Just a little, 1 Not at all. The findings are analyzed using the means, standard deviations. The findings are represented in below table 4.28 for on grid respondent and table 4.29 for off grid PV system respondent.

Table 4. 28 Economic effects of rural electrification strategy for on grid respondents in livelihood transformation

		I have new business as results of electricity	I work more hours because of electricity	I am saving much money by using electricity	Electricity helped youth and entire population to create their own business
N	Valid	80	80	80	80
	Missing	0	0	0	0
Mean		3.0000	3.0625	3.0875	2.9000
Standard deviation		1.03116	0.95922	1.09306	0.93592

Source: Primary Data, 2018

Table 4. 29 Economic effects of rural electrification strategy for off grid PV system connection respondents in livelihood transformation

		I save money as results of using PV solar	My PV system helped my neighbour	I worked more hours because of solar energy	My PV solar are not expensive
N	Valid	175	175	175	175
	Missing	0	0	0	0
Mean		4.4057	3.0229	4.2400	2.7943
Standard Deviation		0.80299	0.95865	0.75017	1.24705

Source: Primary Data, 2018

The findings have varied results In some instances, it shows that the members of the households said that they are saving money by using electricity both on grid and off grid, they are both working more hours as results of night lighting, some households with grid connection also have new business like shopping, salons, milling and the houses with PV system feel that their PV solar system helped their neighbour by helping them charging phones and radios. However, on the other end, they seem to be moderate new business emanating from the connections and less PV solar system owner feel that the PV system are expensive.

4.2.6 Awareness of Busoro peoples on rural electrification strategy

The study looked on awareness of peoples on rural electrification strategy on livelihood transformation in Busoro as one of the objectives of the study., the questionnaire had a set of questions for which respondents were expected to rate the effect level on a likert scale of 1-5 with 5 - Extremely a lot, 4- A lot,3- Moderate,2- Just a little, 1 Not at all .The findings are analyzed using the means, standard deviations .The findings are represented in below table 4.30 for on grid respondent and table 4.31 for off grid PV system respondent.

Table 4. 30 Awareness of households with on grid connection

		I know Rwanda rural electrification strategy	Electricity satisfies my energy needs	I have better living condition than before electricity	I know electricity usage beyond lighting	Electricity is cheaper
N	Valid	80	80	80	80	80
	Missing	0	0	0	0	0
Mean		2.1875	2.5750	3.2375	3.8750	3.7750
Standard deviation		0.74789	0.68943	0.76710	0.89124	1.30214

Source: Primary Data, 2018

Table 4. 31 Awareness of households with off grid connection

		I am satisfied by the solar	I know other existing system	I know how to use PV solar	I know Rwanda rural electrification strategy	I feel that I am more developed
N	Valid	175	175	175	175	175
	Missing	0	0	0	0	0
Mean		2.7943	2.8571	3.0914	3.3143	3.4457
Standard deviation		1.31873	1.16320	1.30986	0.86341	1.13268

Source: Primary Data, 2018

From the finding in the table 4.30 and 4.31 show that the finding have a varied results, with on grid connection the respondents said that they know other electricity usage beyond lighting with a mean of 3.8, this is in the where that majority of respondent have plan for using electricity in different activities though from them they said that the barriers are the capacity of electricity available which is low. The results also show that the electricity is

cheaper and that they have good living condition than before electrification. However less of on grid connection people expressed that they know rural electrification strategy. On other hand the house members with off grid connection feel that there are more developed with 3.44 mean of respondent ,they also shown that they know Rwanda rural electrification strategy on the mean of 3.31 for respondents ,yet those who know to use PV solar system are moderate with mean of 3.09, on the other end, they shown that there aren't know all existing system and that they don't satisfied by the system they have ,this result had standard deviation less than 2 which is little variation in the responses by the respondents which is a testimony to the consistency of the responses.

