IMPACT OF RURAL ELECTRIFICATION ON SOCIO-ECONOMIC DEVELOPMENT IN BUNYALA SUB-COUNTY, KENYA

BY

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DECLARATION

DECLARATION BY THE CANDIDATE

I declare that this research project is my original work and has not been presented in any other university for any other award.

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DEDICATION

I dedicate this work to my late mother Felista Owiji Ouma and my late sister Elizabeth Ngesa Ouma who inspired in life and my beloved children for having stood with me during my professional and academic studies.

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I commence by sincerely thanking the Almighty Allah for guiding me throughout this long journey. It is Him who granted me energy and good mental health to begin and to complete this task successfully. To Him be the glory and honor.

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ABSTRACT

The Government of Kenya established the rural electrification Program in 1973 for purposes of subsidizing electricity supply in the rural areas with a sole aim of improving the social and economic lives of people in rural areas. This study aimed to investigate the impact of rural electrification on socio-economic development in Bunyala Sub-County, Busia county, Kenya. The specific objectives of the study were to; to assess the effect of Rural Electrification Program on the income generating activities in Bunyala Sub-County, to evaluate the effect of Rural Electrification Program on health facilities and services in Bunyala Sub-County, to investigate the effect of Rural Electrification Program on Education sector in Bunyala Sub-County and to determine the effect of Rural electrification program on Energy sector in Bunyala Sub-County, Kenya. The study adopted correlational research design with a target population of 100 households connected through the rural electrification program. A self-designed questionnaire was used to collect quantitative data from the respondents with Likert type of questions to capture the demographic information and specific objectives of the study. Data was analyzed using both descriptive and inferential statistics. Descriptive statistics of means, standard deviation and percentage was used on raw data. The inferential statistic of linear regression was used. A computer package, Statistical Package for Social Science (SPSS) version 21 for window was used to do analysis. Majority (78%) of the respondents in Bunyala Sub-County reported to engaging in income generating activities like poultry farming, Fish preservation, shopkeeping, posh-milling due to rural electrification program. The study findings indicated that Majority (86%) of the respondents noted that rural electrification has led to development contributions to health sector in Bunyala Sub-County. The findings indicated statistically significant effect of rural electrification on health sector development (p-value 0.000< 0.05) in Bunyala Sub-County. Rural electrification was found to have a positive contribution to a unit change in health sector (β= 0.202). Similarly, the results indicated statistically significant effect of rural electrification on education sector developmental contributions (p-value 0.000< 0.05). The ANOVA results indicated that model 4 had an F-statistic value of 17.004 with the p-value of 0.000 hence the overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on energy consumption was rejected. The explanatory power of the model measured by coefficient of determination adjusted R-square was 0.826 implying that 82.6% of the income generating activities in Bunyala Sub-County are significantly explained by the inception of rural electrification through the REP. The study concluded that all models were statistically significant (p-value 0.000< 0.05) implying significant effect of rural electrification on , health sector, education sector, income generating activities and energy consumption in Bunyala Sub-County. The study findings are vital providing a basis for public policy evaluation and institution of policy changes by the Rural Electrification and Renewable Energy and the Kenyan Government and also indicates the local electricity consumption in the villages after the infrastructure set up of the rural electrification project. This provides proper feedback on the planning process for the rural electrification programs in the country.

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ACRONYMS AND ABBREVIATIONS

ADB: African Development Bank

CDF: Constituency Development Funds

ERC: Energy Regulatory Commission

GDP: Gross Domestic Product

GEF: Global Environment Facility

GE: Grid Electricity

GHG: Greenhouse Gases

GNESD: Global Network of Energy for Sustainable Development

GOK: Government of Kenya

HDI: Human Development Index

IAEA: International Atomic Energy Agency

IBRD: International Bank for Reconstruction and Development (World Bank)

SPSS : Statistical Package for Social Sciences

NACOSTI: National Commission for Science, Technology and Innovation

KTH: Kungliga Tekniska Hogskolan

PM: Per Cubic Meter

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Rural electrification is the process of bringing electrical power to rural and remote areas where electricity is a key component for development, and has a distinct positive effect on the quality of life, (Bensch, APA, 2011). The introduction of electricity results in an enhanced sense of security and longer hours of work, education and recreation. Subsequently, rural electrification not only enhances economic growth, but also opens lines of communication to local people and enhances their access to information with substantial social and educational benefits, (Bensch, APA, 2011). It is universally accepted that electrification enhances quality of life at the household level and stimulates economy at a broader level. The immediate benefit of electrification comes through improved lighting, which promotes extended hours of study and reading and other household chores, and in turn contributes to better educational achievements. Lighting can also benefit many other household activities, such as sewing by women, social gatherings after dark, and many others. Communication devices such as radios and television also improve the access to information by rural households and can provide entertainment to family members. In addition, household's economic activities both from inside and outside home benefit tremendously from electricity. For example, crop productivity can be increased by the application of electric irrigation pumps, businesses can be operated longer hours in the evening, electric tools and machinery can impart efficiency and production growth to industrial enterprises, and so on. The benefits of electricity have been discussed in a large body of literature (Cabraal and Barnes 2006;

Barnes APA, 2003; Kulkarni and Barnes, 2004; Khandker, 1996; Filmer and Pritchett, 1998; Roddis, 2000; World Bank, 2002; Agarwal, 2006).

Given its substantial benefits, electrification together with other sources of modern energy has been identified as essential in fulfilling the Millennium Development Goals (MDGs) (UNDP 2005). The World Bank views electrification as an integral part of development and has supported electrification projects in many developing countries. This study examines one such electrification project called Rural Electrification Program in Kenya with specific focus of Tala in Machakos County. Most of the electrification projects financed by the Bank in many developing countries often expand coverage of grid electrification with specific objectives in mind, for example, improving welfare such as income and education, establishing institutional mechanisms for rural electrification, providing inputs to power sector reform, formulating guidelines for tariffs, subsidies, and others. Among the multiple objectives, making a positive impact on the livelihood of rural people is the foremost.

Rural electrification (RE) in developing countries has been a subject of debate amongst the different stakeholders. The bone of contention lies between the high costs of RE programs on the one hand and the sluggish, non-monetary, yet significant, benefits on the other (Hannyika, 2005). As such, there have been two main ideologies in understanding the impacts of RE. One looks at RE with a dim light saying that the expectations are more and that the social benefit are not strong enough to dismiss the "rate of return" criteria in its evaluation (Pearce and Webb, 1987, Ranganathan, 1993). This ideology has been persistent even today as some experts still feel that RE has "drained" resources of

utilities (Barnes, 2005; Hourcade APA,, 1990). Others have argued for the numerous benefits expected from RE ranging from the stemming of rural-urban migration to bringing social equity. According to IEA and WB (2017), more than 1 billion people globally live without electricity access, and more than 3 billion are reliant on biomass to meet their household cooking needs. The problem is heavily concentrated in rural areas, where only 73 percent of people globally have access to electricity, compared to 96 percent in urban areas (IEA and WB 2017). Lack of electricity access is one component of energy poverty; the other is reliance on polluting fuels, such as firewood, dung, agricultural waste, or kerosene, to meet household energy needs (IEA 2011). The consequences of energy poverty are wide-ranging and multi-scalar (Jeuland and Pattanayak 2012) and include air quality and climate (Jetter APA, 2012), human health (Rückerl APA, 2011; Anderson APA, 2012; Adair-Rohani APA, 2016), productivity (Kammila APA, 2014), forest degradation (Hofstad APA, 2009; Köhlin APA, 2011; Pattanayak APA, 2004), and education (Khandker APA, 2012). Many of these burdens disproportionately fall on women and children, primarily girls (Adair-Rohani APA, 2016; Köhlin APA, 2011).

World Bank and KTH Royal and Institute of Technology (2017), extending electricity access to rural areas is an important part of ending energy poverty, and there is an increasingly diverse set of technologies available for rural electrification (RE). These include extension of the national grid as well as mini-grids and stand-alone. But simply extending electricity access does not guarantee that the negative consequences of energy poverty will be mitigated. In recent years, there have been multiple efforts to compile and

review electrification impact evaluations (Köhlin APA, 2015; Bonan APA, 2017; Peters and Sievert 2016). The 39 studies reviewed, published between 2004 and 2015, provide evidence that electricity access can lead to improvements in productivity, employment, labor, and/or income. There is weak evidence regarding the impacts of electrification on health and education outcomes, and impacts are highly context specific. On the other hand, in terms of productivity, we see positive effects from RE across the majority of contexts. RE have been evaluated for impact assessments based on the set objectives of such RE. Gaunt (2003), while using long planning horizons in evaluating RE infrastructure ,found out the following socio-economic factors; Health, Electrification addresses health impacts by reducing reliance on kerosene and biomass fuels which reduces indoor air pollution. Consider some examples. Electrification was seen to reduce the number of respiratory infections in children under six years of age because of reduced kerosene use and lower particulate matter concentrations in electrified households in El Salvador (Barron and Torero 2017). In another case, solar home systems were associated with improved health, particularly for women and girls in Bangladesh (Samad APA, 2013).

Education*;* Electrification can impact education because of increased time for studying and/or for more activity in general (as the "day" expands). Lipscomb APA, (2013) found that electrification at the county level led to improvements in both enrollment and literacy rates in Brazil. Khandker APA, (2012) find that household-level electrification led to increases in both completed years of schooling and daily study time in Bangladesh, with impacts almost twice as high for boys compared to girls. In the African context, studies

find an increase in study time *after* nightfall, but only in Senegal are researchers able to identify an increase in total study time (Peters and Sievert 2016). Household Productivity*:* Electrification can also impact employment, labor supply, income and other productive uses of energy (Köhlin APA, 2011, Bonan APA, 2017). Using panel data, Khandker APA, (2009a) find that electrification led to a twenty-five percent increase in household income in Vietnam, most of which came from increases in farm income. Dinkleman (2011) found positive impacts on female employment in South Africa, likely due to less time spent doing housework, but found no increase in wages due to no change in labor demand. Peters and Sievert (2016) find that electrification did not lead to increases in employment in Sub-Saharan African, and that households rarely use electric appliances for productive uses. In their review, they also fail to observe a shift in time use from household tasks to income earning activities in any of the African contexts they studied. They hypothesize that these effects are muted, relative to other contexts, due to lack of market connectivity, i.e., new firms will not take hold because they cannot access markets for their goods. In the few contexts where they do find positive effects on new enterprise (Rwanda and Benin), these effects are observed in business centers with established market connections.

Firm Productivity; At the community level, electrification can promote the growth of energy-intensive enterprises and bring about increases in labor demand and wage-earning opportunities (Figure A1). A small set of studies that assess the impact of electrification on firms find positive impacts on (i) the quantity and diversity of firms and (ii) output (Rud 2012; Peters APA, 2011). Others find that unreliable electricity has negative effects

on firms' productivity and revenue (Allcott APA, 2016; Fisher-Vanden APA, 2012; Reinikka and Svensson 2002). Local Environment**;** only one of the three reviews considers local environmental outcomes, such as fuelwood extraction, and that review finds very few studies that focus explicitly on environmental outcomes (Köhlin APA, 2015). For example, a study of electrification via solar photovoltaic panels in Peru found that households with solar PV spent less on firewood, but this does not necessarily mean a reduction in amount of firewood consumed, as many households also collect firewood (Arráiz and Calero 2015).

The impact evaluations reviewed above conduct simple, "back of the envelope" calculations to compare their identified impacts to the costs of rural electrification. Khandker APA, (2009a) show that the present value of monthly benefits from improved income [$18.90 per household per month] were almost four times greater than the costs of grid extension and household connection, and the marginal costs of generation and transmission in Vietnam. Khandker APA, (2009b) identified similar results in Bangladesh, estimating a per household electrification cost of $4.50 per month and comparing it to the income gain from grid connection, which was $12 per month. This value understates the full benefits for health and education, for example. With respect to off-grid solutions in Bangladesh, Khandker APA, (2014) find that household benefits from reduced kerosene consumption and increased income are 500 percent higher than the cost of the solar home system. In their preceding impact analysis, the authors identify impacts on health and time use, but they do not include these as benefits categories in their CBA.

In Bangladesh, before the liberation in 1971, there existed little facilities created for the rural people. Virtually, government had little opportunities for expansion of the distribution network in a massive scale. In 1972, Rural Electrification Directorate (under Power Development Board) was established to gear up efforts towards formation of a separate body responsible for electrifying rural areas. As a result, Rural Electrification Board was formed to take up efforts at bringing down changes in rural living patterns. The program has brought light to many families, hitherto remaining in complete darkness. It has given them the enlightenment towards modern living, freedom from poverty, malnutrition and hunger. Electricity has brought many families close to the rural homes. Some of them are thinking of taking new initiatives in industrial and agricultural sectors. Rural Electric societies have provided jobs to rural families/youths. In addition, a total of 5,800 persons are employed in the construction firms and consulting offices working for the program. Rural people now have much better work-habits and an improved sense of discipline and social security, which came as a result of the assurances of basic amenities in life. Literacy rate in the rural areas has increased significantly due to the expansion of mass education program.

In Philippines, the most data-intensive investigation so far of development impacts from energy provision (ESMAP, 2002a). The study is built on survey data from questionnaire-based interviews with 500 households in each of four provinces in the Philippines. The survey covered attitudes as well as quantitative measurements, and the authors identified both quantitative and qualitative benefits so as to present a fuller picture of how

electrification affects rural households and areas. The benefits which the study sets out to investigate, i.e., goods and services into which electricity is assumed to be a key input, are: education, health, entertainment and communication, comfort and protection, convenience, and productivity in home businesses and agriculture (DEA, 2007). With respect to education, attitudes among both electrified and non-electrified households were measured with several questions. These respondents expressed strong favour of electrification as important in children's education, in the children's studying at night, as well as in facilitating reading in the home at night. Still, many households claimed that television takes away study time from children and thus is a negative impact of electrification. Multivariate analyses showed that having access to electricity reduced the probability of children studying at night, when controlling for covariates of electrification, such as parents' education, earnings, and aspirations for the children, as well as children's employment status and the building materials of the home. However, once at study, children in electrified homes read for a longer time. Also, adults in electrified homes tended to read more, with similar controls in multivariate analysis.

According to Abdalla, (2005), industrialized countries and rich developing countries have electricity access to their rural populations at nearly 100%, the access in rural parts of poor countries is to a large extent below 10%. A great deal of effort to improve the level of access is being made but the impact of the efforts is still minimal. Kenya is not an exception in facing energy dilemma just like most countries in Sub-Saharan Africa (SSA), one of the key obstacles to the shift to modern energy consumption is the limited access to electricity for households, particularly in the rural areas. The overall

electrification rates in SSA stand at 23%, with the urban and rural area figures standing at 51% and 8% respectively (International Energy Agency (IEA), 2002). However, Kenya has electrification rates below the SSA average with 14% overall connection and a breakdown of 42% and 4% for urban and rural areas respectively (Kenya National Bureau of Statistics (KNBS), 2000). One reason for this low level of electrification in rural areas is the lack of available finance to cover capital and operating costs for generation, transmission and distribution of electricity, which are higher than in urban areas. The high connection costs coupled with low consumption of electricity and low incomes among rural households are further obstacles to the electrification of these households. Most rural households consume traditional energy sources derived from wood fuel, charcoal, agricultural residues and cow dung. In fact, the dominant energy source for non-electrified households in Kenya is primarily wood fuel and charcoal. Wood fuel provides 70% of the energy for all sectors in the country, except for the transport and commercial sector. Its use is common among households in rural areas, because it is relatively cheap and widely available and in fact 80% of these households consume this type of fuel. The impact of these traditional fuels on rural households includes adverse effects, such as: indoor air pollution (IAP), poor lighting and deteriorating environmental and economic well-being.

There have been various policy programs set up by the government and other relevant institutions, such as the Kenya Power and Lighting Company Plc., to increase rural electrification. One of the major areas has been the rural electrification program (REP) established in the early 1970's. The REP funds are obtained from a 5% levy, namely the

rural electrification program levy fund (REPLF), which is charged to all electricity users nationwide. The REPLF is one of seven decentralized operational funds in Kenya aimed at alleviating socio-economic disparities at the local level. The major aims of REP are to make electricity connection easier, affordable and faster (KPLC, 2006). In Kenya the REP cost has been estimated to be between US¢ 30 to US¢ 40 per kWh, compared with an amortized life-cycle cost of US$ 1 to US$ 2 per kWh for solar and battery-operated systems (Jacobson, 2005). According to the World Bank (1995), only 10 to 50% of the economic cost of REPs is recovered from the users; thus, these programs have to be heavily subsidized by urban industrial users or by the government. About 60% of the REPLF finances new grid-extensions, with the rest being spent on operation and maintenance. Kenya's REP has been handicapped by financial burdens (Kenya Integrated Household Budget Survey (KIHBS), 2007). According to Eberhard and Gratwick (2005) the greatest challenge for energy market in Kenya is the sustainable balance between investment and supply. Investment through greater involvement of new providers including the private sector is an arduous task. In the case of Kenya, privatization of the electricity sector is still embryonic and more has to be done to improve the reform efforts, (Abdullah and Markandya, 2007).

The Rural Electrification and Renewable energy was established under Section 66 of the Energy Act, 2006 (No 12 of 2006) as a body corporate. It was created in order to accelerate the pace of rural electrification in the country, a function which was previously undertaken by the Ministry of Energy. Its mandate is to accelerate the pace of rural electrification in order to promote sustainable socio-economic development. It is

specifically supposed to manage the Rural /electrification Program Fund, develop and update the rural electrification master plan, promote the use of renewable energy sources including small hydro-power, wind, solar, biomass, geothermal, hybrid systems and oil fired components taking into account specific needs of certain areas including the potential for using electricity for irrigation and in support of off-farm income generating activities, implementation and sourcing of additional funds for the rural electrification program and management of the delineation, tendering and award of contracts for license and permits for rural electrification (REA, 2012).

1.2 Statement of the Problem

Rural electrification has been the cornerstone of rural energy strategies in developing countries. It is also a source of controversy among development analysts. Advocates of rural electrification claim that it has major impacts on agricultural and industrial productivity, reduces rural-urban migration, creates more jobs and significantly raises the overall quality of life in rural areas. Critics claim that rural electrification may not have the hoped-for effects on social and economic life and in its unequal incidence could contribute to social tension. Rural Electrification Programs have been undertaken in many parts of Kenya for many years. However, the socio-economic impacts of the program on the intended beneficiaries and stake holders appear to be minimal with continued economic poverty, low income and seemly unchanged social economic life of the rural inhabitants especially in Bunyala Sub-County. This study seeks to evaluate and assess the social economic and political impact of the Rural Electrification Program in Bunyala Sub-County, Busia county. Rural electrification is a very important process to

provide access to modern energy, especially to the poor people in developing countries like Kenya.

The United Nations has established the positive relationship between per capital energy consumption and the human development index (HDI) of many countries and there is empirical evidence to show that access to modern energy and human development are closely linked. (IEA, UNDP, 2005). In Kenya, the government through the Ministry of Energy formed the Rural Electrification and Renewable energy which is fully funded by the government of Kenya. The mandate of the rural electrification and renewable energy is to implement rural electrification. The programs focus on providing development assistance through the supply of electricity services to stimulate economic productivity and enhance the society of life in rural areas. These projects currently do not start with an assessment of the needs of the people they are meant to serve. They often fail to evaluate specific impacts resulting from these services on the target populations. The rural electricity evaluation programs at present are confirmed to measure only qualifiedly variables such as number of households electrified. They are not designed to measure social development effects. This incomplete understanding of the program impacts on members of the target community hinders the development of initiatives that respond to rural needs and have positive equitable and sustainable socioeconomic development impacts. Most studies on rural electrification are qualitative in nature. Literature has not used any special index to capture the effects of rural electrification. Studies by Abdalla (2005), Abdullah and Markandya (2007) have dwelt on the levels of accessibility and the benefits thereof. Attempts to segregate the impact of other social amenities from

electrification in assessing the social and economic effects has been a challenge to many researchers. As such the credibility of exposing rural electrification as a main benefactor of rural socio-economic progress remains questionable. This study seeks to fill the research gap in knowledge and determine the socio-economic effect of rural electrification in Bunyala Sub-County, Busia County, Kenya.

1.3 Objectives of the Study

The broad objective of the study was to establish the economic and social impacts of Rural Electrification Program in Bunyala Sub-County. The specific objectives of the study were to:

i. To assess the impact of Rural Electrification Program on the Economic sector in Bunyala Sub-County, Kenya.
ii. To evaluate the impact of Rural Electrification Program on health sector in Bunyala Sub-County, Kenya.
iii. To investigate the impact of Rural Electrification Program on Education sector in Bunyala Sub-County, Kenya.
iv. To determine the impact of Rural electrification program on Energy sector in Bunyala Sub-County, Kenya.

