FACTORS INFLUENCING ACCESS TO RENEWABLE ENERGY BY RURAL HOUSEHOLDS IN KENYA: A CASE OF SIMGAS BIOGAS PROJECT IN CENTRAL IMENTI, MERU COUNTY

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DECLARATION

I declare that this research project is my original work and has not been submitted for a degree in any other university or college for examination or academic purposes.

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L50/9681/2018

This research project has been submitted for examination with our approval as the University Supervisors.

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DEDICATION

I dedicate this research project to my parents Mr. and Mrs. Kimathi and my siblings Purity, Martin, Dennis and Linah for their continued support during the period of study

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ABBREVIATIONS AND ACRONYMS

ABPP African Biogas Partnership Program

ANOVA Analysis Of Variance

BSP Biogas Support Partnership

EIA Environment Impact Assessment

GEF Global Environment Facility

GER Green Economy Report

GHG Greenhouse Gas

IT Information Technology

KENDBIP Kenya National Domestic Biogas Program

KENFAP Kenya National Federation of Agricultural Producers

KPLC Kenya Power and Lighting Company

LPG Liquefied Petroleum Gas

MDGs Millennium Development Goals

MOERD Ministry of Energy and Regional Development

MW Megawatt

NGOs Non-Governmental Organizations

OFREPS On-Farm Renewable Energy Production Survey

RETs Renewable energy technologies

SEP Special Energy Program

SPSS Statistical Package for Social Sciences

UN United Nations

UNEP United Nations Environmental Programme

ABSTRACT

Adoption of renewable sources of energy has been low in rural areas due to varying factors like poverty levels, nature of human settlements and dispersed populations. In Central Imenti, Meru County, most of the rural population use kerosene for lighting and charcoal or firewood for cooking which are known to have caused many health problems due to the carbon emitted as well as burns caused by the open flames, the huge risks of house fires and suffocation from use of these traditional fuels. The study established the factors influencing access to renewable energy by rural households in Kenya, A case of Simgas Biogas Project in Central Imenti, Meru County. The study was guided by the following objectives: to establish influence of household income, availability of information, cost analysis and availability of alternative source of energy on access to renewable energy by rural households in Central Imenti, Meru County in Kenya. The study was grounded on resource dependence theory. For this study, a descriptive research design was undertaken to ascertain and be able to describe the characteristics of variables of interest. The target population was 512 that include; the Meru County Energy Department officials, Community leaders, Ministry of Energy, Project managers and SIMGAS Biogas Project officials. To obtain the desired sample size of 216 for the study with the population of 512, Nassiuma formula was used. Stratified random sampling was used. Primary data was obtained using self-administered questionnaires. After data cleaning, which entailed checking for errors in entry, descriptive statistics such as frequencies, percentages, mean score, standard deviation and coefficient of variation was estimated for all the quantitative variables. The qualitative data from the open-ended questions was analyzed using conceptual content analysis. Multiple regression analysis was used to establish the relations between the independent and dependent variables. The information was presented in form of tables. The employment status of household heads, level of household income and the ability to pay influenced the access to renewable energy to a great extent. The availability of information proved to be of very great influence on the access to renewable energy. technical knowhow influenced access to renewable energy in rural households very greatly while the ease of access and installation cost influence access to renewable energy in rural households greatly. The types of alternative energy sources influence the access to renewable energy by rural households in Meru County very greatly while reliability, affordability and individual preferences influence the access to renewable energy by rural households in Meru County. The study concluded that availability of information had the greatest effect on the access to renewable energy by rural households in Central Imenti, followed by cost analysis, then household income while availability of alternative source of energy had the least effect to the access to renewable energy by rural households in Central Imenti. The study recommends that the government could arrange for a plan that allows households to pay an agreeable small amount of money per month in a bid to increase the use of renewable energy. The study further recommends that Ministry of Energy should provide training and education to increase the availability of information and awareness on the use of renewable energy.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Renewable energy is energy that can be derived from resources which are naturally replenished on a human continuance, for instance sunlight, biogas, wind, hydropower, tides, waves and geothermal heat. Renewable energy sources can substitute conventional energy sources in four distinguishable areas: electricity generation, hot water/space heating, motor fuels, and rural (off-grid) energy services (World Bank, 2014). World energy consumption is projected to grow by 56% between 2010 and 2040, from 524 quadrillion British thermal units (Btu) to 820 quadrillion Btu. Most of this growth will come from non-OECD (non-Organization for Economic Cooperation and Development) countries, where demand is driven by strong economic growth (EIA, 2013). However, adverse health effects from energy use are aggravated by increasing instances of land degradation and deforestation, leading to a simultaneous loss of biodiversity.