4.2.7 Implementation, Barriers and Sustainability

Lastly the study sought on the implementation, barriers and sustainability of rural electrification strategy on livelihood transformation in Busoro as last of the objectives of the study. Questionnaire had a set of questions for which respondents were expected to rate the effect level on a likert scale of 1-5 with 5 - Extremely a lot, 4- A lot, 3- Moderate, 2- Just a little, 1 Not at all .The findings were analysed using the means, standard deviations. The findings are represented in below table 4.32 for on grid respondents and table 4.33 for off grid PV system respondent.

Table 4. 32 Implementation, barriers and sustainability of rural electrification for on grid respondents

	N		Mean	Standard deviation
	Valid	Missing		
I want to shift to PV solar system	80	0	1.9250	0.92470
I have planned to extend use of electricity	80	0	4.0125	0.84933
I want to combine using grid and solar system	80	0	3.4375	1.16753

Source: Primary Data, 2018

Table 4. 33 Implementation, barriers and sustainability of rural electrification strategy for off grid PV solar respondents

		My system is enough for energy need in household	I need to change system	I have a reliable source of lighting than being connected with electricity	I want to combine using grid connected and PV solar system
N	Valid	175	175	175	175
	Missing	0	0	0	0
Mean		2.9943	3.1257	3.2743	3.6171
Standard deviation		1.22473	1.04835	1.17158	1.06498

Source: Primary Data, 2018

The finding in the table 4.32 from on grid respondents are differs, Majority of owner of on grid electricity all have the plan to extend use of electricity as indicated by mean of 4.01, those who want to combine using grid connection are numerous with mean of 3.4, on another hand the respondents who want to shift from on grid connection to off grid connection are low with mean of 1.9. For off grid PV solar connection respondents as presented in the table 4.33, they had standard deviation all over 1 but no one extend 2 which also can prove the homogeneity of responses, the respondents who shown the desire to combine PV solar and grid connection electricity were many with mean of 3.6 , followed by those who agrees that they had reliable sources of electricity with a mean of 3.2 and those who wish to change the system have mean of 3.1 though the respondents who agreed that the system are enough for home energy need were low with ,mean of 2.9.

4.3 Interpretation and Discussion

This subchapter gives the summary of the findings and the interpretation joined together the finding from questionnaire, interviews and direct observation on the field and discussion. The findings are summarized alongside the objectives of the study and are discussed according to the relevance of the findings.

4.3.1 Social effects of rural electrification strategy

From the finding of both on grid and off grid PV solar beneficiary of Rwanda rural electrification strategy of Busoro cell peoples, the electricity helped them to transform their lives on people's socialization, by having electricity powering radio, television and phones helped them to be in contact with their families, news exchange between them and their families and friends and they are knowing everything happening in the country and around the world through use of those information transmission devices, with interviews with Busoro cell leaders they emphasized on the importance of television, radio, and phones by saying that it is easy for them to communicate with people about government program, leaders said that each peoples have leaders phone number to inform them or to discuss with them about any matter without losing time by coming to the administration office. They said also that electricity improved health based on the fact that almost all Busoro peoples before electricity they have been using kerosene for lighting which is emit CO_2, by using devices which use petrol which had negative effect on them like burning their houses, burning the users also by having communication devices the peoples with illness it easy to inform the health center or neighbour to save him or through radio and television peoples are getting information on the new diseases and the way to fight against them. The leaders also pointed out that electricity improved the education by helping children to have more time to study during night and also before electricity they had to go long distance to cut off their hairs and now they have salons where they are saving time for studies and they have opportunities to use informatics devices for the studies and an entertainment. The leaders also said that the electricity improved security in Busoro because it is easy for peoples to inform government security agencies and leaders about any criminal action of insecurity in their villages, and also by lighting during the night it is easy to capture anyone who can cause insecurity in the villages. The electricity helped peoples to do entertainment by following sport games ,music on tv or radio it helped them to socialization activities during night like playing games, visiting one to another during night from direct observation I saw peoples watching all world cup 2018 football match during night others playing card, the peoples said that they had to go more than 7 km to go to Buyoga centre or Kinihira to watch football match where they have losing time and also they could have insecurity during night and now there are following every match in their villages. The social effect of electricity also was shown by the finding from peoples respondents which all question had to mean over 3 and the standard deviation of on grid and off grid those not reach 2 as a proof of responses homogeneity.