1.4 Research Hypotheses

The study was guided by the following hypotheses:

$H0_1$: There is no statistically significant impact of rural electrification programs on Economic sector in Bunyala Sub-County, Busia County, Kenya.

$H0_2$: There is no statistically significant impact of rural electrification programs on Health sector in Bunyala Sub-County, Busia County, Kenya.

$H0_3$: There is no statistically significant impact of rural electrification programs on Education sector in Bunyala Sub-County, Busia County, Kenya.

$H0_4$: There is no statistically significant impact of rural electrification programs on Energy sector in Bunyala Sub-County, Busia County, Kenya.

1.5 Significance of the Study

The study findings are vital providing a basis for public policy evaluation and institution of policy changes by the Rural Electrification and Renewable energy and the Kenyan Government. The data generated was valuable to public administration in the Sub-County and can assist in making decisions concerning poverty eradication efforts in the Sub-County especially on public resource allocation. Similarly, findings drawn are important to other stakeholder like development partners, ie World Bank, Danida, Spanish Government, and AFDB etc who funds Rural Electrification Projects in the country through direct funding certain project through Rural Electrification and Renewable energy. E.g, Installation of solar power system at Murijo Boarding primary school in Samburu west. The planners will also benefit from this study in its annual planning, allocation of resources and evaluation of income per capita of Bunyala Sub-County and the people of Bunyala. This is the first research study on rural electrification and its impact on the people of Bunyala Sub-County where conclusions drawn on social

transformation on the people helps the government in planning on distribution of social-amenities in the study area.

This study is also significant to the Kenyan government. It reveals the local electricity consumption in the villages after the infrastructure set up of the rural electrification project. This provides proper feedback on the planning process for the rural electrification programs in the country. It is also important to the researchers and academicians as it will be a useful guide for future researchers interested in undertaking a study on the socio-economic effects of rural electrification in other parts of Kenya. The findings from the study are of great benefits to the project planners and implementers. Project planners takes special interest in how electrification serves as a main project driver in implementing development projects as well as livelihood projects that target rural communities.

1.6 Scope of the Study

This study examined the socio-economic impact of rural electrification program in Bunyala Sub-County. The study involved fishermen, farmers, entrepreneurs, school management, health facilities and households to gather information regarding the socio-economic effects of REP. The study focused on determining the impact of REP on education sector, health sector, income generating activities and energy sector in Bunyala Sub-County.

1.7 Limitations of the Study

The following were the limitations of the study.

i. This study was limited to evaluate the impact of the Rural Electrification Program on socio- economic development in Bunyala Sub-County as perceived by the actual program beneficiaries including public and private learning institutions, medical institution, county government market, fish landing beaches and business community in the area. The study was concentrated in Bunyala Sub-County in the wider Busia County administrative unit.

ii. Due to the sensitivity of some questions in the questionnaire, some of the limitations encountered include the unwillingness of some respondents to respond to some questions. To overcome this problem, the research assistants were trained well and were hailing from the respective villages and the research team was also part of it.

iii. Some questionnaires were translated into the local dialect a challenge that some of the translators could not translate the technical terms into the local language. However, the research team included research assistants who hailed from the community who made correct interpretations of the questions to the respondents.

iv. Since the area is flood prone, the research assistants had to use canoes to reach schools, hospitals, fish landing beaches and irrigation scheme. They had a very difficult time since some feared boarding the boats.

1.8 Assumptions of the Study

The study was based on the following assumptions

i. This study was conducted with the assumption that the Rural Electrification Program is long-term Government program that seeks among other objectives to

improve socio economic status of the residents of Bunyala Sub-County. Electrification is undertaken in the pre-planned places with fully funding from the Government of Kenya, CDF and other development partners like World Bank, Spanish Government and Swedish Government.

ii. Another assumption of the study is that program implementation recorded from Rural Electrification and Renewable energy is available and will be assessed by the researcher

iii. It was assumed that the data collection instruments would have the construct validity meaning that both content and predictor validity would be realized in order to draw findings that are logical indeed.

iv. It was assumed that the respondents in the study would respond to the questions. It was assumed that they would demonstrate requisite threshold of skills, knowledge and favorable attitude to truthfully respond to the questions in the instruments.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examines various areas of information on rural electrification using thematic approaches and chronology. The literature on rural electrification encompasses issues on access and affordability; success stories and problems; institutional dimensions; subsidies; social, economic and environmental impacts; project planning, design and implementation; and more recently on the energy, poverty and gender nexus. It also highlights some of the important issues discussed in various international forum, journals and books that the study finds relevant to the objectives.

2.2 Rural Electrification

Access to modern forms of energy in general and electricity in particular to the poor, especially in developing countries has gained considerable attention. Rural electrification is well recognized as one of the important pre-requisites in uplifting living standards of the geographically and economically disadvantaged communities in developing countries. More studies since the late 1970's have begun and are still continuing. Approximately 1% of the rural populace in Kenya have access to electricity, implying that very few households for the poor are electrified. This ratio seems to have stalled over the past few years. This demonstrates key shortfalls in the provision of electricity to the poor. First, the amended Electricity Act of Kenya does not sufficiently address the issue of the electrification of the poor. Reports from the utilities, Ministry of Energy and the regulatory agency make no attempt to track electrification of the poor, (Karekezi APA, 2011). Secondly, power sector reforms show no discernable impact on the poor and, if

any, it appears negative. Reforms have led to increased electricity tariffs and as a result have made electricity costly for the poor. In normal circumstances, subsidies should be provided to the poor to cushion them from the impacts of the high tariff increases triggered by reforms. However, available data on subsidies indicates that the non-poor are absorbing the bulk of the subsidies, (Karekezi APA, 2011).

Fluitman (1994) argued that most of the existing impact studies were of a descriptive nature and he concluded that "costs it appears, becomes trivial compared to the happiness of a villager who can see (an electric) light at the end of the poverty tunnel". Gaunt's (2003) suggests that with the ethics behind international aid only social objectives are valid to carry out Rural Electrification in developing countries. Cecelski (2000) and Zomers (2003) found it difficult to quantify and segregate the improvement in the general well-being of the people as a result of electrification. Foley [1992] goes to the extent of saying "in some cases, development had occurred without rural electrification". For a particular case of Bangladesh, Zomers (2001) and Barkat (2002) agree that, where, in addition to electrification, other infrastructure such as roads, health services and educational facilities are developed, the economic effects are greater.

Ranganathan (2000) pointed out that post electrification studies have criticized RE programs for not meeting its anticipated effects, for over-emphasizing the social benefits and for being too expensive. The study considered RE to be a merit good where the positive externalities are not internalized as part of an infrastructure besides being a commodity and a production input. As such the return on investment (ROI) criterion may not be appropriate to be the only yardstick in judging an RE program's success. He states

that the developing countries' governments want to subsidize RE at the utilities' costs. The study argues that electricity cannot cause development unless it is used and that there are complementary inputs as well. In Thailand, Yang, [2018] the net present value of an RE projects financial analysis was negative but its economic analysis showed an internal rate of return of 12.5%. In Kenya, electrification has not development in rural area without other complimentary input like road infrastructure roads, micro finance institution, setting up higher learning institution on rural area, coming up with conducive environment for investor like security, tax holiday, conducive environment to get business license and work permit for foreign investors among others.

Karekezi APA, (2011) recommends that other countries in the sub-region whose reforms are not at advanced stages (e.g., Ethiopia and Tanzania) should ensure that they establish structures and mechanisms for increased rural electrification before embarking on large-scale market-oriented reforms such as privatization. Evidence from other developing countries indicates that high rural electrification levels have been achieved when rural electrification initiatives precede the privatization process. In case of my study, it has been achieve as result GoK allocating more funds in the annual budget, and also when members of parliament allocates fund from CDF to finance RE. Reforms should adopt innovative approaches to promote increased electrification. One approach could be making electrification targets a pre-requisite for the purchase of attractive distribution rights. For example, the purchase of attractive city distribution rights can be linked to the mandatory electrification of low-income urban settlements as well as selected rural areas. This will ensure that private investors are simply not cherry-picking the most profitable

portions of the electricity industry and leaving the unprofitable portion (e.g., rural electrification) to the state. Another measure for ensuring that reforms support the electrification of the poor would be to ascertain that a significant proportion of the proceeds from license fees, concession fees and sale of utility assets directly contribute to the Rural Electrification Fund.

2.2.1 Benefits of Health Sector from electrification in Rural Areas

According to Hutton (2006), health sector benefits from RE operates through a number of channels like, improvements to health facilities, better health from cleaner air as households reduce use of polluting fuels for cooking, lighting, and heating improved health knowledge through increased access to television and better nutrition from improved knowledge and storage facilities from refrigeration. Each of these benefits is explored here. The findings support the view that there are health benefits from RE, including fertility reduction but the survey instruments were not designed with the intention of examining these issues and so should be seen as suggestive; further research and evaluations are needed to strengthen the evidence base.

A review of existing studies showed that exposure to indoor cooking using traditional methods increased the risk of premature death by a factor between two and five. These diseases caused by indoor air pollution cause between 1.6 and 2 million excess deaths each year, 5 more than half of them among children younger than five. This figure accounts for 2.7 percent of the global burden of disease. There is also a fire risk. In

addition, fuel collection imposes a costly time burden of up to 8 hours a week, once again usually mainly on women.

In principle, RE can tackle both of these issues, promoting better health through reduced indoor air pollution and reducing the time burden on women of fuel collection. However, in practice, these benefits have been little realized because electricity is largely not used for cooking in rural areas. But improvements in indoor air quality can also come about through changes in lighting source. Kerosene lamps emit particles that cause air pollution; these are measured by the concentration of the smallest particles per cubic meter (PM10). Burning a litre of kerosene emits PM51 micrograms per hour, which is just above the World Health Organization 24-hour mean standard of PM10 of 50 micrograms per cubic meter. But these particles do not disperse, so burning a lamp for four hours can result in concentrations several times the World Health Organization standard.

The extra risk of respiratory sickness from exposure to these levels of PM10 is captured in the hazard ratio (the relative probability of the exposed versus unexposed being sick), which is 3.5. Lost adult work days average 3 per year, and the additional under-five mortality is 2.2 per 1,000. So, substituting electric lighting for kerosene lamps has a quantifiable health benefit of $2.50 per household. The health risks from candles have only recently been appreciated, since a 2021 Australian study showed that the lead used in candle wicks results in air lead concentrations at levels far in excess of established safety standards. Burning a candle for a few hours in an enclosed room results in lead

concentrations sufficient to cause fetal damage or to harm the mental development of children. Since the Australian study was done, many developed countries have banned the use of lead in wicks, but these bans do not affect candles made for developing county markets. However, candles are not used for lighting that much. They do have non-lighting uses, such as for ceremonial purposes— but these are not affected by electrification, so these effects are not captured in this study.

Electrification can affect time use in a variety of ways: watching TV, greater participation in community activities and socializing, reducing time spent on household work or shifting it to the evening, increasing time spent reading or—for children—doing homework, and extending hours of home businesses. These additional activities are made possible by the longer working hours electricity makes possible, with households reporting they stay up, on average, an additional one to two hours. The main use of this additional time is watching TV; indeed, time spent watching TV is greater than the increased time available, suggesting that it cuts into other activities. One such activity is reduced time on housework—the Philippines study found that women spent one hour less on such tasks as a result of electrification. But other studies have suggested that women's work burden can actually increase, as household activities can be carried out in the evening, allowing more working hours on other activities. Indeed, the latter may be one explanation for increased business hours, which are found in IEG's analysis of data from Ghana and the Philippines.

Lack of access of electricity is one of the major impediments to growth and development in rural economies in developing countries. That is why access to modern energy, in particular to electricity has been one of the priority themes of many countries. A few countries are considered, that is, India, Bangladesh, Phillipines and Zimbabwe. The cases of the social effects globally point to how rural electrification has transformed lives. India has experienced rapid economic growth over the past decade, with an expanding middle class larger than the population of the United States. In 2000, the population grew at a rate of over 6 per cent, which required a rate of 9 per cent of energy growth. In the past 20 years alone, urbanization has driven a 208% growth in India's energy consumption. Under these conditions, it is imperative that India meets its growing energy necessities in a self-reliant, sustainable manner. However, providing 1 billion plus people with a constant energy supply is very difficult, especially for a developing country facing rising gas prices. Inclusive growth starts with providing energy access to the most disadvantaged and remote communities.

2.2.2 Rural electrification and Education Sector

The main channels through which electrification may affect education are; improving the quality of schools, either through the provision of electricity-dependent equipment, or increasing teacher quantity and quality and time allocation at home, with increased study time, though the availability of TV may decrease that time (but at the same time it may also possibly provide educational benefits). Children in electrified households have higher education levels than those without electricity. The ESMAP Philippines study (ESMAP 2003) finds almost a two-year difference (8.5 versus 6.7 years). However, this

is a single difference estimate that does not allow for other factors such as parental education, household income, and school facilities. But IEG's analysis of DHS data for nine countries also found that electricity has a direct impact on rural education once these factors are controlled for. In low-income countries rural schools often lack basic equipment, such as furniture and adequate textbooks—the presence of electricity does not affect these important constraints. The failure of teachers to take up posts in remote locations and frequent absenteeism from such postings are problems in many countries, and the evidence presented in the last chapter, albeit for just one country, supports the argument that the availability of electricity makes rural positions more attractive to teachers. This is thus one possible reason for the higher education levels, with improved school quality encouraging students to stay on longer or enabling them to do so as their grades improve from better teaching. The other possible explanation is that increased study time at home results in better grades, so children stay in school longer. There is indeed evidence that electricity increases study time (by approximately an hour an evening in the case of the Philippines, but no study follows the causal chain through to improved results and higher educational attainment.

2.2.2 Rural electrification and Income generating activities

Empirical studies and intuitive appeal highlight the role of energy in economic development. The International Energy Agency has underscored the high correlation between access to energy and development (Silva and Nakata, 2009). Over 2 billion people all over the world live with no electricity and they continue to subsist below the poverty line (UNDP cited in Haayika, 2006). In cognizance of this, rural electrification has been a government priority for two decades so much so that the Philippines has

finally achieved 100% electrification of the 41,980 barangays or villages in 2009. To accomplish this, the government has had to mobilize a lot of multi- and bilateral support as well as programs from the major IPPs operating in the Philippines (Anonuevo, 2009). According to the National Electrification Authority, the government has spent pp (Philippine peso) 49.3 billion (US$ 1 billion) or pp2 million for each barangay from 2001 to 2009. Of that amount, 37.64 billion came from loans and pp11.68 billion from subsidies (Anonuevo, 2009). Historically, a great majority of the new barangays were connected via line extensions from the existing distribution network. Under this approach, last mile connections became harder and harder to reach. Moreover, as the lines became extended longer and longer, quality became problematic. Increasing losses and subsidies limited what could be achieved. Under this metric, only the existence of a tapping point within the barangay was recorded, while utilization and the number of actual household connections were ignored. Similar to the dissonance noted in the impressive GDP growth, full electrification of the barangays did not impact on poverty incidence mitigation. Clearly, a more pro-active stance on providing electricity is needed. In 2003, ADB commissioned a study to find out why some "New and Renewable Energy" (NRE) projects failed to achieve their desired objectives. Among the areas that need attention include lack of stakeholder mobilization and beneficiary participation, institutional problems, including unsuitable management practices, technical problems, including lack of spare parts for operation and maintenance and use of obsolete technologies, financial problems, such as high initial and maintenance costs, or high tariffs for consumers.

The general impact on industrialization is measured in terms of growth of industrial activity, productivity and employment in the rural community. The impact of rural electrification on these non-agricultural activities was found to be positive but weak by some studies (Samanta and Sunderama, 1983; Herrin, 1983; Djeflat, (1985) and substantial in others (Barkat APA, 2002]. The level of industrialization in electrified but has improved. Area like Narok, Kajiado, Nandi, in Kenya can now store their milk in cold house before selling or packaging for sale. In central Kenya and Kericho, Nandi, tea and coffee factories have been set up as result of electrification. In Bunyala Sub-County, fish cold house has been put up at Marenga beach to store fish from the fishermen. Bunyala irrigation scheme has been put up to grow and process rice before its sold as result of electricity.

Lim (1984) argues that the poor economic returns of rural electrification in Malaysia could possibly improve when other socio-economic inputs to rural development were also provided. In USA, rural electrification in the 1930's was expected to improve the economic competitiveness of farm families, but unfortunately it was not enough (Yang, 2018). Fluitman (1994) mentions that the benefits of extending the grid tend to be overestimated and the costs understated. The study did not find much evidence to suggest that electricity, which could be used for productive purposes, had any major beneficial impact on the income generation or employment of the rural poor. On the contrary, with the "partial and patchy empirical evidence", he says that, there is some indication of net job losses and of worsening income distribution as a result of rural electrification. This, it is further stated, is not to suggest that rural electrification should not be promoted but that

there is a need for a more judicious planning and evaluation of such programs. Rural electrification may not gap the income disparity if most of the people cannot afford to use it. Only as income rises, the type of fuel used also shifts towards electricity. A survey conducted in South Africa deduces that the energy transition theory is mostly driven by income rather than the access to electricity (David, 1998). Fuel switching towards electricity, the study found out, was evident in a substantial way in wealthier households and electricity substituted other fuels in only a few households. In the middle- and low-income households, electricity appeared to be more of an additional energy source rather than a replacement for other fuels.

Barnes (2004) suggests additional intervention to assist the rural people gain the benefits by helping them consume more energy. He tries to explore ways and means by which the viability of rural electrification could be enhanced. Costs of wiring, lack of credit were some reasons why households in electrified villages remained un-electrified. He suggests introducing credit and loan promotion schemes as part of the rural electrification project. Other areas to enhance the impact is to introduce social infrastructure and community street lighting, electrifying public buildings, functions like vocational training, adult literacy campaigns. Zomers (2003) points out those criteria for decision making as to whether a rural electrification project should be implemented have changed. He says that growing environmental concerns are also playing key roles in rural electrification decisions. Fluitman (1983) concluded that the economic and environmental benefits of rural electrification tend to be overestimated and the costs understated. Many other

studies (World Bank, 2003; DFID, 2002) express the need to assess the externalities in rural electrification programs.

2.2.4 Rural electrification, Poverty reduction and Human development

About 40% of the populations in the electrified households are below absolute poverty line. The corresponding figures for the population in non-electrified households of electrified villages is 51%, and that for the population of non-electrified villages is 43.4%. Compared to the national level of absolute poverty (44.3%) the electrified household's level is 11% less implying that electricity has contribution in poverty reduction. Like absolute poverty, the hard-core poverty was also most prominent among population in the non-electrified households in the electrified villages (27.1%). In the electrified households, 21.8% of the population were found below the hard-core poverty line. The corresponding value for the population in the non-electrified villages was 23.1%. The incidence of cost-of-basic needs (CBN) poverty shows that both the lower and upper poverty lines are much less pronounced for the electrified households than the non-electrified households. The high incidence of both lower and upper poverty among the population of non-electrified households, and high gaps in those incidences between the electrified and non-electrified households with electrified households showing the least incidences (51% less in lower poverty line and 37% less in upper poverty line) signify that access to electricity in the poor households (not in the villages only) had much impact in poverty reduction. Thus, ensuring poor people's (households) access to electricity should be assigned with high priority in any future poverty reduction strategy for the rural Bangladesh.

In Kenya, indeed the population in the electrified household like Westland, Karen, Lavington, Kilimani etc are above absolute poverty line compared to population of non-electrification like Mukuru kwa Njenga, Mathare, Kibera are below poverty line. And this is same with non-electrified areas in rural Kenya. In terms of incidence of poverty, one of the most interesting findings was the positive relationship between the age length of electricity in the household and the declining incidence of absolute poverty. 42.4% population in the households with 3 years of age-length of electrification are poor (below absolute poverty line), which drops down to 37.1% if the household age-length of electrification is 4-5 years, and further falls down to 33.9% if household's electrification age is 6 years. This is quite a revealing finding, which shows show that electricity influences poverty reduction, overtime, with a gestation period. Human Development Index (HDI) values obtained for electrified household is 0.642, for non-electrified households in the electrified villages is 0.440, and for non-electrified households in the non-electrified villages is 0.436. Based on the analysis of HDI of 3 categories of sample households, the following inferences are in order: The HDI for electrified households (HE) 0.642 is substantially higher than the overall HDI of Bangladesh (0.478). The electrified households' HDI corresponds to the lower-mid-level index for medium HDI countries. This implies that, by ensuring 100% access to household electricity in the rural areas, Bangladesh may raise its HDI ranking substantially from current 145^{th} position to a position of around 100 (corresponding to the ranking of such countries as Egypt, Bolivia, Indonesia, Honduras). Thus, electricity's potential impact on enhancement of national HDI could be very significant.