Renewable energy technologies include, inter alia, the provision of electricity generated from renewable sources such as wind, solar, water, tide/wave and geothermal, and the provision of other modern energy services that are powered by renewable sources for activities such as household heating, space conditioning and water pumping. These kinds of technologies have long been subject to international debate and action as a means of expanding access to electricity by means of off grid or grid extension programmes. Similarly, the development of RETs such as improved cookstoves to increase efficiency and reduce health impacts of traditional fuel use has had a long history and has shown some success. However, growing concern over climate change and the increasing acceptance of a need for low-carbon development trajectories have provided renewed emphasis on improving access to modern energy services using RETs. Global investments in renewable energy in 2010 reached US$211 billion representing a year-on-year increase of 32 percent. The increase was mainly because of wind farm development in China and small-scale solar PV installations in Europe (UNEP, 2011).

For the past 10 years, it has been frequently estimated that around 2 billion people have no access to modern energy services. Reducing rural poverty through rural development is viewed as a key requirement to achieving these goals, and underpinning this is the need for expanding access to modern energy services. Modern energy services are benefits derived

from modern energy sources, such as electricity, natural gas, clean cooking fuels and mechanical power, that contribute to human well-being. Most rural societies experience limited access to modern energy services, due to problems of availability and/or affordability. Instead, they rely on traditional fuels – predominately animal dung, crop residues, and wood – for the majority of their energy needs. Such energy poverty has a serious impact on living standards and productivity. When burned, traditional fuels often produce hazardous chemicals with negative health impacts, especially when used indoors (Kandeh, 2012).

The Green Economy Report (GER), (UNEP, 2011) provides that global community and national governments are faced with various challenges regarding to the energy sector such as access to energy Twice that number – nearly 40 per cent of the world's population relies on wood, coal, charcoal, or animal waste to cook their food. Kandeh (2012) establishes that climate change and emissions: Energy-related greenhouse gas (GHG) emissions are the main drivers of anthropogenic climate change, exacerbating patterns of global warming and environmental degradation. Global carbon dioxide emissions from fossil-fuel combustion are reported to have reached a record high of 31.6 gigatonnes. According to EIA (2013), India was the fourth-largest energy consumer in the world after China, the United States, and Russia in 2011, and its need for energy supply continues to climb as a result of the country's dynamic economic growth and modernization over the past several years. At the same time, India's per capita energy consumption is one-third of the global average and is projected to grow at 2.8% by 2040 (Mahat, 2014).

Biogas technology is considered as a sustainable renewable energy source that can be used for cooking, lighting, heating and power generation. Biogas is a clean energy which consists of methane 60 percent -70 percent and carbon dioxide 30 percent -40 percent, 1–5 percent hydrogen and traces of nitrogen, hydrogen sulphide, oxygen, water vapor, and slurry It offers various benefits such as saving fuel wood and protecting forests as well as reduces expenditure on fuels. It further reduces household labor on time spend on cooking and housekeeping and improves hygienic conditions (Gregory, 2010). The gas is produced through anaerobic digestion process, a biological process that happens naturally when bacteria breaks down organic matter of plant origin in environments with little or no oxygen. On smallholder farms, biogas is derived from anaerobic decomposition of livestock wastes-dung, urine and waste feeds (Karanja and Kiruiro, 2013).