This finding is in agreement with World Bank (2008), which found that rural electrification have numerous benefits in contribution of improving quality of life in rural areas like lighting which is the most dominant use of electricity which improves the study environment for school children, access to information, and different entertainment activities like helping people to own televisions. It is also in agreement of study by Raul J (2017) which found that rural electrification improve health and Wamukonya; L (1999)on his similar study carried out in Namibia he found that Electrification by off grid solar or grid connection modified social development, standard and way of living and also results in crime reduction.

4.3.2 Economic effects of rural electrification

According to the World Bank (2008) rural electrification contribute to poverty reduction by improving business and providing employment opportunity. The results from this study show that rural electrification has an economic effect on Busoro cell .Those who are using PV solar system agreed that they are saving money even though complaints of high costs to some extent in terms of system payment with less mean of 2.7, This is because they have to pay PV system monthly in between 1 to 2 years or directly and after payment they are enjoying electricity for free as said in the interview with the suppliers companies .The respondents with PV solar home system also worked more hours and the system helped economically for they neighbor without electricity by for example by charging their phones and radio for free .The respondents that using on grid electricity agreed that they save money by using electricity, they are working more hours and same have new business like salons, shops, and battery charger. The youth and population new business creation have less mean of 2.9 due to the fact that majority of Busoro cell are youth and without capital and many populations are poor as shown on their monthly income as the majority they don't have an income of 100000 Rwf/month .From Interview with cell leaders said Electricity that is provided by rural electrification strategy allowed small and medium entrepreneurs to extend their working day and generate more income. In particular, it was evident that electricity makes it possible for extending their selling hours into evening which helped them to increase the productivity, Local leaders also said that more than 30 shops got electricity, 2 churches have access to electricity,1 administration office also have electricity and one harvested crops conservation got electricity. The new business created jobs as also said by leaders in an interview. However, there is no significant effect of electricity on irrigation in Busoro cell though leaders said that they have the plan for

future use of electricity. In an interview with REG representatives said that some people feel that electricity are expensive due to the fact that in the first time they have to pay their bill adding small percentage of cost of distribution material because they cannot manage to pay the cost once.

The findings are in agreement by the study of Singh (2009) which found that businesses in rural areas of developing countries with access to electricity such as home businesses, small commercial shops, grain mills, and small-scale enterprises can benefit from rural electrification programmes. He is also in agreement with World Bank report (2009) which said that Solar Home Systems (SHS) increases economic activities inside and outside households because business activities operate long hours in the evening.

4.3.3 Awareness of people on rural electrification strategy

From the finding in table 4.30 the awareness of rural electrification and acceptability of the program on the respondents of on grid connection, the majority know another usage of electricity beyond lighting with a mean of 3.8 with a slight variation in standard variation of 0.8,the respondents also agreed that electricity is cheaper with a mean of 3.7 with a high variation in the group of 1.3 the respondents also agreed that they have better living condition than before electricity with a mean of 3.2 and slightly standard variation of 0.7 ,on other hand the respondents are not in agreement that their electricity satisfy they energy need with mean of 2.5 and less standard variation in the group 0.6 , and the majority of respondent they don't know Rwanda rural electrification strategy with a less mean in group of 2.1 and with a standard variation of 0.7. The fact that electricity is not satisfy the people's energy needs is also shown in the table 4.18 where it is clear that majority of respondents are using electricity for lighting and powering low consumption electronics . This has been emphasised by the respondents on the challenges faced in using electricity by saying that though they know another usage of electricity but they still have challenges on the low supplied voltage capacity of their electricity which cannot run high consumption appliances and machine and the challenges on affordability of high consumption electronic appliances near them on this problem in interview with REG representative they said that they know the issues is the result that Rwanda installed capacity is still low and they have to distribute the available capacity in all the country but they will act on the problem as soon as the capacity will increase.