Even the non-electrified households in the electrified villages (WE-EV), which are predominantly poor, represents an HDI almost similar to that of the Bangladesh country average. The former category's HDI value is even higher than the households in the non-electrified villages (which are economically better off than the non-electrified households in electrified villages). This implies that, HDI increases with the village level electrification even when household's access to electricity is denied. This, as found in the survey, is most likely influenced by the relatively low infant mortality rates and higher combined gross enrolment. The differences in HDI values between the electrified HHs and the non-electrified households in the electrified villages is 45.9%; between the non-electrified households in the electrified villages and the non-electrified villages is less than 1%, and that between the electrified households and the households in the non-electrified villages is 47.2%. This implies that, provisioning of access to electricity for the non-electrified households will have spectacular impact in raising HDI in Bangladesh. Thus, village electrification without electrifying the households will have not much effect on improving human development and increasing HDI values. Or, in other words, universal rural household electrification will have spectacular impact on human development in rural Bangladesh

2.3 Empirical Literature

Literature in this arena suggests that infrastructure will interact with physical characteristics to affect the comparative advantage of a region. Investing in electricity to help disadvantaged regions could change characteristics in order that these areas could integrate with more prosperous parts of the economy. Evidence from the transport sector

can be used to illustrate the point. Improved infrastructure in a poorer area may remove a natural trade barrier that was protecting a local industry and lead to a higher concentration of employment in a more successful region. In this way access to electricity in an underdeveloped area could lead to the inward migration of new enterprises moving to lower cost regions. This effect is likely to be reinforced if complementary types of infrastructure and related services are also being developed, which will further contribute to lowering costs. This point is developed in more detail later in the paper in relation to rural electrification.

Huang APA, (2008) has grouped countries by income to investigate the relationship between energy consumption and growth. They use panel data for 82 countries between 1972 and 2002. They find a bi-directional (feedback) relationship between energy consumption and economic growth. In lower income countries there did not appear to be a causal relationship between energy consumption and economic growth, with the implication that setting parameters for energy policy would be less clear cut since increases in energy consumption would not lead to growth. In middle income countries (lower and upper) economic growth leads positively to energy consumption and negatively in higher income countries. This implies that high income countries have already undertaken conservation policies to protect the environment. With the relation postulated for middle income developing countries there is the additional question posed in the literature of whether the benefits resulting from economic growth from energy consumption outweigh the cost imposed on the environment through pollution. This appears in the so-called inverted U relation between the level of economic development

and pollution (Grossman and Krueger 1995). In low-income countries there are not many industrial units to pollute. As an economy grows, pollution increases as it attracts higher polluting industries. Eventually, the pollution problem becomes the main concern and there may be a tendency to produce lower polluting products (although firms can export their pollution by relocating to lower income countries).

Samanta and Sundaram (1983) did a study on socio-economic impact of rural electrification in India. The study addressed the following questions: Does rural electrification increase productivity, income, and employment and bring structural change in rural areas? Does rural electrification reduce excessive migration to urban areas? How does rural electrification fit into the broad strategy of rural development? What complementary conditions make for success in rural electrification schemes? How does rural electrification affect the roles of women and children? The analysis is based on primary data collected by the Operations Research Group (ORG) in 132 villages in four states--Andhn'a Pradesh, Maharashtra, Punjab, and West Bengal. Data were collected a- both the village and household levels, and from State Electricity Board and research and manufacturing enterprises in the sample villages. For 108 of the 132 villages, these data were supplemented by a baseline 1966 survey of agricultural innovation. The ORG study finds that rural electrification has made a major contribution to rural development. It is 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 development of rural industry and services. In the social sectors, the effects were less pronounced though still consequential.

Electricity serves a heterogeneous population, which includes: industrial, commercial and domestic users and each is services under different costs and unit supply. For a variety of reasons, electricity use is cross subsidized among the various categories and there are subsidy differentials for the different types of users. The Kenya Power and Lighting company Plc., tariff schedules distinguish five classes of tariff rates: A (ordinary domestic consumers and small commercial), B (medium commercial and industrial consumers), C (large consumers and industrial consumers), D (interruptible off-peak supplies to ordinary consumers) and E (street lighting). The commercial and industrial consumers are the major users of electricity for economic production and consume 75.5% of the total of the distributed electricity, whereas the domestic class or residential users consume only 23% (KPLC, 2006). The residential group is often considered less important, because of their low consumption rates and low contribution to the economic output. There has been progress in reducing the costs for both grid and off-grid services, but the biggest hurdles are the initial connection fees and monthly consumption costs for low-income households (Townsend, 2000). In order to assess the affordability for connection to electricity services, it is necessary to compare household income with connection cost. Affordability refers to the actual ability of a household to pay for goods/ services and it can be distinguished between the affordability for access and the affordability for consumption (Estache APA, 2002), which are a key determinant in this study.

According to the World Bank, projects furthest from a grid are likely to involve off-grid solutions, where there are small communities. In this way a kind of pecking order is used which favors grid over off-grid support. Financial considerations are also used to

determine the merit order. This is the case because the World Bank's favored model for delivering even off-grid electricity is through the private sector, as in Nicaragua and Laos. However, as the example of Cuba shows the real value of supplying a locality with off-grid technology lies in its ability to draw on local resources and help develop local potential (Cherni and Hill 2009). As far as an overall assessment is concerned it is evident that the private sector has not developed electrification in rural areas on the scale envisaged with privatization and the variety of approaches pursued to increase private participation in infrastructure. This is largely the case whether consideration is given to investment

in rural electrification through privatized utilities, forms of public–private partnerships, increased use of subsidization, through for example output-based aid and more overtly through development assistance.

Khandker APA, (2008) examined the welfare impacts of households' rural electrification based on panel surveys conducted in 2002 and 2005 for some 1,100 households in rural Vietnam. The findings indicated that grid electrification has been both extensive (connecting all surveyed communes by 2005) and intensive (connecting almost 80 percent of the surveyed households by 2005). Vietnam is fairly unique in that once electricity is locally available, both rich and poor households are equally likely to get the connection. The econometric estimations suggest that grid electrification has significant positive impacts on households' cash income, expenditure and educational outcomes. The benefits, however, reach a saturation point after prolonged exposure to electricity. Finally, this study recommends investigating long-term benefits of rural electrification –

not just for households, but for rural economy as a whole. Studies have shown that in electrified homes, energy consumption constitutes, on average, 4% of the household budget, while, in non-electrified homes, 15% of the household budget is spent on energy (MRC 1998). Other studies indicate that, apart from self-collected wood at no financial cost, electricity is the most cost -effective energy source for cooking. The relatively low cost of electricity, coupled with the access programs for the rural areas, has resulted in a much higher proportion of households using electricity for cooking in South Africa than in many other African countries. However, when considering simultaneous cooking and space heating, coal and wood burning stoves appear to be more cost effective than electricity in the higher regions of the country (Graham and Dutkiewicz 1998)

If smaller enterprises generate electricity, they tend to install less than 5 MW thermal generators. Again, although maintenance levels are generally low, essential parts are sometimes difficult to acquire. Reinikka and Svensson (2002) also suggest that the costs of own generation outweigh the benefits. The decisions to generate own electricity result from many factors and the benefits are difficult to measure. They include elements such as lost sales due to power failures and where backup is needed to meet export demand. Since own generation of power is costly there could be opportunities to sell power at full cost. The extent of this is largely unknown and whether or not excess power could be sold to grid to improve national power supply is uncertain. For small firms it is believed that own generation imposes relatively low fixed costs but higher variable costs. For larger firms, the reverse is the case, with firms facing relatively high fixed costs and increasing variable costs, indicating that there could be scope for large firms to sell to small firms.

2.4 Research Gap

The main energy need of the rural population is fuel for lighting, cooking and water heating. Accessibility and cost play an important role in determining the type of fuel used. The use and collection of biomass fuel including wood and dung has little monetary cost associated with it, but can be very costly in terms of man-hours taken up, health and environmental impacts (Howells *APA*,, 2002, Cecelsic, 2000). Most rural population have low and irregular income, which poses two main problems. Firstly, limited fuel options and hence can only afford small amounts of fuel. Secondly limited expendable income to buy appliances: Energy using appliances often require significant capital outlay relative to household income hence the changeover from biomass fuel to electricity for cooking is likely to be gradual (Howells *APA*,, 2002, Peng and Pan 2006). The process of rural electrification in Kenya has been extremely slow due to high network extension costs, low customer density due to the scattered nature of human settlement and low electricity consumption per household due to the low and irregular income in many rural households hence low revenue collected. In addition, high operations and maintenance costs of the extended distribution network compared to the revenue.

Rural electrification customers remained at 13% of the total number of customers who have access to electricity for the years 2000-2005. There has been an annual growth of approximately 7.3%, which is not sufficient given that approximately 80% of the total Kenya population reside in the rural areas. Most of the studies have concentrated on customer connectivity and revenue rather than the benefits accrued from the rural electrification. This study will be conducted in Tala Location since a rural electrification

scheme has been carried out in the location yet there is limited information on effects of rural electrification in the location. The cheapest tariff in KPLC is the first 50 units (kilowatt hours used). This is supposed to cater for the poor and low income. The cost varies depending on fuel adjustment cost.

2.5 Theoretical Framework

This study was guided by Rational Choice theory which assumes that individuals always make prudent and logical decisions that provide them with the greatest benefit or satisfaction and that are in the best self- interest. Most mainstream economics and theories are based rational choice theory. Rational Choice theorists believe that most human decisions are based on maximizing a person's own benefits, while minimizing that which can hurt the individual. Small business owners should consider adapting the theory of rational choice into their business models as it can help predict and explain future consumer spending decisions. Rational choice theory is a framework for understanding and often formally modeling social and economic behavior. It is the paradigm in the currently dominant school of microeconomics. Rationality is widely used as an assumption of the behavior of individuals in micro economic models and analysis which appears in almost all economics dealing with decision- making. The rationality described by rational choice theory is different from the colloquial uses of the word. For most people rationality means sane, in a thoughtful clear- headed manner or knowing and doing what's healthy in the long term. Rational choice theory uses a specific and narrower definition of rationality, simply to mean that an individual acts as if balancing costs against benefits to arrive at action that maximizes personal advantage. In rational

choice theory, the costs are only extrinsic to the individual rather than being intrinsic. Rational choice theory makes two assumptions about individual's preferences for actions: completeness in all actions that can be ranked in an order of preference and transitivity- if action A is preferred to B, and action B is preferred to C and action C is preferred to D. An individual's preferences can also take forms: strict preference occurs when an individual prefers A, B, C or D. While there may be many reasons for a rational choice theory approach, two are important for the social sciences. First assuming humans make decisions in rational rather than a stochastic manner implies that their model can be modelled and thus predictions can be made about future actions.

2.5 Conceptual Framework

In this study, the conceptual framework was based on socio-economic factor which constituted dependent variables while rural electrification was included as the independent variable. The intervening variables included government policies and community goodwill. The purpose for rural electrification is to ensure socio-economic development in Bunyala Sub-County. The relationship between the variables is shown in figure 1

Independent Variable dependable variable

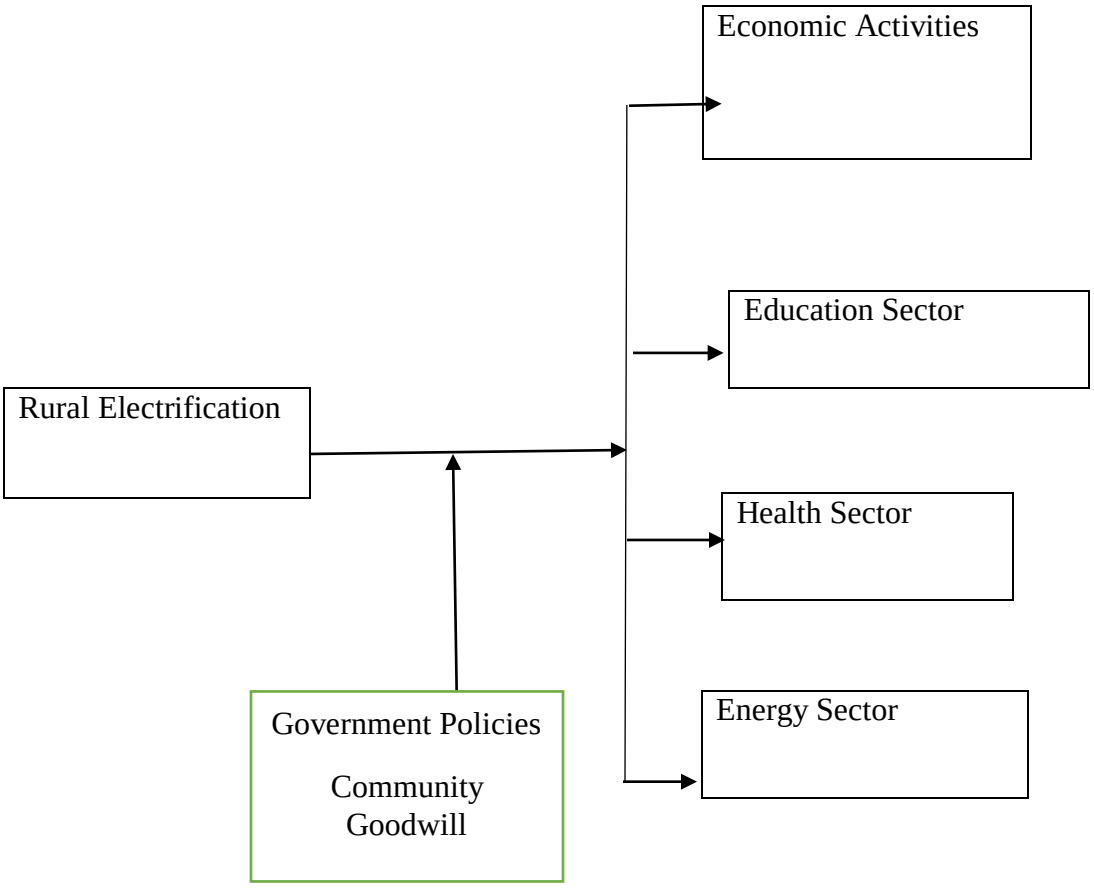


Figure 1: The Conceptual Framework on Relationship between Rural electrification and Socio-economic development in Bunyala Sub-County.

CHAPTER THREE

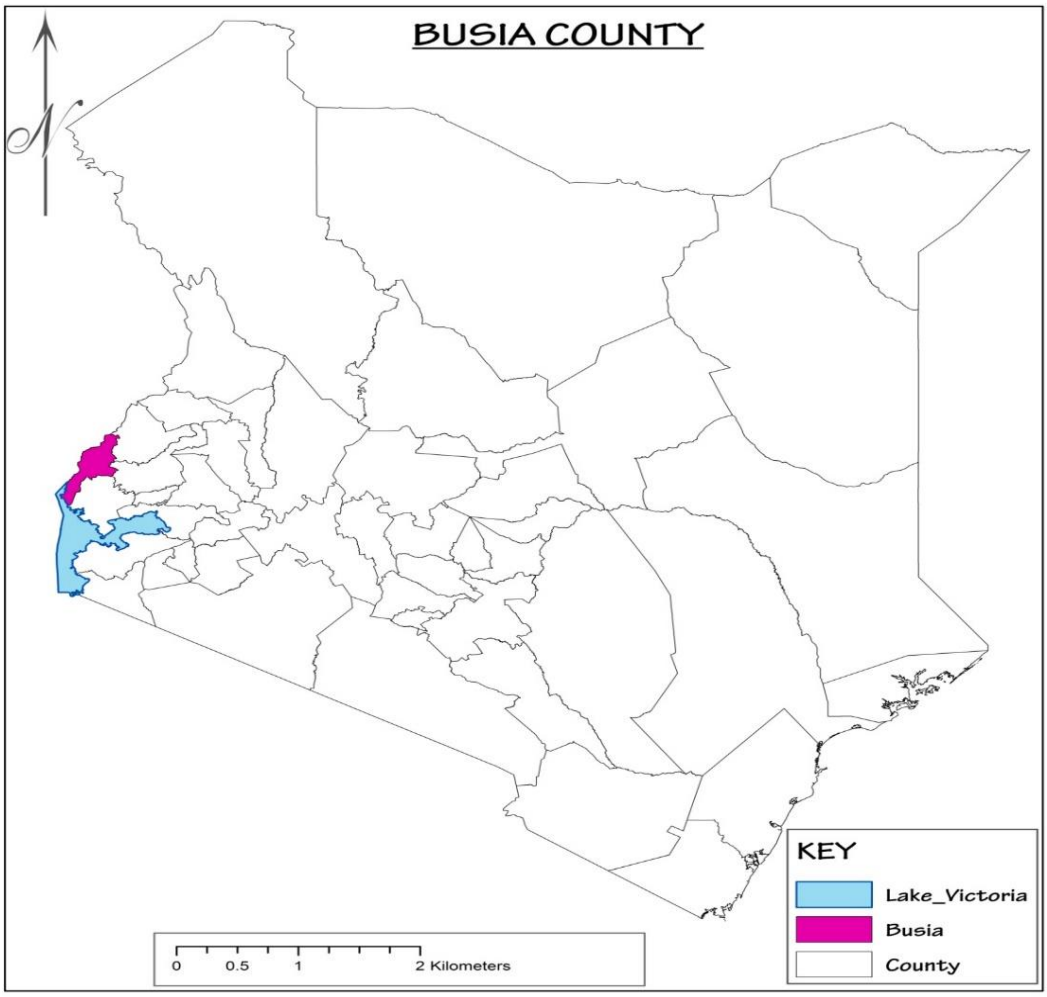
METHODOLOGY

3.1 Introduction

This chapter presents the methodology that the study followed. It explains the design; location of study; target population; sampling procedure and sample size, data collection instruments; methods of testing the validity and reliability of instruments; the research procedure that was followed; and the data management and analysis techniques that were used in conducting the study.

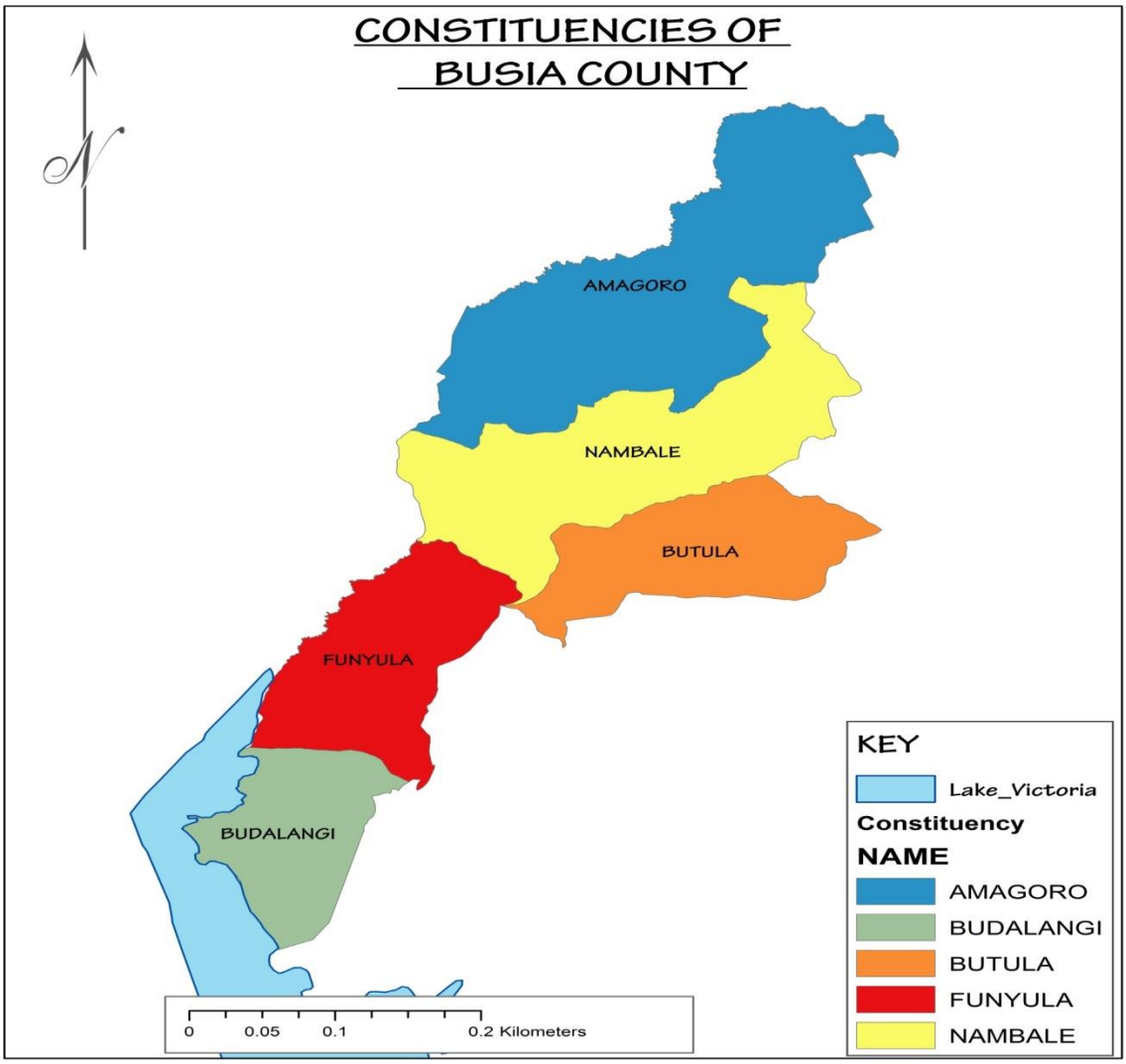
3.2 Location of Study

The study was carried out in 2020 Bunyala Sub-County in Busia County. The inhabitants in Bunyala are the Banyalas a sub-tribe of Luhya who are Bantus. There population as per the last census, 2009 is about 66,723.As show on figure 1.4, the population is evenly distributed. The rainfall is evenly distributed and the Sub-County experience long rains from late march to early may and short rains are between October to December. The rains are normally experience with thunderstorm as the area is just next to Lake Victoria. Bunyala also experience perennial floods from River Nzoia. The dominant economic activity in Bunyala is fishing on Lake Victoria. Another economic activity is growing of rice under Bunyala Irrigation Scheme utilizing abundant water from river Nzoia, and Maize farming at Migingo. Other business activity like retail shops, informal sector i.e., Jua kali, cybercafé, Ice making for preservation of fish.