For the Respondent with PV solar home system as shown in the table 4.31. The majority of respondents are in the agreement that are more developed with mean of 4.3 and a standard variation of 1.1 ,they know Rwanda rural electrification strategy by mean of 3.3 and standard variation of 0.8 ,They know how to use PV solar system on the mean of 3.09 with a standard variation of 1.3. Some respondents they know others existing PV solar home system with a mean of 2.8 with a standard of 1.1.The respondents are less satisfied by system with a mean of 2.7 and with high standard variation in the group of 1.3.The way that the system are not enough for all family is in relation that many houses have 4 and 5 room and in the interview with the company representative the product that majority use have 3 lamps which is called sunking home 60 for ignite power company which is not enough to electrify all room of house, the way they know the Rwanda rural electrification strategy is that though they have the system they have desire of using grid connection even if they are still poor as indicated in the table 4.12 and the distance between the grid connected are high as the told by interview with REG representative who said that among the condition to be required to ask grid connection people should be in 35 m from low voltage transmission lines and be able to pay transmission lines equipment's.

The finding are in agreement with Dufe E (2015) on her study on factors influencing accessibility of rural electrification in Kenya: a case of Naivasha constituency **s**he found that the peoples are aware that benefits of rural electrification range from lighting, access to information, improved study environment for school children as well as improved businesses which in turn create employment opportunities and contribute to development and poverty reduction.

4.4.4 Rural electrification strategy implementation, Pattern's and barriers

The finding in the table 4.32 and 4.33 of rural electrification strategy on grid and off grid PV solar implementation, barriers and sustainability shown that the respondents with on grid connection have the plan to extend use of electricity on the mean of 4 .0 and other majority wish to combine on grid connection and off grid connection with mean of 3.4 and less respondent want to shift to PV solar home system with mean of 1.9.The results of the respondents are in relation with interview from supplier companies representative and open question for respondents who said that the challenges the electricity have is the low voltage capacity of the electricity which cannot run a lot of high consumption appliances of electricity like refrigerators ,microwave, electric cookers, milling machine and the problem as indicated by REG representative will be solved depending on the installed

capacity of the country ,this also is in relevance to the fact that majority of rural population are poor and they cannot afford those appliances. The way that some which to combine use of on grid connection with off grid connection is results that the users of electricity sometimes have electricity shortage and they plan to be supplied by solar energy in this case of shortage also PV solar system they can help them to save electricity bill. In the interview with REG representative they highlighting that among challenges and barriers on electricity distribution is insufficient supply, house which are separated, stealing of transmission lines equipment like cables, erosion disaster which destroy infrastructures, the peoples which use inappropriate or inefficiency appliances like incandescent lamps, they said that for the poor peoples they are the method for long time payment of transmission cost of electricity by paying few money monthly in the time which can reach 10 years.

About those who use PV solar home system as shown in the table 4.33, majority want to combine PV solar home system with grid connection electricity with mean of 3.6 and standard deviation of 1.0, those who said that they have reliable source of electricity had mean of 3.2 with a standard deviation on respondents of 1.1, those who need to change the system had mean of 3.1 with high standard deviation of 1.2. Few respondents said that they have enough sources of the electricity. From the open question with the respondents, interview with REG representative PV suppliers companies, local leaders and direct observation the companies which operate in Busoro cell are loyal trust company which offer free PV solar for local health assistant ,Ignite power ltd, Mobisol, BBoxx, Zola ,Innotech, Nuru, Solar Kiosque ,and Dassy Enterprise, the payment method are dominated by monthly payment ,followed by direct and few fees payment from donors , according to interview with local leaders and REG representatives the peoples in Ubudehe one which should have got system for free are not yet received the system, the program started in Bushoki and base sector of Rulindo district supplied by ignite power company, they have hope that as soon as the government financial will be available they will receive the system .In interview also among the challenges or barriers in the program are the persons who steal the system equipment, The roofs of houses which are old and not sustainable, the some PV solar buyer who pay monthly the system and stop payment without finishing the price, mouse's which eat the cables ,and the smoke from burning wood which absorb the light from lamps.