Source: Kenya Geo Database

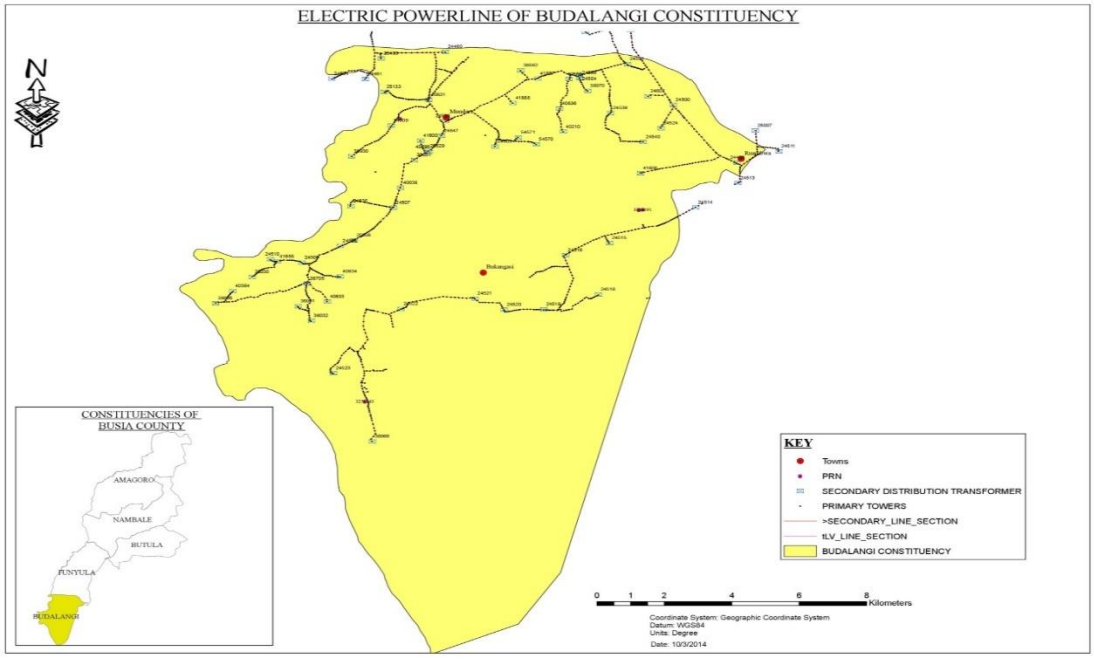
Figure 3.2: Map of Kenya, Busia County in purple with which Bunyala Sub-County is location



Source: Kenya Geo database

Figure3.3: Constituencies in Busia County within which Bunyala Sub-

County(Budalang'i) location



Source: Kenya Power Ltd-Western Kenya Regional office(KSM)

Figure 3.4: Electricity Distribution with Bunyala Sub-County.

3.3 Research Design

Correlation and regression techniques was used in the study. This design involves collection of two or more sets of data from a group of respondents with an attempt to determine the subsequent relationship between those sets of data (Kothari, 2005). Correlational research is used to analyze the degree of relationship between two variables (Mugenda & Mugenda, 2005). In this study, an attempt was made to clarify the relationship between rural electrification and socio-economic development with regard to education sector, health sector, energy sector and economic activities.

3.4 Target Population

The target population for this study comprised of all residents in Bunyala Sub-County particularly from learning institutions, medical institutions, county council markets, landing beaches and various types of business in the Sub-County. The population of interest for the entire Bunyala Sub-County is 66,723 as Kenya National Bureau of Statistics.

3.5 Sampling Procedures and Sample Size

A sample is the selected group used to represent the entire population (Jackson, 2009). Careful selection of the sample ensures that the characteristics of the entire population is represented. The sample consist of those units from the total population which are selected for data collection.

A targeted sample of 100 respondents from learning institutions, medical institutions, and from business people with various county council markets, landing beaches, villages and township. This enable will enable investigator to collect information on education, health and economic activities. The number earmarked above for the study conforms to the widely held rule of thumb that, to be representative, a sample should have thirty (30) statistical or more test units Wayne and Terrel (1975). This is further supported by cooper and Emory (1995) who observe that in a population of 10 million, a sample of more than 2million can be misleading while a sample of 1000 drawn in a proper manner can be more adequate. The response of medical officers, teachers and business people on the use and the importance of electricity in the rural areas would be a reflection of the study. The list of all the learning institution, medical institutions, landing beaches and county councils markets were obtained from Sub-County education office, Sub-County medical

office, Sub-County fisheries office, local authority office and lastly Sub-County trade office. Sample units were randomly selected from the learning and medical institutions and various business entrepreneurs listing. It is from these organizations that the representative sample of 100 was drawn. The respondents were given structured questionnaires. 30 responses were received from the teachers and medical officers, resulted to a response rate of 30% and 70 questionnaires were received from the customers resulting to 70%.

3.6 Data Collection Instruments

These are tools which were used to collect/record information about the specific research objectives. In this case, the researcher used questionnaire for all the respondents. A self-designed questionnaire was used to collect quantitative data from the respondents. The questionnaire was divided into: section A which consisted of information on respondents' demographic profiles, while sections B, C and D contained information on research objectives with Likert type of questions to capture the specific objectives of the study. The questionnaire had questions based on generic dimensions and sequel indicators of the social –economic impact of rural electrification on rural development in Bunyala Sub-County. The indicators are compounded to form attributes to community benefit from rural electrification program, social - economic impact of rural electrification program, impact of rural electrification on health sector in Bunyala Sub-County, and impact of rural electrification on education sector which were scored on the Likert scale continuum to obtain information on the extent to which the social –economic impact of rural electrification program on development in rural area in Bunyala Sub-County. The questionnaires were also issued to Key informants to provide specific information

required by the researcher.

3.7 Pilot Study

Pilot study was carried out amongst 10 respondents from Samia Sub-county which was 10% of 100 of the sample size, since according to Kothari (2005), a pilot sample should constitute 10% of the study sample. Samia Sub-county has the same challenges of rural electrification just as Bunyala Sub-County since they are neighboring sub-counties within Busia county .The 10 respondents was fairly manageable in comparison to 100 respondents for the project. The purpose of conducting the pilot study was to check on suitability and the clarity of the questions on the instruments designed, relevance of the information being sought and the language used and to test the reliability of the instrument. The respondents from whom data was collected during the pilot survey were not considered during the actual data collection for the study.

3.7.1 Validity of the Instruments

Validity is defined as the accuracy and meaningfulness of inferences, which are based on the research results (Borg & Gall, 2020). In other words, validity is the degree to which results obtained from the analysis of the data actually represents the phenomena under study. Content validity of an instrument was improved through expert judgment. Content validity refers to whether an instrument provides adequate coverage of a topic. Expert judgement opinions helped to establish content validity. Thus, the researcher obtained assistance from the supervisors of Moi University in in order to improve content validity of the instrument.

3.7.2 Reliability of the Instruments

It refers to the extent to which studies or findings can be replicated, that is, the accuracy or consistency of the research instrument in measuring whatever it measures (Bland, 2000). It was established using the test-retest method. The researcher administered questionnaires to the same group of respondents after one week. Computation of the correlation between the scores of the two sets was carried out and correlation coefficient was obtained. According to Mugenda and Mugenda, (2005), reliability co-efficient of 0.7 and above is accepted as being reliable test instrument. The questionnaire were therefore deemed to be reliable to use the population.

3.8 Data Collection Procedures

The introduction letters were used by the researcher to introduce himself to respondents seeking permission to carry out research about socio-economic impact of rural electrification in Bunyala Sub-County. The researcher then booked appointments with key informants to administer questionnaires. The duly filled questionnaires were collected and stored safely for data analysis.

3.9 Ethical Considerations

Bland (2000) observes that ethical considerations in research involve outlining the content of research and what was required of participants, how informed consent was obtained and confidentiality ensured. The researcher ensured respect for human dignity by ensuring privacy and autonomy of the respondents .The researcher obtained an introduction letter from Moi University Ethics Committee .This was followed by permit from NACOSTI (Appendix VIII & IX). Informed consent was verbally obtained because

some of the respondents, especially parents, were illiterate or semi-literate. In conducting the study, explanations about its aims were made to the respondents so as to obtain their informed consent. The respondents were assured that their names would not be mentioned and that the data they provide would be treated with utmost confidentiality. The data collected was stored on a hard drive and a computer password designed to make the data as confidential as possible.

3.10 Data Analysis

Data was analyzed using both descriptive and inferential statistics. Descriptive statistics of means, standard deviation and percentage was used on raw data. The inferential statistic of linear regression was used. A computer package, Statistical Package for Social Science (SPSS) version 21 for window was used to do analysis. Descriptive statistics enables researcher to describe a distribution of measurement (Mugenda & Mugenda, 1999). Inferential statistics deals with analysis, interpretation and decision on the basis of results (Nassiuma & Mwangi, 2004).

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study and it is arranged according to the four research objectives that the study sought to answer. The chapter is divided into three subsections namely; introduction, demographic information about the respondents and the results of the data collected from the respondents, findings and discussions on the research objectives that the study sought to answer about effect of rural electrification on social-economic development in Bunyala Sub-County.

4.1.1 Response Rate

The questionnaires were administered to teachers from learning institution, medical officer and nurses from medical institution, various business entrepreneurs e.g., Fishermen, farmers, millers, artisans, shopkeepers, etc. Response rate was critical for this study due to the fact that the fixed sample quantitative data obtained from primary data of the qualifying respondents implied that there was need for a similar response rate from the questionnaire used for the construction of the quantitative primary information. The study utilized a questionnaire presented to the respondents on a personal basis to increase the response rate. The response rate is presented in Table 1.

Table 4.1: ***Response Rate of Respondents***

Category	Frequency	Percentage (%)
Responded	95	95
Did not respond	5	5
Total	100	100.0

Source: Author

From the results presented above, the researcher successfully received responses from 95 respondents from Bunyala Sub-County. The instruments were complete and taken as valid for data analysis which translated to a response rate of 95%. The 5 questionnaires that were either not received at all or were received incomplete accounted for 5% of the sample population and therefore not considered in the analysis. Response rate of 95% is a dependable representation of the targeted population thus adequate for the study analysis. Mugenda and Mugenda (2012) concluded that 50% response rate is adequate, 60% is good, while 70% and above is rated to be very good. This implies that the response rate of 95% is satisfactory and good for analysis, drawing conclusions and making recommendations from the study.

4.2 Demographic Information

The study sought to establish the demographic characteristics of the respondents which included gender, age bracket and education levels of the respondents.

4.2.1 Gender of the Respondents

The researcher analyzed the distribution of the respondents by gender in terms of frequencies and percentages. The subject of gender is considered fundamental in this

study largely because it could help the researcher get a balanced view from both genders. Table 2 shows the distribution of the respondents by gender

Table 4.2: ***Gender of Respondents***

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	54	52.4	54.0	54.0
	Female	46	44.7	46.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results in Table 1 above indicate that slightly more than half (52.4%) of the respondents were male reflecting a frequency of fifty-nine male respondents while fifty-one (51 respondents) representing 46.4% of the sample population were female. The findings imply that the views expressed in these findings are gender sensitive and can be taken as representative of the opinions of both genders. The results can also be presented in a bar chart as shown in figure 1 below.

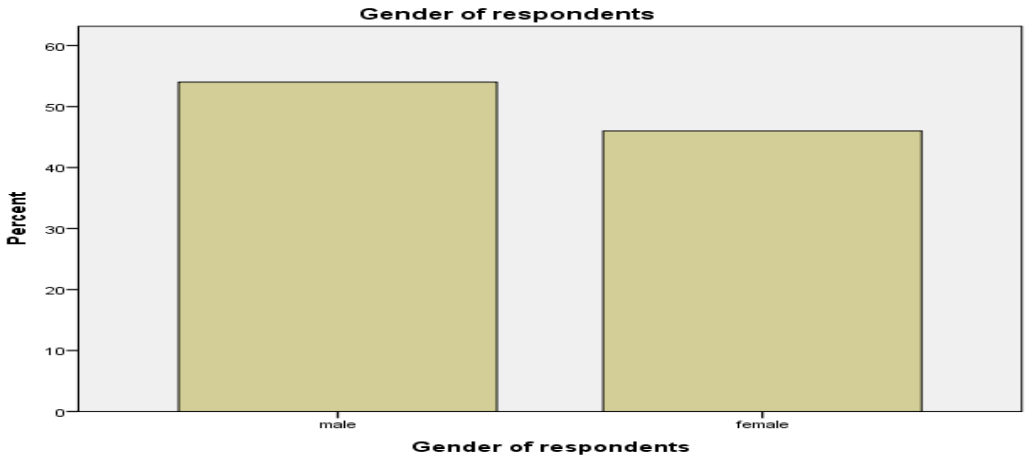


Figure4.5: **Gender of Respondents Source: Author**

4.2.2 Respondents' Age bracket

The study sought to determine how the respondents were distributed across the various age brackets and consequently their opinions on the topic of study. Table 3 presents the results.

Table 4.3: ***Age for all Respondents***

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 20 years	8	7.8	8.0	8.0
	21-30 years	18	17.5	18.0	26.0
	31-40 years	43	41.7	43.0	69.0
	41-50 years	18	17.5	18.0	87.0
	above 50 years	13	12.6	13.0	100.0
	Total	100	97.1	100.0	

Source: Author

As presented in Table 3 above, the results show that respondents who were below 20 years of age were seven representing 6.4% of the sample population. This was as a result of schooling since majority of respondents below 21 years are mostly in schools hence not able to give critical information concerning influence of rural electrification on socio-economic development. Equally, the results indicate that those respondents in the age bracket 21-30 years were eighteen representing 17.5% of the sample population, those of age bracket 31-40 years were forty-three representing 41.7% of the study population sample, 41-50 years were eighteen representing 17.5% of the sample population while respondents above 50 years were thirteen representing only 12.6% of the study sample population. Generally, the results implies that majority of the respondents who provided information were of the age bracket of 21-50 years. This is the active population that

participates actively in income generating activities in Bunyala Sub-County that are influenced by rural electrification program. The results were also presented in the bar chart below as figure 6

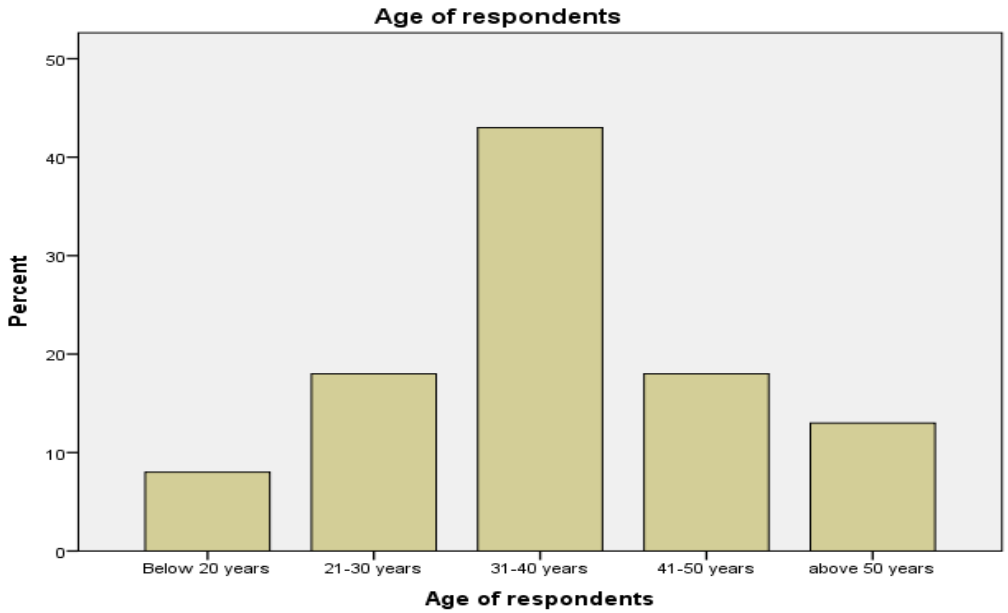


Figure 4.6 ***: Age for all Respondents***

Source: Author

4.3.3 Level of Education

The study sought to establish the academic qualifications attained by the respondents in regard to data collection. The results are as depicted in Table 4 below.

Table 4.4: Level of Education of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary	28	27.2	28.0	28.0
	Secondary	61	59.2	61.0	89.0
	Tertiary	11	10.7	11.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results in above shows that the majority (59.2%) of the respondents had attained secondary education level and hence easily understood the information sought by this study. Similarly, the results indicate that 27.2% of the respondents reported to have attained primary level education while only 10.7% had tertiary level of education. The results can also be presented in bar chart as shown below.

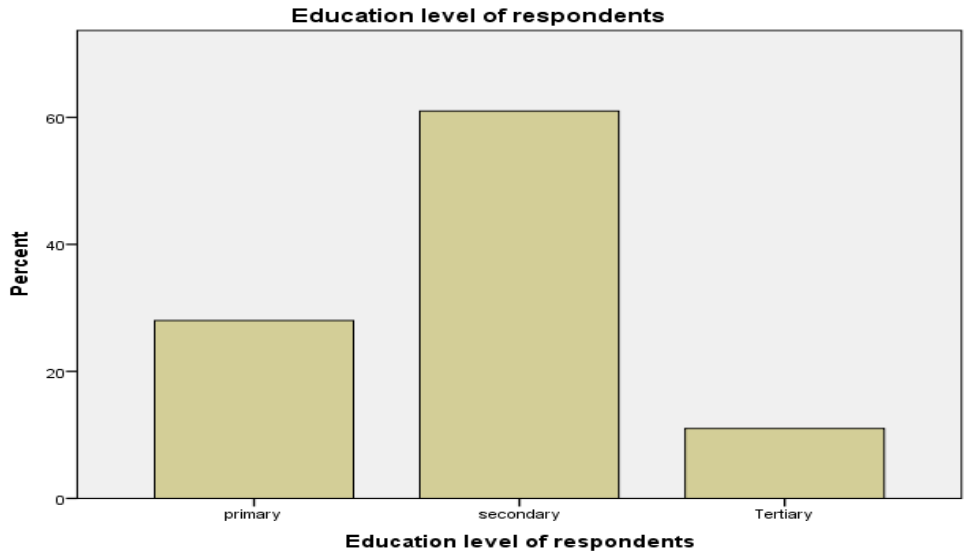


Figure4. 7: Education level of Respondents Source: Author

4.3 Rural Electrification and Income generating activities in Bunyala Sub-County

The study aimed to establish the effect of Rural Electrification Program on the income generating activities like fishing, carpentry, rice farming, poultry etc. in Bunyala Sub-County.

4.3.1 Residents Income generating Activities and Rural Electrification

The study sought to whether residents in Bunyala Sub-County had income generating activities that depends on electricity. The response of the respondents were presented in table 7.

Table 4.5: Income activity and Electricity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	78	75.7	78.0	78.0
	No	22	21.4	22.0	100.0
	Total	100	97.1	100.0	

Source: Author

Majority (78%) of the respondents in Bunyala Sub-County reported to engaging in income generating activities like poultry farming, Fish preservation, shopkeeping, posh-milling e.t.c that largerly depends on electricity supplied by rural electrification program while 22% of the sample population are involved in other forms of income generating activities that doesn't rely on electricity. The results were also presented in figure 8 below

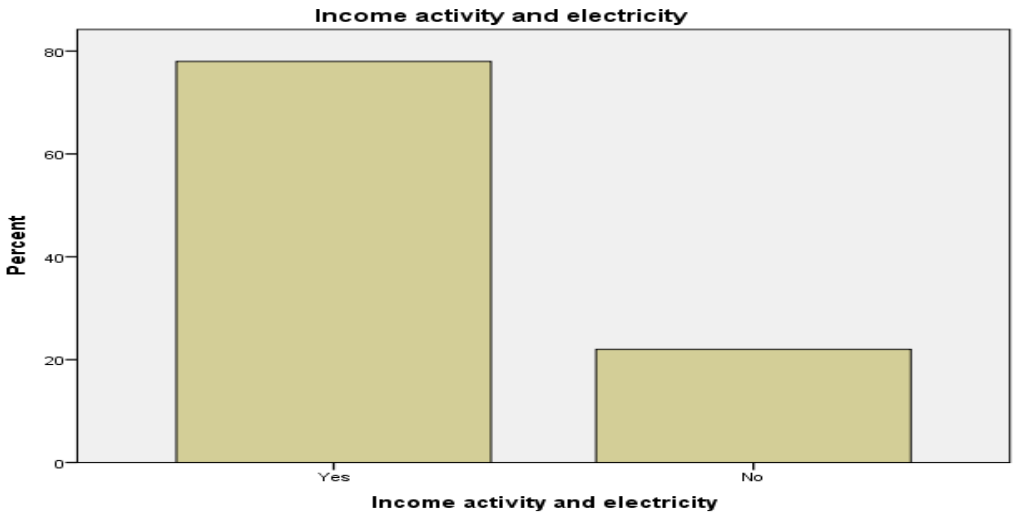


Figure 4.8: Income generating activity and RE

Source: Author

The study sought to investigate the type of income generating activities that are carried out in Bunyala Sub-County. The results are presented in table below

Table4.6: ***Type of Income activity***

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sewing	6	5.8	6.0	6.0
	poultry farming	10	9.7	10.0	16.0
	Fish preservation	20	19.4	20.0	36.0
	Carpentry	28	27.2	28.0	64.0
	Rice farming	16	15.5	16.0	80.0
	Posho-milling	6	5.8	6.0	86.0
	Welding	6	5.8	6.0	92.0
	Video shops/phone charging	8	7.8	8.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results in Table 6 above depicts that 6% of respondents are engaged in sewing as income generating activity, 10% poultry farming, 20% fish preservation, 28% carpentry,

16% rice farming and milling, 6% posho-milling, 6% welding and artisan, 8% video shops and phone charging. The results are also presented in the figure below

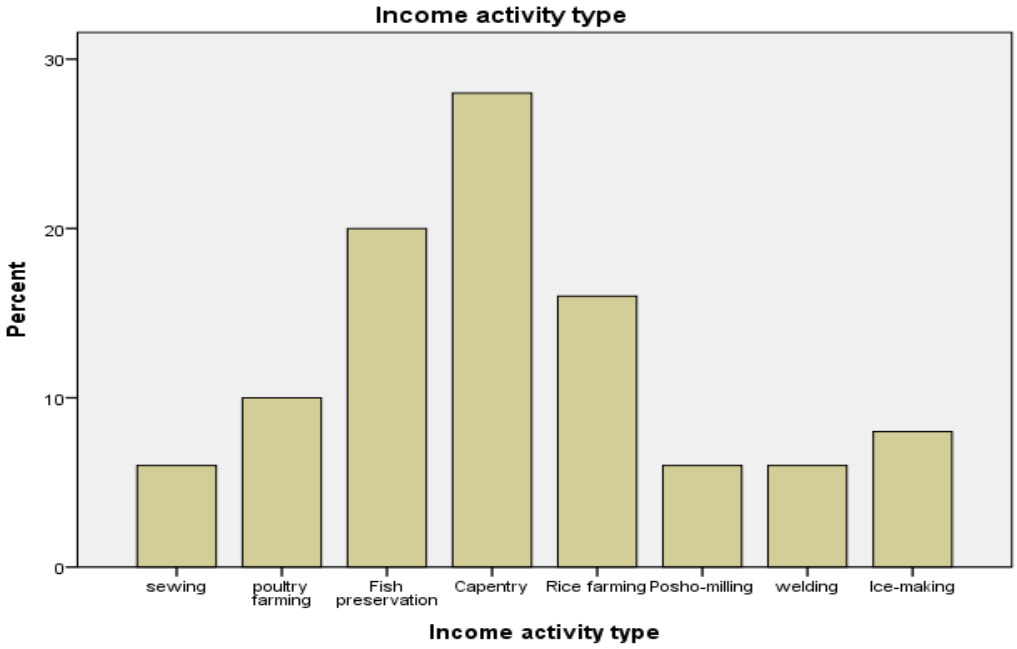


Figure 4.9: Income generating Activity type and RE

4.3.2 Extent of influence of rural electrification on income activities

The study used information gathered from the respondents to determine the extent of influence of rural electrification on income generating activities in Bunyala Sub-County. The results are presented in the Tables below.

Table 4.7: ***Rice farming, milling and Rural electrification***

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low extent	15	14.6	15.0	15.0
	Average extent	35	34.0	35.0	50.0
	Great extent	50	48.5	50.0	100.0
	Total	100	97.1	100.0	

Source: Author

As shown in Table 7 above, half (50%) of the respondents agreed that rural electrification program in Bunyala Sub-County greatly influenced rice farming and milling. Those who were interviewed supported this finding by indicating that they have benefited from REP as they now have rice mills within Bunyala irrigation scheme for processing of their harvests and also rice irrigation is necessitated through water pump which use electricity to pump water in their farms at cheaper cost. 35% and 15% of the respondents indicated that the extent of influence of rural electrification program on rice farming and milling was average and low respectively. The results were also presented in the figure below.

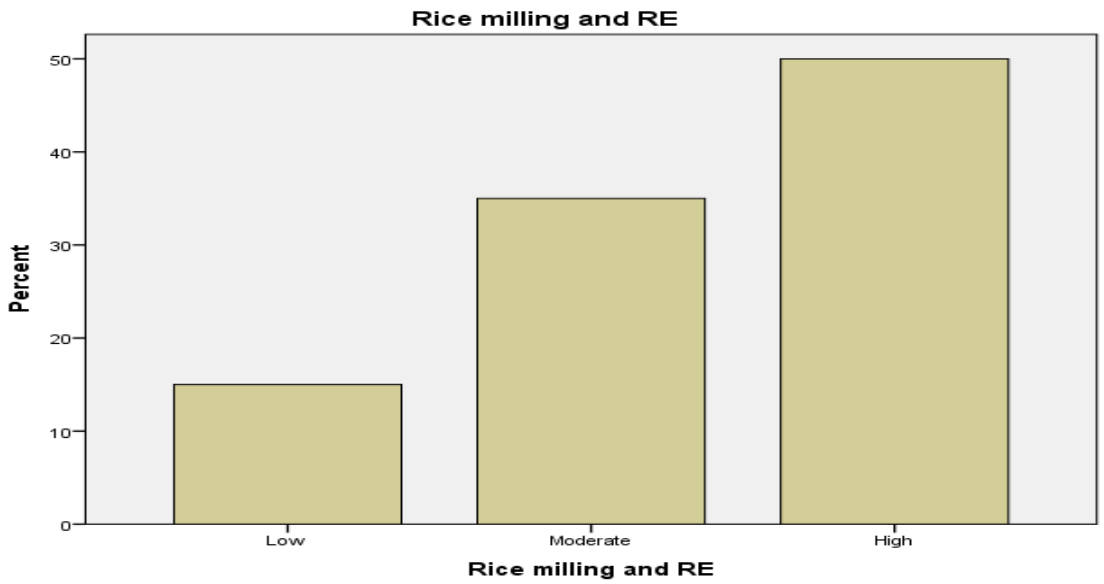


Figure 4.10: Rice milling and RE

Source: Author

Table 4.8: Fish preservation and Rural electrification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low extent	11	10.7	11.0	11.0
	Average extent	43	41.7	43.0	54.0
	High extent	46	44.7	46.0	100.0
	Total	100	97.1	100.0	

Source: Author

As shown in Table 8 above, over half (54%) of the respondents agreed that rural electrification program in Bunyala Sub-County greatly influenced fish preservation activities Fish mongers along the lake reported that they can preserve their fish in refrigerators because of availability of electricity and also Marenga cold house connected with electricity produces ice block for fish preservation especially big catch that comes within Bunyala Sub-County lake shores. Fish fillets are also produced and value addition

done at the fish processing plant in Marenga beach all because of availability of electricity. 43% and 11% of the sample population agreed that rural electrification program in Bunyala Sub-County had average and low influence on fish preservation activities along the shores of Bunyala Sub-County. The figure below presents the results for fish preservation

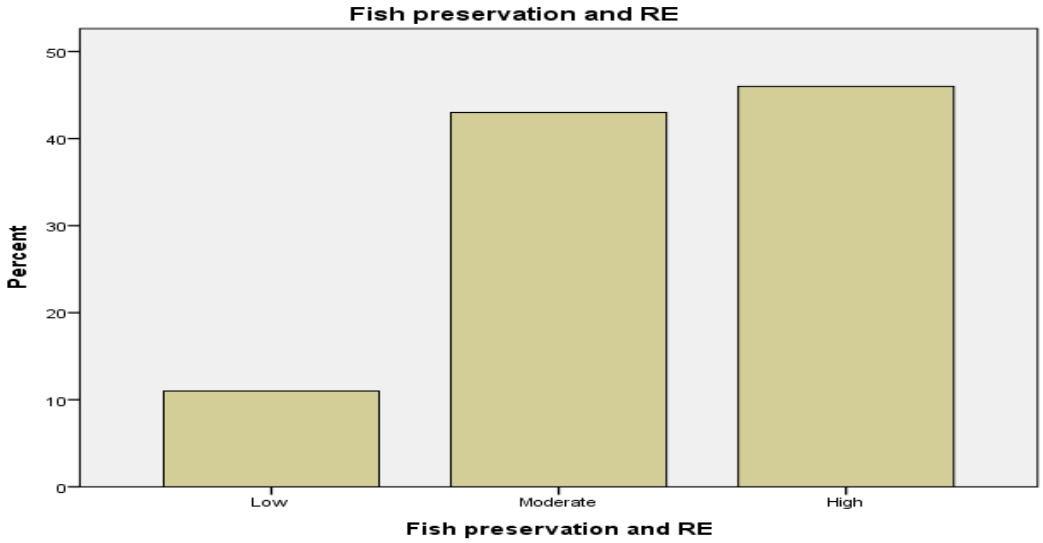


Figure 4.11: Fish preservation (Income generating activity) and RE

Source: Author

Table4. 9: Carpentry (Income generating Activity) and Rural electrification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	35	34.0	35.0	35.0
	Moderate	37	35.9	37.0	72.0
	High	28	27.2	28.0	100.0
	Total	100	97.1	100.0	

Source: Author

As shown in Table 9 above, 37% of the respondents agreed that rural electrification program in Bunyala Sub-County had an average influence on carpentry as an income generating activity, 35% recorded low influence while 28% of the respondents noted that rural electrification highly influenced carpentry. The cost of timber in Bunyala Sub-County is high hence setting up carpentry shops is also expensive. Similarly, with low-living standards in the region, many people cannot afford the sewing and drilling machines for carpentry services.

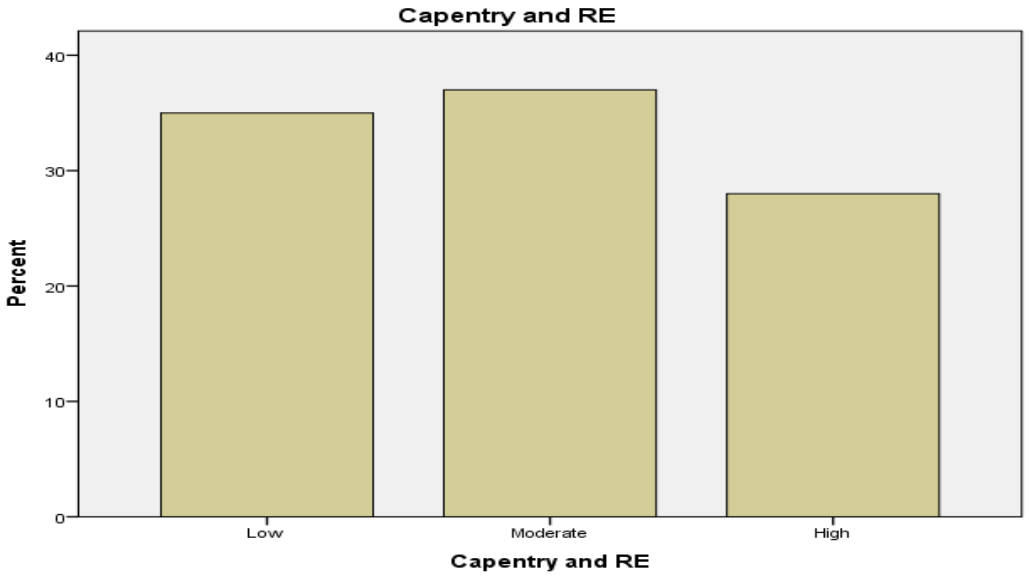


Figure 4.12: Carpentry (Income generating activity) and RE

Source: Author

Table 4.10: Sewing (Income generating activity) and Rural electrification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	72	69.9	72.0	72.0
	Moderate	22	21.4	22.0	94.0
	High	6	5.8	6.0	100.0
	Total	100	97.1	100.0	

Source: Author

As shown in Table 10 above, majority (72%) of the respondents agreed that rural electrification program in Bunyala Sub-County had a low influence on sewing as an income generating activity, 22% recorded moderate influence while only 6% of the respondents noted that rural electrification highly influenced sewing. The cost of timber in Bunyala Sub-County is high hence setting up carpentry shops is also expensive. Similarly, with low-living standards in the region, many people cannot afford the sewing and drilling machines for sewing services.

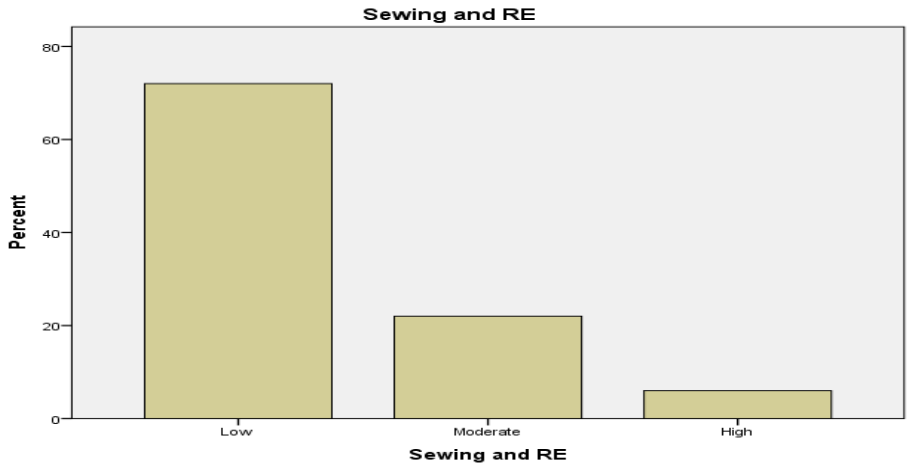


Figure 4.13: Sewing (Income generating activity) and RE

Source: Author

Table 4.11: Posho-milling(Income generating activity) and Rural electrification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate	16	15.5	16.0	16.0
	High	84	81.6	84.0	100.0
	Total	100	97.1	100.0	

Source: Author

Majority (84%) of the respondents noted that rural electrification highly influenced posho-milling as income generating activity while 16% of the sample population noted a moderate influence. Because of rural electrification program, many homesteads and market centers are connected with electricity encouraging many residents set up posho-mills that relies on electricity to operations. The results were also presented in the figure below

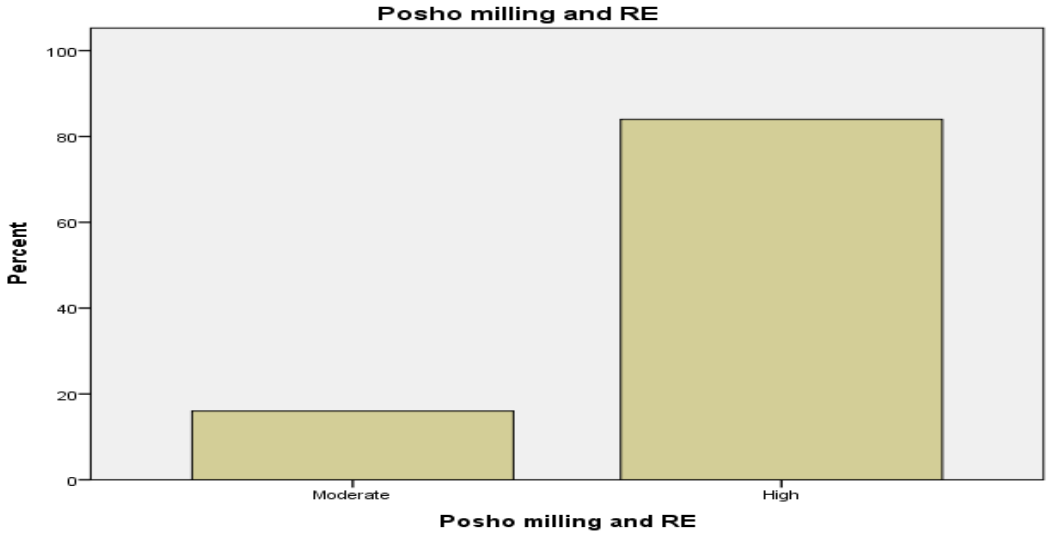


Figure 4.14: Posho milling (income generating activity) and RE

Source: Author

Table 4.12: Video shops, Phone charging(income generating activity) and Rural electrification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	100	97.1	100.0	100.0

Source: Author

The results in Table 12 above indicates that all (100%) the respondents reported that rural electrification highly influenced video shops and phone charging as income generating activity. The setting up of such enterprises relies on the availability of electricity hence

rural electrification has connected many market centres with electricity to facilitate such activities like Ibra phone charging shop and Dan video shops in Port-Victoria.

Table 4.13: Poultry farming (Income generating activity) and Rural electrification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	50	48.5	50.0	50.0
	Moderate	28	27.2	28.0	78.0
	High	22	21.4	22.0	100.0
	Total	100	97.1	100.0	

Source: Author

As shown in Table 13 above, half (50%)of the respondents reported that rural electrification program in Bunyala Sub-County had a low influence on poultry farming as an income generating activity because majority of the residents engage in free-range method of poultry farming, 28% recorded moderate influence while 22% of the respondents noted that rural electrification highly influenced poultry farming especially for those residents practicing broilers and layers chicken farming. The results were also presented in the figure as shown below

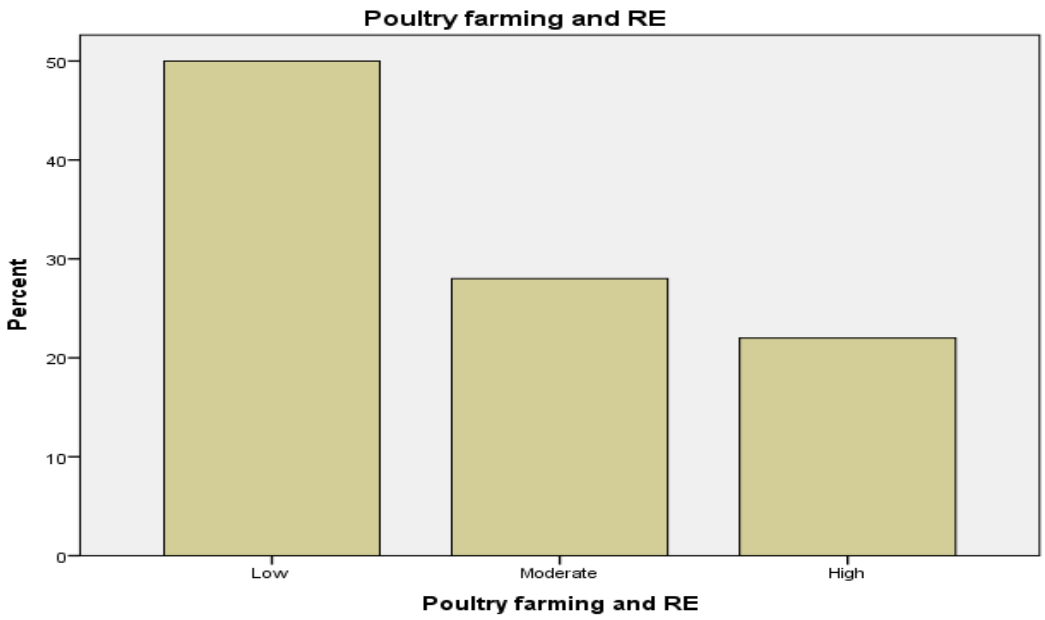


Figure 4.15: Poultry farming(income generating activity) and RE

Source: Author

Table 4.14: Descriptive statistics for Economic activities

	N	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Rice milling and RE	100	2.35	.730	-.654	.241
Fish preservation and RE	100	2.35	.672	-.552	.241
Carpentry and RE	100	1.93	.795	.127	.241
Sewing and RE	100	1.34	.590	1.554	.241
Poultry farming and RE	100	1.72	.805	.555	.241
Posho milling and RE	100	2.84	.368	-1.883	.241
Ice making and RE	100	3.00	.000	.	.
Valid N (listwise)	100				

4.4 Rural Electrification and Health Sector Development in Bunyala Sub-County

The study sought to establish the effect of rural electrification on health sector development in Bunyala Sub-County. The results and findings are presented and discussed in Tables below.