For interview with local leaders they said that they are in the process of educating peoples to live in village where it will be easy to get government programs like water and electricity. The REG also said that the country are in process of increasing supply of

electricity both on grid and off grid, The PV solar system companies they are looking on how they can reach each area of the country and reducing PV solar cost, The government also through Rwanda Development Bank they are also planned program of sacco credit for the peoples who wish to buy PV solar system.

The finding are in agreement with finding by Forcano R ;(2003),in a similar study carried out in Chile who found that rural area are very unlikely to be reached by the extension of the electricity grid, due to remoteness and isolation of many rural communities and usually low demand for electricity, it is also in agreement with Urwego bank (2016) report which said that access to finance, high costs of financing, increased taxation, an unclear implementation of the RES and other policies, are among the problem faced by Rwandan off-grid solar market.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter present the conclusion, recommendation and area of future study on the topic relate to this, the recommendation are addressed to policy makers ,companies suppliers, households members and leaders to improve or accelerate rural electrification strategy in order to achieve government target of 100% peoples access in 2024 in sustainable way.

5.2Conclusion

The main objective of this study was to assess socio-economic impact of Rwanda rural electrification strategy on livelihood transformation a case study in Busoro cell of Rulindo district, based on the findings on the data collection using questionnaire, interview, and direct observation, it is evident that the rural electrification both on grid connection or off - grid connection transformed lives of Busoro cell Peoples. From general information in the study, respondents were dominated by the male with majority in the young ages less than 35 years. Their education was dominated by primary level, the house members of their families are the majority in the range between 2-7 members. The respondents' main roof tools were tiles with the majority of them having monthly income less than 100000Rwfs. The study found out that most dominate other energy for both target respondents were the wood products and for both the common appliances used were the lamps, phones, and radios, for PV solar home system owners majority got information from companies representative and they are paying the system them self. From almost all respondents they got the connection in the time less than 15 months which is the short time for full social economic exploitation of benefit of the program. From that information on the questions asked and others open questions, interview and direct observation ,the study found out that the program has the positive impact on educations, the students have enough time to study and using other electronic sources of knowledge, The people's health has been improved due to the fact that they are no longer use appliances which emit CO2 like candle and kerosene for lighting ,the information appliances helped them on exchanging information between them ,families, friends, and leaders. The security and entertainment also have been improved as result of electricity

This study showed that electricity has improved economic activities in Busoro cell livelihoods, this is shown by fact that the peoples work more hours ,the new business resulting for electricity, saving by lighting using electricity , however the study found that

rural electrification strategy in Busoro cell has neglecting Impact on agriculture for irrigation .

This study found that people are aware on use and interest on electricity for their household transformation this is shown on the way the peoples are buying the PV solar system and are planning for future use of electricity though they still have some challenges for proper use of electricity like availability capacity and electronic appliances.

This study looked at program implementation, barriers and sustainability of the program and found out that electricity rollout program connexion have Implemented in Busoro cell and 7 private PV solar suppliers companies are acting in Busoro cell especially in isolated area, the study revealed that they are some challenges like poverty of peoples, low voltage of electricity supplied and stealing the transmission equipment which affects the full livelihood transformation. The study by looking at awareness and acceptability of the program on the peoples and the way the peoples are planning for maximizing the benefit of rural electrification for their livelihood transformation predict sustainable program.