4.4.1 Health sector Contributions

The study sought to investigate whether there have been any development contributions by rural electrification on health sector in Bunyala Sub-County. The response of the respondents were presented in table 15.

Table 4.15: Heath sector contributions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	86	83.5	86.0	86.0
	NO	14	13.6	14.0	100.0
	Total	100	97.1	100.0	

Source: Author

Majority (86%) of the respondents noted that rural electrification has led to development contributions to health sector in Bunyala Sub-County. Port-Victoria sub-Sub-County hospital is equipped with automated health services like X-rays, scanning e.t.c. Only 14% of the respondents noted that rural electrification has not had tremendous contributions to health sector especially in flood prone regions like Maduwa and Bulwani which all have dispensaries but connected with electricity. The results were also presented in the figure below

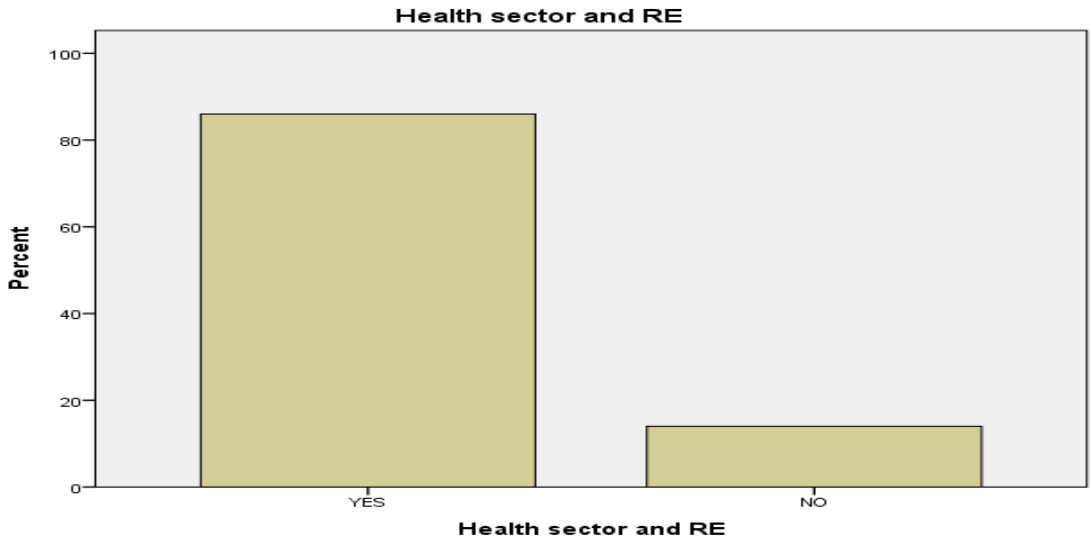


Figure 4.16: Health Sector and RE

Source: Author

Table 4.16: Mortuary Services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	49	47.6	49.0	49.0
	strongly agree	51	49.5	51.0	100.0
	Total	100	97.1	100.0	

The results above depicts that all the respondents strongly agreed (51%) and agreed (49%) that Port-Victoria Sub-Sub-County offers mortuary services courtesy of rural electrification program which enabled the hospital to be connected with electricity. Preservation of dead bodies in the mortuary entirely relies on electricity. Because of the dire need for electricity to support mortuary services in the hospital, Kenya power and lighting company Plc., has set up a sub-station office in Port-Victoria for emergency

electricity services within the region. The results on mortuary services and rural electrification can also be presented in a figure as shown below

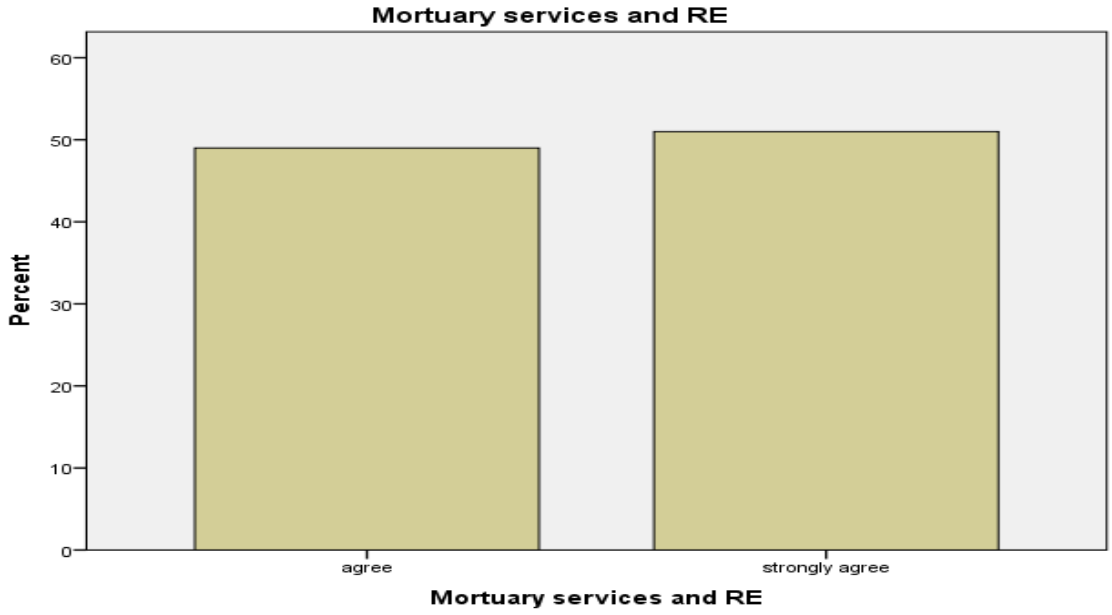


Figure4. 17: Mortuary Services (Health Sector) and RE

Source: Author

Table 4.17: Vaccination Services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	55	53.4	55.0	55.0
	strongly agree	45	43.7	45.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results above depicts that all the respondents strongly agreed (45%) and agreed (55%) that vaccination services are offered in hospitals in Bunyala Sub-County courtesy of rural electrification program which enabled the hospital to be connected with

electricity. Preservation of vaccines in refrigerators entirely relies on electricity. Because of the dire need for electricity to support mortuary services in the hospital, Kenya power and lighting company Plc., has set up a sub-station office in Port-Victoria for emergency electricity services within the Sub-County to support health sector and other consumption needs. The results on mortuary services and rural electrification can also be presented in a figure as shown below

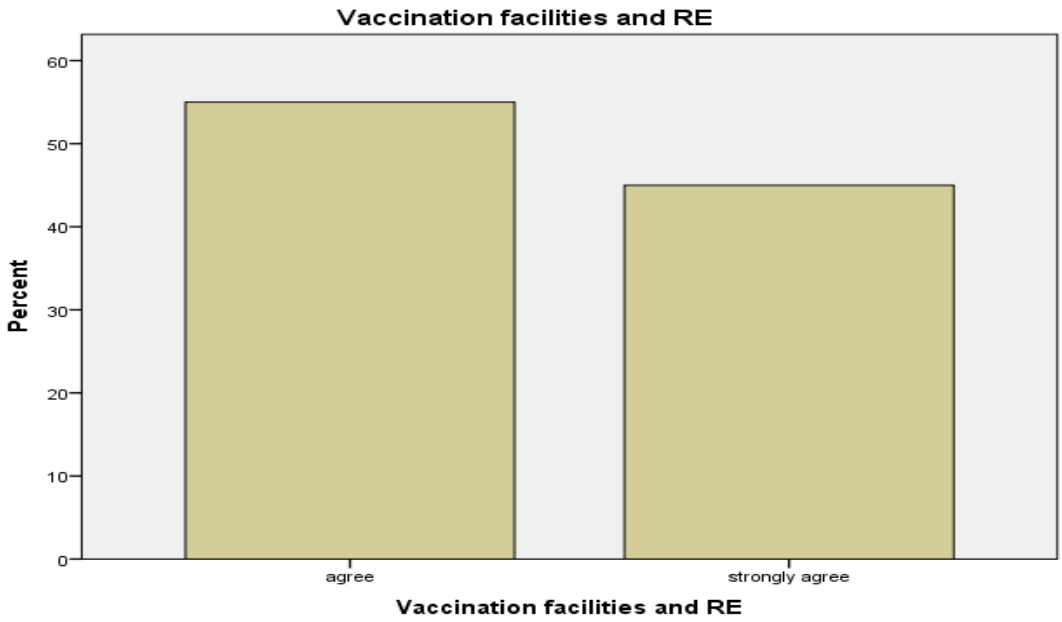


Figure 4.18: Vaccination facilities (Health Sector) and RE

Source: Author

Table 4.18: Laboratory Services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	22	21.4	22.0	22.0
	Agree	41	39.8	41.0	63.0
	strongly agree	37	35.9	37.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results above depicts that 41% respondents agreed and strongly agreed (37%) that laboratory services are offered in hospitals in Bunyala Sub-County courtesy of rural electrification program which enabled the hospital to be connected with electricity while 22% of the sample population disagreed that laboratory services are offered in hospitals courtesy of rural electrification. Some dispensaries like Bulwani and Maduwa are not connected with electricity but still offer laboratory services. The results on laboratory services and rural electrification can also be presented in a figure as shown below

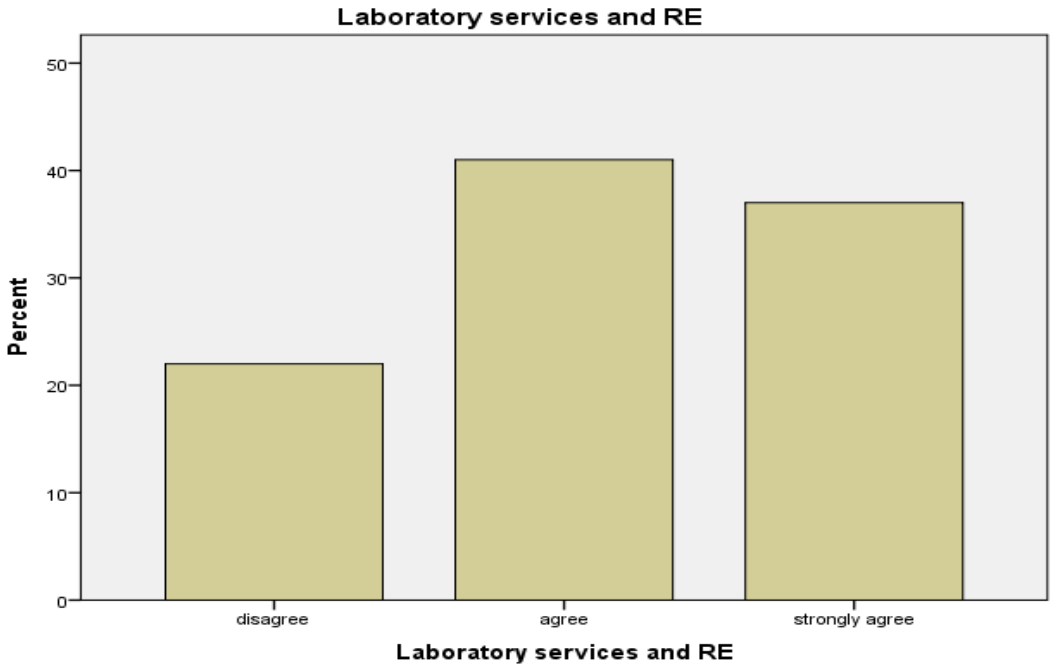


Figure 4.19: Laboratory services (Health Sector) and RE

Table 4.19: Services Delivery and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	13	12.6	13.0	13.0
	Agree	40	38.8	40.0	53.0
	strongly agree	47	45.6	47.0	100.0
	Total	100	97.1	100.0	

Source: Author

Nearly half (47%) of the respondents strongly agreed that service delivery in health institutions in Bunyala Sub-County improved since inception of RE program, 40% of the sample population agreed while 13% of the respondents disagreed with the statement. Services in hospitals in Bunyala Sub-County have been automated like M-pesa payment of hospital bills, laboratory services, vaccination and body examinations are all computerized courtesy of electricity supply in hospitals which increases the efficiency of service delivery in health institutions. The results were also presented in the figure below

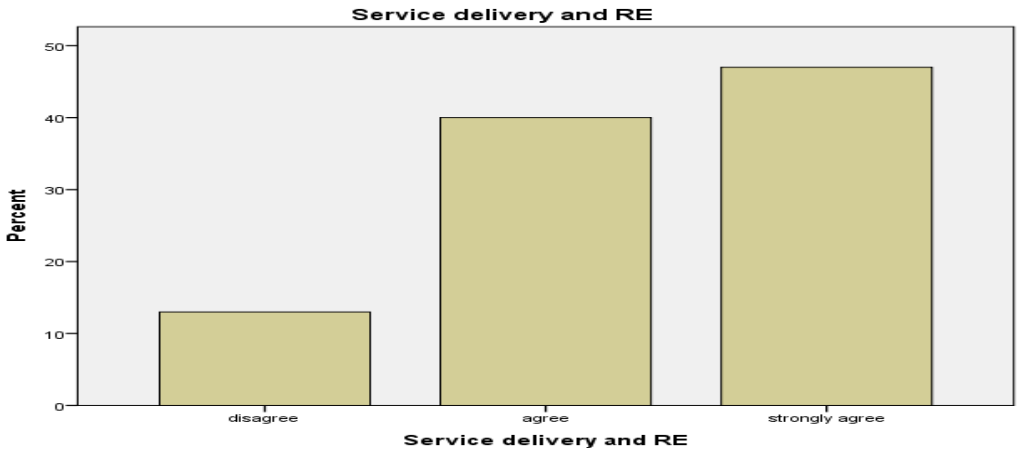


Figure 4.20: Service Delivery(health Sector) and RE

Source: Author

Table 4.20: Dispensaries, Health centers(Health Sector) and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	100	97.1	100.0	100.0

Source: Author

All (100%) the respondents strongly agreed that dispensaries, health centers and hospitals in Bunyala Sub-County are connected with electricity because of inception of rural

electrification program to enhance lighting and service delivery. Dispensaries with no electricity connectivity like Maduwa and Bulwani have solar installations to generate electricity for lighting. Rural electrification program has connected many parts of Bunyala Sub-County with electricity including dispensaries and health centers like Mukhobola to support the health sector in health service provision and delivery.

Table4.21: Descriptive statistics for Health sector

	N	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Mortuary services and RE	100	4.51	.502	-.041	.241
Vaccination facilities & RE	100	4.45	.500	.204	.241
Laboratory services and RE	100	3.93	1.121	-.824	.241
Service delivery and RE	100	4.21	.977	-1.297	.241
Dispensaries, Health centers & RE	100	5.00	.000	.	.
Automation of service delivery and RE	100	4.21	.977	-1.297	.241
Valid N (listwise)	100				

Source: Author

4.5 Rural Electrification and Education Sector in Bunyala Sub-County

The study sought to establish the effect of rural electrification on education sector in Bunyala Sub-County. The results and findings are presented and discussed in Tables below.

4.4.1 Education sector Contributions

The study sought to investigate whether there have been any developmental contributions by rural electrification on education sector in Bunyala Sub-County. The response of the respondents were presented in tables below.

Table 4.22: Lighting in schools (education Sector) and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	18	17.5	18.0	18.0
	Agree	50	48.5	50.0	68.0
	strongly agree	32	31.1	32.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results above indicate that majority (82%) of the respondents strongly agreed and agreed that since the inception of rural electrification program, most primary and all the secondary schools in Bunyala Sub-County are connected with electricity for lighting to enhance security. Only 18% of the respondents disagreed that many primary schools are not connected with electricity for lighting purposes possibly because such schools like Bubamba, Maduwa, Igigo e.t.c are located in swampy regions making it difficult for accessibility and installation of power lines by Rural electrification and Renewable energy. Equally, headteachers and board of governors' members interviewed noted that local politics influences allocation of CDF funds for REP making some schools and regions lack electricity connectivity. The main channel through which electrification may affect education is by improving the quality of schools, either through the provision

of electricity-dependent equipment, or increasing teacher quantity and quality. The results were also presented in the figure as shown below

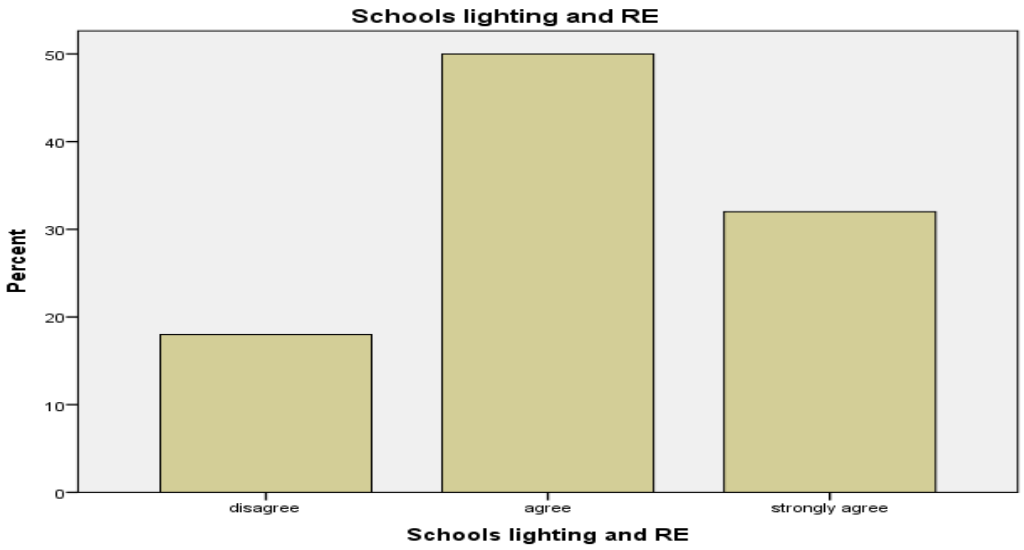


Figure4. 21: School Lighting (Education Sector) and RE

Source: Author

Table 23: Computer Subject(Education Sector) and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	22	21.4	22.0	22.0
	Agree	46	44.7	46.0	68.0
	strongly agree	32	31.1	32.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results above show that majority (78%) of the respondents strongly agreed and agreed that many schools in Bunyala Sub-County offer computer as a subject mainly because of availability of computer laboratories connected with electricity courtesy of rural electrification program. Without electricity, computer classes cannot take place in schools hence since the inception of REP students in Bunyala Sub-County are able to

undertake computer classes. Budalangi CDF allocates funds to implement the REP in schools and construction of computer laboratories like Namenya girl's computer lab for computer classes. in low-income countries like Kenya, rural schools often lack basic equipment, such as furniture and adequate textbooks—the presence of electricity does not affect these important constraints. The failures of teachers to take up posts in remote locations and frequent absenteeism from such postings are problems in many countries, and the evidence presented in the (IEG Publication), albeit for just one country, supports the argument that the availability of electricity makes rural positions more attractive to teachers. This is thus one possible reason for the higher education levels, with improved school quality encouraging students to stay on longer or enabling them to do so as their grades improve from better teaching. The other possible explanation is that increased study time at home results in better grades, so children stay in school longer. There is indeed evidence that electricity increases study time (by approximately an hour an evening, but no study follows the causal chain through to improved results and higher educational attainment. This could be main reason as to why majority of the residents, staffs and school administration agreed that they have all benefited from lighting in schools. The figure below also depicts the results analyzed above

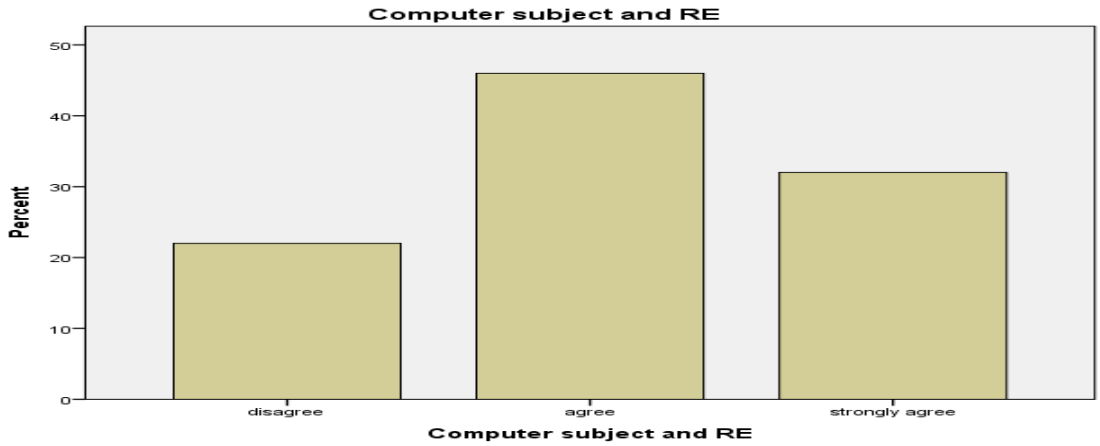


Figure 4.22: Computer Subject (Education Sector) and RE

Source: Author

Table 4.24: Security in Schools (Education Sector) and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	27	26.2	27.0	27.0
	Agree	52	50.5	52.0	79.0
	strongly disagree	21	20.4	21.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results above indicate that majority (73%) of the respondents strongly agreed and agreed that since the inception of rural electrification program, security in most primary and secondary schools in Bunyala Sub-County is enhanced because of security lights. 27% of the sample population disagreed that implementation of REP enhanced security in schools in Bunya Sub-County. The results were also presented in the figure below

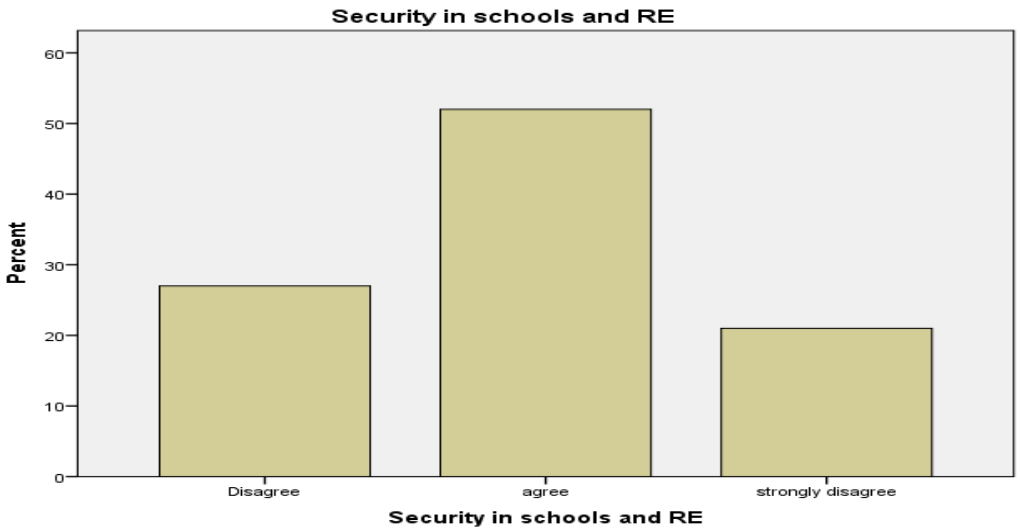


Figure 4.3: Security(Education Sector) and RE

Source: Author

Table4. 25: Evening and Morning studies and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	7	6.8	7.0	7.0
	strongly agree	93	90.3	93.0	100.0
	Total	100	97.1	100.0	

Source: Author

From the results shown above, all the respondents strongly agreed and agreed that since the inception of rural electrification program in Bunyala Sub-County, many schools both primary and all secondary schools conduct evening and morning studies because of availability of lighting in classes and provision of security lights to enhance security. These has seen education performance of many schools in Bunyala Sub-County improve with higher enrollment rate from primary to secondary schools. Through Budalang'i CDF

and REP, many schools in Bunyala Sub-County are connected with electricity for quality education provision. The results were also displayed in the figure below

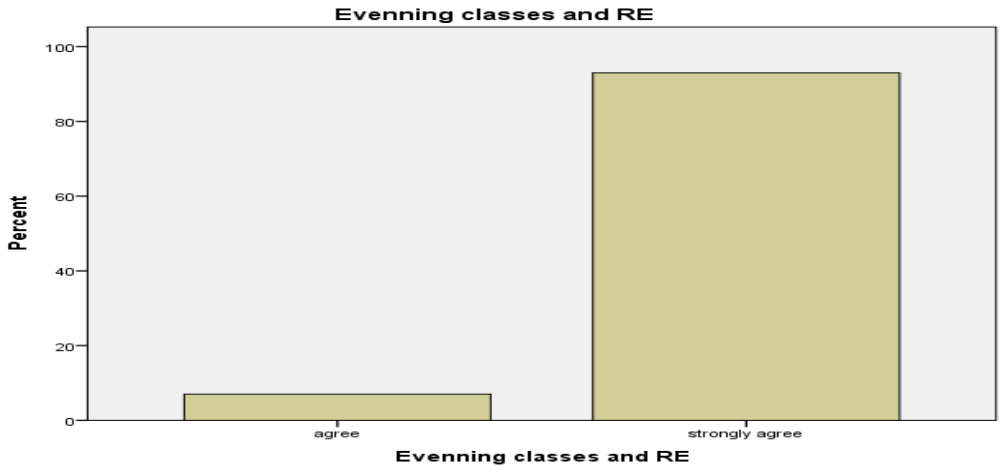


Figure 4.24: Morning and Evening (Education Sector) and RE

Source: Author

Table 4.26: Learning Environment and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	100	97.1	100.0	100.0

Source: Author

All the respondents agreed that inception of REP program in Bunyala Sub-County has led to a better learning environment in schools hence improved performance. Many schools are connected with electricity facilitating enhanced security through security lights, evening studies are enabled because of lighting, photocopying services in secondary schools, printing of exams and generation of automated report cards, lighting in dormitories etc. all provides a conducive learning environment to students and provision

of education services by teachers in schools. The results were also displayed in the figure below

Table 4.27: Education standards(Education Sector) and RE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	37	35.9	37.0	37.0
	Agree	55	53.4	55.0	92.0
	strongly agree	8	7.8	8.0	100.0
	Total	100	97.1	100.0	

Source: Author

The results above show that majority (63%) of the respondents strongly agreed and agreed that education standards in Bunyala Sub-County compare to other Sub-Countys in Busia county has tremendously improved courtesy of rural electrification program. Many primary schools and secondary schools from Bunyala Sub-County are amongst the top performing schools in Busia county. This is because of quality of learning environment as a result of inception of rural electrification program. Electrification can impact education because of increased time for studying and/or for more activity in general (as the "day" expands). Lipscomb APA, (2013) found that electrification at the county level led to improvements in both enrollment and literacy rates in Brazil. Khandker APA, (2012) find that household-level electrification led to increases in both completed years of schooling and daily study time in Bangladesh, with impacts almost twice as high for boys compared to girls. In the African context, studies find an increase in study time *after* nightfall, but only in Senegal are researchers able to identify an increase in total study time (Peters and Sievert 2016).

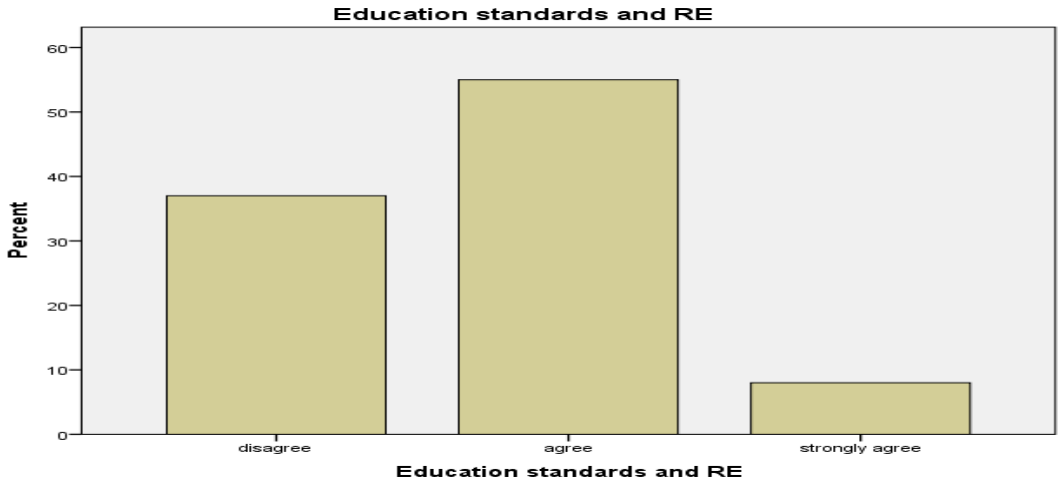


Figure 4.25: Education standards(Education Sector) and RE

Source: Author

Table 4.28: Descriptive statistics for Education sector

	N	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Schools lighting and RE	100	3.96	1.024	-.955	.241
Computer subject and RE	100	3.88	1.094	-.795	.241
Security in schools and RE	100	3.67	1.092	-.589	.241
Evenning classes and RE	100	4.93	.256	-3.422	.241
Learning environment & RE	100	4.00	.000	.727	.000
Electric fence and RE	100	1.61	.490	-.458	.241
Education standards and RE	100	3.34	1.066	-.312	.241

Source: Author

4.6 Inferential Analysis

To complement the descriptive results, the researcher conducted inferential analyses involving reliability test, analysis of variance (ANOVA), regression analysis, Karl

Pearson Correlation analysis and Diagnostic tests. The dependent variables in the study were; health sector, education sector, Income generating activities and Energy sector while the independent variable was rural electrification.

4.6.1 Reliability Test

The Cronbach's alpha approach is effective in determining the reliability of the questionnaire. The researcher utilized this approach in the pilot study where sample questionnaires were issued to a group of respondents. The main areas of concern were language and question clarity, and suitability. The Cronbach's alpha was employed in measuring the internal consistency or reliability of the questionnaires. The study conducted a pretest to test the reliability of the research instrument. Table 29 shows the results.

Table 4.29: Reliability Analysis

Factor	Cronbach's Alpha
Health sector	0.841
Education	0.750
Economic activities	0.703
Energy sector	0.760

Source: Author

From the results in Table 29 above, Health sector had a Cronbach's alpha value of 0.841, Education had Cronbach's alpha value of 0.750, Income generating activities had an alpha value of 0.703 while Energy sector had a Cronbach's alpha value of 0.760. Accordingly, all the Cronbach alpha values were found to be above 0.7 for all the variables and therefore the construct was found to be acceptable. This was supported by Mugenda and Mugenda, (2005) who stated that the reliability co-efficient of 0.7 and

above is accepted as being reliable test for study instrument. The questionnaires were therefore deemed to be reliable for further analysis.

4.6.2 Karl Pearson Correlation Analysis

Karl Pearson Moment correlation helps in testing the relationship between the explanatory variable so that the strength of the variables can be determined, to help establish which variable best explains the relationship between rural electrification, health sector, education sector, economic activities and energy sector.The correlation between energy sector and education sector is beyond 0.8, suggesting its multi collinearly. The results are as shown in Table 30

Table 4.30: Pearson Correlation coefficients

Variables	Correlations	Rural-electrificati	Health sector	Education	Economic Activities	Energy sector
Rural electrification	Pearson Correlation	1	.321	.526	.122	.062
	Sig. (2-tailed)	.000	.020	.032	.039	.027
Health sector	Pearson Correlation	.321	1	.426	.166	.263
	Sig. (2-tailed)	.020	.000	.002	.024	.001
Education Sector	Pearson Correlation	.526	.426	1	.042	.810
	Sig. (2-tailed)	.032	.002	.000	.047	.015
Economic activities	Pearson Correlation	.122	.166	.042	1	.792
	Sig. (2-tailed)	.039	.024	.047	.000	.007
Energy sector	Pearson Correlation	.062	.263	.810	.792	1
	Sig. (2-tailed)	.027	.001	.015	.007	.000

Source: Author

These results show that there is significant relationship among variables (rural electrification, health sector, education sector, economic activities and energy sector) since sig value < 0.05 at 5% level of significance. From the findings, there was a positive correlation between rural electrification and health sector with a Pearson correlation coefficient of 0.321 ($p < 0.05$), a positive correlation exists between rural electrification and education sector with a Pearson correlation coefficient of 0.526 (p-value 0.032 < 0.05) at 5% significance level. Equally, there exist a positive correlation between rural electrification and economic activities with a correlation coefficient of 0.122 (p-value 0.039 < 0.05) at 5% significance level. Rural electrification is positively correlated with energy sector depicting a correlation coefficient of 0.062 (p-value 0.027 < 0.05) at 5% level of significance. This implies that for every unit increase in rural electrification, there is a positive change in health sector, education sector, economic activities and energy sectors simultaneously. The other ideology supported by some institutions [World Bank, 2004] and some scholars Nieuwenhout APA,, (1998) is that the social benefits of RE are; lighting in increasing children's hours of study, making the evenings more productive and women more empowered. that lighting alone makes an impressive difference when it comes to the ability to do household chores during the evening hours and read for education and leisure. They point out the importance to appreciate RE's social impact.

4.7 Diagnostic Tests

The researcher estimated five models being, reliability test, analysis of variance (ANOVA), regression analysis, Karl Pearson correlation analysis and diagnostic test.

However, before reporting the results of the regression models, it was necessary to carry out diagnostic tests to ascertain that the OLS assumptions had been met and that the models estimated were reliable for making inferences. Pre-estimation diagnostics were carried out on the presence of autocorrelation and heteroscedasticity. Multicollinearity test was not performed since the study adopted univariate models for analysis.

4.7.1 Test for Autocorrelation

Autocorrelation test was performed to establish whether the error terms were serially interdependent using Durbin Watson statistics. Autocorrelation is present if the DW statistics is close to 0 and 4. A value of 0 shows evidence of perfect positive autocorrelation while 4 shows evidence of perfect negative autocorrelation. A Durbin Watson value between 2 and 2.5 indicates absence of autocorrelation. Absence of autocorrelation implies that the data is reliable and suitable for estimation. The results for autocorrelation test are presented in Table below.

Table4. 31: Autocorrelation Results

Model	Durbin Watson	Status
Model 1	2.38	No autocorrelation
Model 2	1.78	Weak positive autocorrelation
Model 3	2.20	No autocorrelation
Model 4	2.48	No autocorrelation

Source: Author

Table 31 indicates that model 1 had a Durbin Watson value of 2.38. Since this value lies between 2 and 2.5, it indicates absence of autocorrelation in the model. The Durbin

Watson values for models 3 and 4 was 2.20 and 2.48 respectively which imply absence of autocorrelation while model 2 had a D-W value of 1.78 which implies weak positive autocorrelation. The existence of weak positive autocorrelation does not have significant effect on the model estimation and prediction.

4.8.3 Test for Heteroscedasticity

Heteroscedasticity occurs when the variance of the error term is not constant in each period and for all values of the independent variable. This assumption violates the assumption of classical linear regression model which assumes that the variance of the error term remains constant. The test of hypothesis on the relationship between rural electrification and health sector, education sector, economic sector and energy sector. Heteroscedasticity may also occur when some important variables are omitted from the model. In this study, heteroscedasticity was tested by performing Breusch-pagan test to establish whether the residuals had a constant variance. Heteroscedasticity is present if the P-value is less than 0.05. The results are presented in Table below.

Table 4.32: Breusch-pagan test for Heteroscedasticity

	Chi-square	Prob > Chi-square
Model 1	8.23	0.3465
Model 2	4.23	0.765
Model 3	3.803	0.701
Model 4	7.920	0.291

Source: Author

The results of Table 32 indicate that in all the models, p-value is greater than 0.05 at 5% level of significance thus leading to the acceptance of the null hypothesis of a constant variance implying absence of heteroscedasticity.

4.9 Test of Hypothesis on the Relationship between Rural electrification and Health sector

The study sought to test the hypothesis whether there is no statistically significant effect of rural electrification on health sector in Bunyala Sub-County, Kenya.

4.9.1 Analysis of Variance

The Analysis of variance (ANOVA) was used to determine whether there was a regression relationship between rural electrification and health sector. The F-ratio in the ANOVA results tested whether the overall regression model was good and fit for making statistical inferences. The results obtained are presented in Table 33

Table 4.33: Analysis of Variance (ANOVA).

		Sum of Squares	Df	Mean Square	F-statistics	Sig.
1	Regression	2.743	2	2.743	15.353	.000
	Residual	64.507	98	0.179		
	Total	67.250	100			

Dependent Variable: Health sector
Independent Variable: Rural electrification Source:Author

The ANOVA results in Table 33 indicates that model 1 had an F-test value of 15.353 with the p-value of 0.000. The overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on health sector was rejected. Hence, the study concludes that there exists a significant effect of rural electrification on health sector in Bunyala Sub-County. This therefore shows that the model is fit for finding out the relationship between the dependent and independent variables hence suitable for making statistical inferences. The results were in agreement with Samad APA, (2013), Electrification addresses health impacts by reducing reliance on kerosene and biomass

fuels which reduces indoor air pollution. Consider some examples. Electrification was seen to reduce the number of respiratory infections in children under six years of age because of reduced kerosene use and lower particulate matter concentrations in electrified households.

4.9.2 Coefficient of Determination

The researcher extracted the model summary which portrays the coefficient of determination which measures the goodness of fit of the model. Table 34 shows the results of the model summary.

Table 4.34: Model 1 Summary

Model	R	R-Square	Adjusted R Square	Std. Error of the estimate
1	. 797[a]	.835	.873	.269

Source: Author

From the model summary, the explanatory power of the model measured by coefficient of determination R-square (R^2) was 0.835 and adjusted R-square of 0.873 implying that 87.3% of the health sector development in Bunyala Sub-County is significantly explained by the changes in rural electrification through the REP. On the other hand, only 12.7% of the contributions in health sector was influenced by other factors not captured in the model.

Table 4.35: Regression Coefficients

Model		Unstandardized Coefficients		Standardize Coefficients	t-value	Sig. value
		B	Std. Error	Beta		
1	(Constant)	3.646	0.160		22.844	.000
	Rural electrification	0.142	0.036	0.202	3.918	.000

Dependent variable: Health sector

Source: Author

The result in Table 35 indicates statistically significant effect of rural electrification on health sector development (p-value 0.000< 0.05) in Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in health sector (β= 0.202). This means that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity connectivity leads to developmental contributions in health sector by 20.2%. The results are inconsistent with study by Barnes (2004) reports that in Costa Rica after the electrification of rural areas, significant social improvements took place: the number of education institutions with lighting and night classes increased considerably, new hospitals were set up and the number of health centers increased.

4.10 Test of Hypothesis on the Relationship between Rural electrification and Education sector

The study sought to test the hypothesis whether there is no statistically significant effect of rural electrification on education sector in Bunyala Sub-County, Kenya.

4.10.1 Analysis of Variance

The Analysis of variance (ANOVA) was used to determine whether there was a regression relationship between rural electrification and education sector. The F-ratio in

the ANOVA results tested whether the overall regression model was good and fit for making statistical inferences. The results obtained are presented in Table 36

Table 4.36: Analysis of Variance (ANOVA).

Model		Sum of Squares	Df	Mean Square	F-statistics	Sig.
2	Regression	0.630	2	8.781	54.219	0.000
	Residual	21.282	98	0.162		
	Total	21.912	100			

Independent Variable: Rural electrification
Dependent Variable: Education sector Source:Author

The ANOVA results in Table 36 indicate that model 2 had an F-statistic value of 54.219 with the p-value of 0.000. The overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on education sector was rejected. Hence, the study concluded that there exists a significant effect of rural electrification on education sector in Bunyala Sub-County. This therefore shows that the model is fit for finding out the relationship between the dependent and independent variables hence suitable for making statistical inferences. Contrary to these findings, the rate of illiteracy in Kenya is high in non-electrified regions like Northern part of Kenya; Turkana, Wajir, Madera, Pokot, Narok and other part of rural Kenya. Most of urban area in Kenya is access to electricity e.g., Nairobi, Mombasa, Kisumu, Nakuru, Eldoret etc. hence the literacy level is high as the inhabitants not only access to electricity in their household for lighting, hence can have extra hours to study, watch television, access to internet with use of computer etc. The quality of education measured in terms of household expenditure on

education, marks (grades) obtained in the last final examinations, school drop-outs, school attendance rate, and time spent for study by students at night – all found much improved in the electrified than in the non-electrified household. Electricity matters in improving the quality of education. This quality improvement in the electrified households works through vary many channels: more time available for study after the sunset, the quality of that time due to sufficient light and fan for comfort, strengthening the knowledge-based due to access to TV (which in turn increases the appetite for learning), parents (especially mothers/other elder female members) devote more time in assisting children's education compared to before electricity etc.

4.10.2 Coefficient of Determination

The researcher extracted the model summary which portrays the coefficient of determination which measures the goodness of fit of the model. Table 37 shows the results of the model summary.