5.3 Recommendation

This study recommended the following recommendation for government, stakeholders, rural peoples and policymakers

- The government and entrepreneurs should decentralize general infrastructure for the wellbeing of peoples likes computer rooms and others technological appliances in order to facilitate rural peoples for maximizing the use of electricity for their livelihood transformation in the same time teaching them their working principles.

- The government leaders, suppliers companies, and stakeholders should work together in the implementation of rural electrification in order to accelerate the dissemination of the program and rural access to energy in a sustainable way.

- The supplier's companies and Rwanda energy group technicians should visit the beneficiaries frequently in order to get the challenges that they have and try to fix them and to improve the distribution method.

- The government should interdict of inappropriate or inefficient equipment in the use and transmission of electricity which can cause the incident in the same cases to rise the cost of electricity

- The government should strengthen the Housing in the village which will facilitate the isolated peoples to be closer with others so that the government program can be reached to them easily.

- The government should provide huge funds to support rural electrification program especially for poor peoples and facilitate suppliers companies for access to the loan in order to have enough and efficient product

5.4 Area of further Research

This study suggested the following topics should be addressed in further studies:

1. Assessment of rural electrification policies impact on access of electricity of the African countries

2. Comparative analysis of PV solar home system supplied by private suppliers companies in Rwanda

3. Assessment of the social economic impact of Rwanda rural electrification strategy in other parts of Rwanda

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APPENDICES

A. Questionnaires

1. Questionnaire of households connected to electricity

Dear Respondent,

The researcher is a Master student in Energy Policy at Pan African University; Institute of water and energy science Include climate change located at Tlemcen Algeria. This is purely an academic study on a topic, of 'Assessment of socio economic impact of Rwanda rural electrification strategy on livelihood Transformation case study in Busoro cell, Rulindo District'. You have been selected to participate in this study because of relevant information on this topic. The information you provide is solely for academic purposes and will be treated with utmost confidentiality. Kindly spare some of your valuable time to answer these questions by giving your views where necessary or ticking one of the alternatives given. Indeed your name may not be required. Thank you for your time and cooperation.

SECTION A: GENERAL INFORMATION

(Please tick the appropriate option)

1. Your sex: (a) Male (b) Female

2. Your age group: (a) 14 – 24 (b) 25 – 35 (c) 36 – 44 (d) 45 – 54 (e) 55and above

3. What is your highest level of education?

(a)Never been to school (b) Primary (c) Secondary (d) University

4. How many people live in this household? (a) 1 (b) 2-3 (c) 4-7 (d) More than 7

5. What is the materials from which your roof of your house is made from?

(a) Tiles (b) Iron sheets

6. What is the average monthly net income in Rwandan francs of the household?

(a)Less than 100000 (b) Over 100, 001

7. On average, how much do you pay for your electricity bill monthly?

(a) Less than Rwf 500 (b) Rwf 500-1000 (c) Rwf 1000-2000 (d) Over Rwf 2000

8. When was the electricity connected to your main house?

(a) Less than 5 month ago (b) 6-10 month ago (c) 11-15 month ago (d) 16-20 month ago (e) Over 20 month ago

9. What are the type of lamp do you use?

(a) Incandescent (b) Led (c) CFLs

10. What are other sources of energy do you use?

(a) Fire wood product (b) biogas (c) a and b

11. Tick all the appliances in your household that use electricity

(a)Bulbs, Cell phone and Radio

(b) Bulbs, Cell phone Radio and Television

(b) Others (refrigerators, iron, mills, cookers.)+1and2

Impact of Electricity and awareness

12. Using the scale below, rate how you feel electricity, has really been helpful to you and how do you know and your plan to use electricity in future?

5- Extremely a lot, 4- A lot, 3- Moderate, 2- Just a little, 1 Not at all

		5	4	3	2	1
	Socio impact					
	I know a lot happening around me and Government program because of listening to the radio and using phone.					
	There is more security in the village because of the lights					
	I am participating in the entertainment as results of electricity					
	My health have been improved due to the access to electricity					
	I am connected with friends and family by using phone					
	My children perform better in class because they have more time to read at home					
	Economic impact					
	I have new business as results of electricity					

	I work more hours because of electricity					
	I am saving much money by using electricity					
	Electricity helped youth and entire population to create their own business					
	Awareness					
	I know Rwanda rural electrification strategy					
	Electricity satisfies my energy Needs					
	I have better living condition than before electricity					
	I know electricity usage beyond lighting					
	Electricity is cheaper					
	Implementation					
	I want to shift to PV solar system					
	I have planned to extend use of electricity					
	I want to combine using grid and solar system					

Challenges and sustainability

Please answer the following questions

13. What are the challenges do you have in using electricity?

……..

……

……

……

14. Are there any improvement you feel, could be made to your electricity?

……..

……

……

15. Are there any negative things in regards to the electricity?

……

……

……..

16. What are your income generating activities resulting from electricity access?

……

……

……

17 What are your plan in regards to use of electricity?

……

……

Thank you for your cooperation

2. Questionnaire of Households with off grid PV home system

Dear Respondent,

The researcher is a Master student in Energy Policy at Pan African University; Institute of water and energy science including climate change at Tlemcen Algeria. This is purely an academic study on a topic, Assessment of socio economic impact of Rwanda rural electrification strategy on livelihood Transformation case study Busoro cell, Rulindo District, You have been selected to participate in this study because of relevant information on this topic. The information you provide is solely for academic purposes and will be treated with utmost confidentiality. Kindly spare some of your valuable time to answer these questions by giving your views where necessary or ticking one of the alternatives given. Indeed your name may not be required. Thank you for your time and cooperation.

General information

1. Your sex: (a) Male (b) Female

2. Your age group: (a) 14 – 24 (b) 25 – 35 (c) 36 – 46 (d) 47 – 57 (e) 58 and above

3. What is your highest level of education?

(a)Never been to school (b) Primary (c) Secondary (d) Post-secondary

4. How many people living in this household? (a) 1 (b) 2-3 (c) 4-7 (d) More than 7

5. What is the roof of your main household? (a)Tiles (b) Iron sheets (c) Grass

6. What is the average monthly net income in Rwandan francs of the household?

(a)Less than 100000 (e) Over 100000

7. What is the distance between household and grid connected household

(a)Less than 500metres (b) Less than 1 km but more than 500metres (c) 1-2km (d) 2-5km (e) More than 5km

8. What are other sources of energy do you use?

(a) Fire wood product (b) biogas (c) a and b

PV home system information

9. Where did you learn about PV solar?

(a) Friends (b) advitersiment (c) company representative (d) Local leaders

10. When was PV solar electricity connected to your main house?

(a) Less than 5 month ago (b) 6-10 month ago (c) 11-15 month ago

(d) 16-20 month ago (e) Over 20 month ago

11. On average, how much do you save monthly by lighting using PV solar compare to the time before?

(a) Less than Rwf 500 (b) Rwf 500-1000 (c) Rwf 1000-2000 (d) Over Rwf 2000

12. How have you got the PV system?

(a) Government / Ubudehe (b) self payment

13. PV solar System payment Method

(a)Direct (b) monthly c) bank loan

14. Tick all the appliances in your household that use PV solar electricity

(a) Lighting bulbs and phones

(b) Bulbs, phone and radio

(c) Bulbs, phones, radio and television

Benefits of PV

15. Using the scale below, rate how you feel PV has really been helpful to you and your view on PV solar? 5- Extremely a lot 4- A lot 3- Moderate 2- Just a little 1-Not at all

		5	4	3	2	1
	socio					
	I know a lot happening around me because of listening radio and using phone					
	My children perform better in class because they have more time to read at home					
	I have good health because of PV solar					
	I do entertainment as result of PV solar					
	economic					
	I save money as a result of using PV solar					
	My PV system helped my neighbour					
	I work more hours because of solar energy					
	My PV solar are not expansive					
	Awareness					
	I am satisfied by the system					
	I know other existing system					
	I know Rwanda rural electrification strategy					
	I feel that I am more developed					
	implementation					
	I know how PV works					
	My system is enough for energy need in household					
	I need to change system					
	I have a reliable source of lighting than being connected with electricity					
	I want to combine using grid connected and PV solar system					

16. Which company does it supply you the system?

……

……

17. Which Type of PV solar do you use?

……

……

18. What are the challenges do you face by using PV?

……

……

……..