Table 4.37: Model 2 Summary

Model	R	R-Square	Adjusted R Square	Std. Error of the estimate
2	.502	.715	.703	.269

Source: Author

From the model summary, the explanatory power of the model measured by coefficient of determination R-square (R^2) was 0.715 and adjusted R-square of 0.703 implying that 70.3% of the education sector developmental contributions in Bunyala Sub-County are significantly explained by the changes in rural electrification through the REP. 29.7% of the contributions in education sector was influenced by other factors not captured in the

model. Primary schools currently seem to neither have the resources nor an elevated need for electricity. Even in electrified regions, electricity is only used, if at all, for the installation of the headmaster's office. Secondary schools, on the other hand, do have significant electricity needs where schools have a back-up electricity system. On a daily basis, students' study during night at school. Commonly two thirds of them are boarders, staying in nearby dormitories. Many schools already have computers and television sets, but due to the high fuel costs, they can use them only sporadically. It therefore is quite probable that these schools will substitute grid electricity for their present electricity sources.

To further test for the hypothesis, linear regression was carried out and results presented in table 38

Table 4.38: Regression Coefficient

Model		Unstandardized Coefficients		Standardize Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	3.070	0.164		18.750	.000
	Rural Electrification	0.277	0.038	0.361	7.363	.000

Dependent Variable: Education sector

Source: Author

The result in Table 38 indicates statistically significant effect of rural electrification on education sector developmental contributions (p-value 0.000< 0.05) in Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in contributions to education sector (β= 0.361). This means that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity connectivity leads to developmental contributions in education sector by 36.1%. The

results were in agreement with the overall literacy rate in Bangladesh was found much higher at 70.8% in the electrified households, compared to that in the non-electrified with 54.3% in the electrified villages and 56.4% in the non-electrified villages. Compared to the non-electrified households, the overall literacy rates for both male and female in the electrified were significantly higher, especially due to the household's access to electricity which has contributed much both in economic terms as well as in raising awareness about value of education. The rich-poor divide in literacy was also less pronounced in the electrified than that in the non-electrified households. The adult literacy high rate for both male and female, relatively less gender disparity, and relatively less rich-poor divide. Therefore, of literacy, it can be forcefully argued that ensuring access to electricity in the households should be seen as a major strategy to reduce the knowledge-poverty (in terms of both raising overall literacy and adult literacy) in rural Bangladesh. The gross enrolment ratio – one of the major indicators of educational attainment - was high at 64% in the electrified villages, and around 55% in the non-electrified households.

4.11 Test of Hypothesis on the Relationship between Rural electrification and Economics activities

The study sought to test the hypothesis whether there is no statistically significant effect of rural electrification on income generating activities in Bunyala Sub-County, Kenya.

4.11.1 Analysis of Variance

The Analysis of variance (ANOVA) was used to determine whether there was a regression relationship between rural electrification and income generating activities. The

F-ratio in the ANOVA results tested whether the overall regression model was good and fit for making statistical inferences. The results obtained are presented in Table 39

Table 4.39: Analysis of Variance (ANOVA)

Model		Sum of Squares	df	Mean Square	f	Sig.
3	Regression	.9197	1	9.197	57.194	.000
	Residual	58.053	311	0.161		
	Total	67.250	312			

Independent Variable: Rural electrification
Dependent Variable: Economic activities *Source:Author*

The ANOVA results in Table 39 indicate that model 3 had an F-statistic value of 57.194 with the p-value of 0.000. The overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on income generating activities was rejected. Hence, the study concluded that there exists a significant effect of rural electrification on economic activities in Bunyala Sub-County. This therefore shows that the model is fit for finding out the relationship between the dependent and independent variables hence suitable for making statistical inferences. The results are inconsistent with Fluitman (1983), who points out that electricity in the rural had no major impact on the income generation and employment of the rural poor. Having more spare time enables the villagers to engage in additional income activities like weaving, kitchen gardening, small services, etc. But here it must be borne in mind that electricity is a prerequisite for further investments in the agricultural sector, and that only two years at most had passed since electricity was introduced in these villages. Once the density of monetarization (the actual amount of money circulating in local rural economies) increases, there will be

more investments in new machines and technologies to strengthen local agricultural productivity.

4.11.2 Coefficient of Determination

The researcher extracted the model summary which portrays the coefficient of determination which measures the goodness of fit of the model. Table 40 shows the results of the model summary.

Table 4.40: Model 3 Summary

Model	R	R-Square	Adjusted R Square	Std. Error of the estimate
3	.692	.885	.826	3 .079

Source: Author

From the model summary, the explanatory power of the model measured by coefficient of determination R-square (R^2) was 0.885 and adjusted R-square of 0.826 implying that 82.6% of the income generating activities in Bunyala Sub-County are significantly explained by the inception of rural electrification through the REP. 17.4% of the income generating activities are influenced by other factors not captured in the model.

To further test for the hypothesis, linear regression was carried out and results presented in table 41.

Table 4.41: Regression Coefficient

Model		Unstandardized Coefficients		Standardize Coefficients	t-value	Sig. value
		B	Std. Error	Beta		
3	(Constant)	2.585	0.223		11.587	.000
	Rural electrification	0.380	0.050	0.370	7.563	.000

Dependent Variable: Economic activities

Source: Author

The result in Table 41 indicates statistically significant effect of rural electrification on income generating activities (t-value 0.000< 0.05) in Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in income generating activities (β= 0.370). This means that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity connectivity leads to increased income generating activities by 36.1%. The results are consistent with study by Prasad and Dieden (2007) indicated that growth in income generating Rural Electrification and Rural Development activities primarily resulted from businesses already connected to electricity. Prasad and Dieden used household survey data between 1995 and 2004 to examine the impact of electrification on the development of micro, small and medium sized enterprises and those in self-employment amongst households. They estimated that between 40 and 53 % of the increase in enterprise activity was attributed to the extension of the electricity grid, indicating that enterprise growth was higher amongst those already connected. However, in the more remote rural areas the take up did appear to be stronger. It increased by more than 40 % amongst non-connected and only 10 % amongst the connected. Enterprises were mainly in the wholesale and retail sectors. The increase in cellular telephone technology was also a contributing factor to uptake.

World Bank (2006), the societal approach involves two different areas of data interpretation. It is evident from this study that although households do not necessarily record a change in the household incomes resulting from projects implemented at the households, at the community level, this is not the case. The empowerment at the community levels follows a shared view that the communities with connectivity are developed than those that are not connected. On the other hand, there is a shared view that land value has significantly increased over the last 6 years with the connections being prevalent in the last 4 years. The socio-cultural impact on the societal level is also tremendous - village life has changed not only individually but also collectively. Electricity empowers communities, resulting in more community activities and strengthening solidarity among members of the community. On the other hand, the socio-economic impact - interpreted from the macro-economic level - is less evident. In the current situation, community economies are too weak to permit investment in new machinery or equipment that could raise agricultural productivity. Very few farmers can afford to buy new electrically powered rice-mills, for instance. As yet, the impact of rural electrification on the local economies cannot be seen directly, in terms of higher family incomes through the use of new techniques, or greater agricultural productivity - only indirectly.

4.12 Test of Hypothesis on the Relationship between Rural electrification and Energy sector

The study sought to test the hypothesis whether there is no statistically significant effect of rural electrification on energy sector in Bunyala Sub-County, Kenya.

4.12.1 Analysis of Variance

The Analysis of variance (ANOVA) was used to determine whether there was a regression relationship between rural electrification and energy consumption. The F-ratio in the ANOVA results tested whether the overall regression model was good and fit for making statistical inferences. The results obtained are presented in Table 42

Table 4.42: Analysis of Variance (ANOVA)

Model		Sum of Squares	df	Mean Square	F-statistic	Sig. value
4	Regression	.9197	2	7.127	17.004	.000
	Residual	58.053	98	0.191		
	Total	67.250	100			

Independent Variable: Rural electrification
Dependent Variable: Energy consumption *Source:Author*

The ANOVA results in Table 42 indicates that model 4 had an F-statistic value of 17.004 with the p-value of 0.000. The overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on energy consumption was rejected. Hence, the study concluded that there exists a significant effect of rural electrification on energy consumption in Bunyala Sub-County. This therefore shows that the model is fit for finding out the relationship between the dependent and independent variables hence suitable for making statistical inferences. Extending electricity access to rural areas is an important part of ending energy poverty, and there is an increasingly diverse set of technologies available for rural electrification (RE). These include extension of the national grid as well as mini-grids and stand-alone systems (World Bank and KTH Royal

and Institute of Technology 2017). But simply extending electricity access does not guarantee that the negative consequences of energy poverty will be mitigated.

4.12.2 Coefficient of Determination

The researcher extracted the model summary which portrays the coefficient of determination which measures the goodness of fit of the model. Table 43 shows the results of the model summary.

Table4.43: Model 4 Summary

Model	R	R-Square	Adjusted R Square	Std. Error of the estimate
4	.077	.595	.576	34 .009

Source: Author

From the model summary, the explanatory power of the model measured by coefficient of determination R-square (R^2) was 0.595 and adjusted R-square of 0.576 implying that 57.6% of energy consumption in Bunyala Sub-County is significantly explained by the inception of rural electrification through the REP. 42.4% of the energy consumption is influenced by other factors not captured in the model.

To further test for the hypothesis, linear regression was carried out and results presented in table 44.

Table 4.44: Regression Coefficient

Model		Unstandardized Coefficients		Standardize Coefficients	t-value	Sig. value
		B	Std. Error	Beta		
3	(Constant)	2.585	0.223		2.587	.000
	Rural electrification	0.380	0.050	0.610	3.063	.000

Dependent Variable: Energy Consumption

Source: Author

The result in Table 44 indicates statistically significant effect of rural electrification on energy consumption (p-value 0.000< 0.05) in Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in energy consumption (β= 0.610). This means that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity connectivity leads to increased electricity consumption by 61%. Lack of electricity access is one component of energy poverty; the other is reliance on polluting fuels, such as firewood, dung, agricultural waste, or kerosene, to meet household energy needs (IEA 2011).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of main research findings, conclusions and recommendations for further research as discussed under the research objectives.

5.2 Summary of Research Findings

This section provides a summary of the findings of the research objectives which included; To assess the effect of Rural Electrification Program on the income generating activities in Bunyala Sub-County, Kenya, to evaluate the effect of Rural Electrification Program on health facilities and services in Bunyala Sub-County, Kenya, investigate the effect of Rural Electrification Program on Education sector in Bunyala Sub-County, Kenya and to determine the effect of Rural electrification program on Energy sector in Bunyala Sub-County, Kenya .

5.2.1 Socio-Economic development of Rural electrification

Based on the first objective of the study; to assess the impact of rural electrification program on the income generating activities in Bunyala sub-county, Majority (78%) of the respondents in Bunyala Sub-County indicated that because of rural electrification program, they engage in income generating activities like poultry farming, Fish preservation, shopkeeping, posh-milling e.t.c that largerly depends on electricity supplied while 22% of the sample population are involved in other forms of income generating activities that doesn't rely on electricity. In regard to second objective, Majority (86%) of the respondents noted that rural electrification has led to development contributions to

health sector in Bunyala Sub-County. Port-Victoria sub-Sub-County hospital is equipped with automated health services like x-rays, scanning e.t.c. Only 14% of the respondents noted that rural electrification has not had tremendous contributions to health sector especially in flood prone regions like Maduwa and Bulwani which all have dispensaries but connected with electricity. Similarly, majority (82%) of the respondents strongly agreed and agreed that since the inception of rural electrification program, most primary and all the secondary schools in Bunyala Sub-County are connected with electricity for lighting to enhance security. Only 18% of the respondents disagreed that many primary schools are not connected with electricity for lighting purposes possibly because such schools like Bubamba, Maduwa, Igigo e.t.c are located in swampy regions making it difficult for accessibility and installation of power lines by Rural electrification and Renewable energy.

5.2.2 Model Findings

The results for model 1 indicated an F-test value of 15.353 with the p-value of 0.000. The overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on health sector was rejected. Hence, the study concludes that there exist a significant effect of rural electrification on health sector in Bunyala Sub-County. The explanatory power of the model measured by coefficient of determination R-square (R^2) was 0.835 and adjusted R-square of 0.873 implying that 87.3% of the health sector development in Bunyala Sub-County is significantly explained by the changes in rural electrification through the REP. Similarly, the results indicated statistically significant effect of rural electrification on health sector development (p-value 0.000< 0.05) in

Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in health sector (β= 0.202). This means that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity connectivity leads to developmental contributions in health sector by 20.2%.

In regard to model 2, the results indicated an F-statistic value of 54.219 with the p-value of 0.000. The overall model was significant since the p-value 0.000 < 0.05 at 5% level of significance, therefore, the null hypothesis that there is no statistically significant effect of rural electrification on education sector was rejected. Hence, the study concluded that there exists a significant effect of rural electrification on education sector in Bunyala Sub-County. The explanatory power of the model measured by coefficient of determination R-square (R^2) was 0.715 and adjusted R-square of 0.703 implying that 70.3% of the education sector developmental contributions in Bunyala Sub-County are significantly explained by the changes in rural electrification through the REP. The model indicated statistically significant effect of rural electrification on education sector developmental contributions (p-value 0.000< 0.05) in Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in contributions to education sector (β= 0.361). This means that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity connectivity leads to developmental contributions in education sector by 36.1%. The results were in agreement with the overall literacy rate in Bangladesh was found much higher at 70.8% in the electrified households, compared to that in the non-electrified with 54.3% in the electrified villages and 56.4% in the non-electrified villages.

5.3 Conclusions

The following conclusions were made from the study. It is evident that the rural communities with easy access to the tarmac road are mainly served with the connection. It is also evident that the communities near the power grid are mostly served faster than those in interior from the main grid. At the household level, households that are near the tarmac road and close to the main grid of connection are well served.

Connectivity of the electricity at the households and the communities has many uses that vary from the households and the community levels. At the household level, electricity use is through the appliances that are acquired and used by the households that require electricity to run. From the findings, at the household level, the household mainly use the electric power for lighting. This is reported in all the households. On the other hand, heavy consumption witnessed with high consumption appliances such as hot instant showers, refrigerators as well as microwave warmers are rarely in use. At the community level, electricity connection is mainly in enterprises such as battery charging outlets, shops, barber shops among others. Religious buildings are the least in connection. Schools are also well served with electricity.

The study concludes that all models were statistically significant (p-value 0.000< 0.05) implying significant effect of rural electrification on , health sector, education sector, income generating activities and energy consumption in Bunyala Sub-County. The results equally show that rural electrification has a positive contribution to a unit change in; energy consumption (β= 0.610), income generating activities (β= 0.370), contributions to education sector (β= 0.361) and health sector (β= 0.202). These implied that, ceteris paribus, a unit increase in rural electrification measured in terms of electricity

connectivity leads to increase in contributions to health sector, education, economic activities and energy sector.

5.4 Recommendations

Drawing from the research findings and conclusions discussed herein, the study makes the following recommendations:

i. The government should review the regulations that govern rural electrification. For rural electrification to be successful the infrastructural development should be considered. Communities near the tarmac road are likely to benefit more. Therefore, there is need to either review the rural electrification policy or guidelines or develop the infrastructure in all areas to enable the realization of rural electrification.

ii. The Government should be proactive in determining the economic value of the rural electrification project. A thorough economic analysis does not yield much to the investment in the rural areas. Perhaps, the government should enlighten the communities on what more they can do with electricity. From the findings, communities and households are only using electricity for mainly lighting and seem not aware of the enormous benefits they would accrue to having electricity.

iii. There is need for the government to speed up the rural electrification. This will make communities to feel that they are developed, since communities feel that they are more empowered with electricity connectivity, even if the lives do not necessarily change, security is improved, and increased land value which also spurs investor confidence.

iv. It is apparent that rural electrification is not sufficient to increase economic changes, the government should initiate programs that will enable the communities to acquire machinery adequate to install income generating activities such as mechanization of agriculture, installing outlets for business. The use of devolved funds through county governments as well as other funds such as the youth, women and constituency development fund will be most beneficial.

5.5 Suggestions for Further Research

The researcher suggests further research on the following areas:

i. Empirical analysis of rural electrification on education outcomes in Bunyala Sub-County, Kenya.
ii. Rural electrification and attainment of big four agenda by Jubilee Government.
iii. Modeling of rural electrification and its impact on productivity in Kenya.

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APPENDIX I

LETTER OF INTRODUCTION

My name is Thomas Taka Ouma, a postgraduate student of Moi University pursuing Master of Public Administration Degree and carrying out a field research. The focus of this study is on: **EFFECT OF RURAL ELECTRIFICATION ON SOCIO-ECONOMIC DEVELOPMENT IN BUNYALA SUB-COUNTY, KENYA.** You have been identified as a respondent and the information will be used purely for academic purpose and your name will not be mentioned in the report. Findings of the study, shall upon request, be availed to you.

Your assistance and cooperation will be highly appreciated.
Thank you

Thomas Taka Ouma
Researcher

APPENDIX II

QUESTIONNAIRE FOR RESPONDENTS

By means of a tick (√) kindly indicate an option that best describes:

1. Gender

☐ Female ☐ Male

2. Age Bracket

Below 20 years [ ] 20-30 years [ ] 31-40 years [ ]
41-50 years [ ] Above 50 years [ ]

3. Level of Education

Primary [ ] Secondary [ ] Tertiary [ ]

A.IMPACT OF RURAL ELECTRIFICATION ON INCOME GENERATING ACTIVITIES

3. Do you have any income generating activity which depends on electricity?

A. ☐ Yes B. ☐ No

5. Which income generating activities do you carry out?

A. ☐ Weaving B. ☐ Sewing C. ☐ Carpentry D. ☐ Poultry

☐ ☐ ☐ ☐

E. Iron Works F.Fish Preservation G. Ice Making H. Posho-mill

Other Specify_____

_____

Please indicate the extent of influence of Rural electrification program on income generating activities. Please tick (□) as appropriate in a corresponding box. Use a scale of 1 to 4, where 1. Low 2. Moderate 3. High 4. None

		1	2	3	4
	What is the extent of influence of Rural electrification program on production and milling of rice from Bunyala irrigation scheme				
	To what extent does rural electrification influence fishing and fish preservation in Bunyala Sub-County.				
	To what extent does rural electrification influence welding and Jua cali industry in Bunyala Sub-County.				
	To what extent does rural electrification program influence carpentry as income generating activity in Bunyala Sub-County.				
	To what extent does rural electrification program influence sewing as income generating activity in Bunyala Sub-County.				
	To what extent does rural electrification program influence Poultry farming as income generating activity in Bunyala Sub-County.				
	To what extent does rural electrification program influence posho-milling as income generating activity in Bunyala Sub-County.				
	To what extent does rural electrification program influence Ice making as income generating activity in Bunyala Sub-County.				

9. What other new major economic activities do you know of that have come up due to the availability of electricity result from Rural Electrification and Renewable energy in Bunyala Sub-County?_____

10. What size of industries do you have?

A. ☐ Small scale B. ☐ Medium scale C. ☐ Large scale

B.IMPACT OF RURAL ELECTRIFICATION ON HEALTH SECTOR DEVELOPMENT IN BUNYALA SUB-COUNTY

Have there been any development contributions by rural electrification on health sector in Bunyala Sub-County?

1.YES_____ 2. NO_____

To what extent do you agree with the following statements about rural electrification? Please tick (□) as appropriate in a corresponding box. Use a scale of 1 to 5, where 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree

		1	2	3	4	5
	Does the local Sub-County hospital offer mortuary services as a result of rural electrification					
	Does the hospital offer vaccination facilities					
	In your view have medical services such as laboratories services, X-Ray e.t.c improved after the connection of electricity by Rural Electrification and Renewable energy?					
	In your opinion has the efficiency of services delivery at the hospital Bunyala Sub-County improved after power connection by Rural Electrification and Renewable energy?					
	Are all the dispensaries and health centers in Bunyala Sub-County connected with electricity to enhance lighting?					
	Automation of service delivery like payment of hospital bills is influenced by rural electrification program					

5. In your view, in what specific ways has the availability of electricity through Rural Electricity affected the health sector?_____

C.IMPACT OF RURAL ELECTRIFICATION ON EDUCATION SECTOR

To what extent do you agree with the following statements about rural electrification? Please tick (□) as appropriate in a corresponding box. Use a scale of 1 to 5, where 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; and 5 = Strongly Agree

	Do schools in Bunyala Sub-County connected with electricity to enhance lighting	1	2	3	4	5
	Schools in Bunyala Sub-County offer computer as a subject because of electricity connectivity by RE program					
	Security in schools in Bunyala Sub-County is enhanced by electricity connectivity by RE program					
	Many primary and secondary schools in Bunyala Sub-County conduct evening classes facilitated by electricity lighting					
	In your view has availability of electricity through RE program improved learning environment in schools in Bunyala Sub-County					
	Many schools in Bunyala Sub-County have electric fences to enhance security in schools					
	In your opinion has the standard of education improved after power connection?					

6. In your opinion has the standard of education improved after power connection

Explain_____