19. Are there any improvements you feel could be made to your system?

……

……..

……..

20. Are there any negative things in regards to the system?

……

……

21. What are the suggestions would you like to give in the improvement of Solar system distribution?

……

……..

……

22. What are the services do you get after receiving the PV from PV supply?

……..

……

Thank you for taking time to respond to Questions

3. Questionnaire guide for interview with the supplier company

Rwanda energy group (REG)

How do you implement rural electrification strategy?

……

……

What are the people contribution or requirement to be connected?

……

What are REG plan on socio economic activities of household?

……..

What are the challenges in electricity Distribution?

……

…….

What is REG support for poor people to have access to the electricity?

……

……

Are there existing mini grid or construction plan in Busoro?

……

…..

Thank you for your cooperation

4. Questionnaire guide for interview with PV Supplier Company

What are the products offering and their price?

……..

What are the Payment methods?

…….

What is the product people are interested on?

…….

What are socio economic impact brought by the product supplied?

…….

How is your target and marketing plan?

……..

What are challenges are you facing in your business?

…….

How do you rate the awareness of people on your product?

……

Thank you for your cooperation

5. **Questionnaire guide for interview with Local leaders**

1. What are the social effects brought by rural electrification strategy for livelihood transformation in Busoro cell?

2. What are the economic effects and/ or activities brought by rural electrification strategy for livelihood transformation in Busoro cell?

3. Are any program for poor people to access to the electricity or system?

4. What are the views and plan of people for rural electrification strategy for livelihood transformation in Busoro cell?

5. What are the program implementation strategy, partners, barriers and its sustainability for livelihood transformation in Busoro cell?

9. What are the Busoro facilities connected by this program?

10. What are government action to accelerate the socio economic use of electricity?

Thank you for your cooperation

B: Table to Determining sample size from a given population by small sample Technique for Selection of Sample

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—N is population size.

S is sample size

Source: Krejcie, Robert V., Morgan and Daryle W, 1970

C. PHOTO PLATES

Photo plate 1Data collection in Busoro with household wife connected on grid

This picture show the way that collection was administrated

By filling house to house questionnaire, in this case I was with

On wife on her home filling questionnaire.

Photo plate 2Data collection with the young having shop

This picture show the collection data with young Boy beneficiary

By rural electrification strategy on grid connection in Gashubi center

By having new shop for retailing. Here he was responding on the questionnaire questions

Photo plate 3 Direct observation photo

This photo is from direct observation taken during night in Gashubi

Of Busoro cell when the peoples were watching world cup match

Which is the result of social effect of rural electrification livelihood transformation

Photo plate 4 Data collection from Owner of off grid PV system Women

This photo illustrate when I was conducting survey

With a Busoro woman having PV solar home system,

It is shown the radio, system lamp which is part of appliances using in her day live

C. Budget

NO	ITEM	Description	Cost in Dinars	Cost in RWF	Cost in USD
1	Travel Expenses	-Airplane ticket	88,847		838
		-Ticket from Kigali Airport - Jabana-Rulindo		69,660	81
		-Ticket from Rulindo-Jabana-Kigali international Airport		69,660	81
		-Data collection		602,000	700
2	Assistant	-Data collector		500,000	581
		-Data Entry		255,000	297
3	-Printing and Binding	-Questionnaires		185,640	216
		- Research Books		150,500	175
	-Research equipment's	-Pens+ Papers+ stapler+ clip fastener		26 ,660	31
Total					**3000**