Biogas technology has been advanced around the world as a renewable energy by various organizations such as government agencies, international organizations and non-governmental organizations (NGOs). For instance, Biogas support program (BSP) has been promoting the use of biogas in Nepal since 2003. By 2009 the program had achieved installation of 208,000 biogas plants benefitting 1.25 million people across the country (Rai, 2009). Traditional forms of energy used for cooking in rural Nepal come mainly from cattle dung cakes, fuelwood and agriculture residues. However, since the early 1990s there has been an increased effort to utilize biogas produced from cattle manure, human excreta and vegetable wastes in anaerobic bioreactors. This has significant potential to generate income, improve livelihoods and save fuel costs. Today there are over 170,000 household biogas plants in Nepal, and the development of the sector owes a great deal to the Biogas Support Partnership (BSP), an independent non-profit organization financially supported by the Netherlands, Germany and Nepal (Gautam et al., 2009). Health and biodiversity is the processing and use of energy resources pose significant health challenges, pertaining to increased local air pollution, a decrease in water quality and availability, and increased introduction of hazardous substances into the biosphere (Kandeh, 2012).

Japan has adopted targets for the deployment of renewable energy through 2020. These targets are sizable both in terms of total installed capacity as well as the anticipated contribution of renewable energy. A critical objective of renewable energy development in Japan is to reduce emissions and the reliance on imported energy by decoupling rising fossil energy use from economic growth over the next several decades. This decoupling is expected to have a positive impact on local air and water quality as environmental pollution is estimated to cost over 4 percent of GDP each year (Karplus, Paltsev & Reilly, 2010).

Africa as a region continues to face critical challenges in its energy sector characterized by inadequate access to modern energy services, low purchasing power, poor infrastructure, low investments and over reliance on traditional biogas to satisfy their basic energy requirements. Comparing Africa with other parts of the globe, the lack of access to energy is most pronounced in the continent. In most Sub-Saharan countries access to the electricity grid is less than 1 percent. In spite of the environmental, social and health challenges associated with its use, traditional biogas still remains the major source of energy for the majority of the poor. Biogas accounts for about 70-90 percent of primary energy supply in some economies and about 86 percent of energy consumption. Moreover, adoption of renewable energy is limited due to high initial transition costs (Love, 2012). There are however distinct variations within

the continent, with biogas energy accounting for only 5 percent of energy consumption in Northern Africa and 15 percent in South Africa (Daly, 2012).

Access to modern energy services and electricity is in many developing countries, particularly in sub-Saharan Africa. If the MDGs are to be achieved in these parts of the world, then significant efforts are needed to bring rural areas out of energy poverty. This can be done in two ways: increasing access to energy for domestic use essentially increasing access to technologies which use modern fuels or make use of traditional fuels in cleaner, safer and more environmentally sound ways. Mwakaje (2012) revealed that in Tanzania households with biogas were saving 3-4 hours per day that was previously used in wood fuel collection. Biogas technology also helps in soil fertility improvement. Mwirigi et al. (2014), suggests that social- cultural factors have slowed down the promotion and dissemination of biogas technology in many areas of Sub-Saharan Africa, because biogas is considered to be a dirty technology and social stigma exists against its use. Amigun et al. (2010) observes that although the development of large-scale anaerobic digestion technology in Africa is still embryonic, but it has a lot of potential in the future.

The energy sector in Kenya is largely dominated by petroleum and electricity, with wood fuel providing the basic energy needs of the rural communities, urban poor, and the informal sector. An analysis of the national energy shows heavy dependency on wood fuel and other biomass that account for 68 percent of the total energy consumption (petroleum 22 percent, electricity 9 percent, others account for 1 Kenya National Domestic Biogas Program). Kenya has vast renewable energy resources such as solar, wind, biomass, bio-fuel, geothermal and hydropower although their exploitation has been limited (apart from hydropower). Therefore, renewable energy accounts for approximately 67.1 percent, thus Kenya power generation is now majorly green. Expansion of the renewable energy sector is being catalysed by the increasing global oil and gas prices and environmental pressure. Currently, the Kenyan energy sector is characterized by the heavy reliance on unsustainable biomass use, frequent power outages, low access to modern energy, over reliance on hydroelectricity and high dependence on oil imports. Renewable energy is, therefore, an important and timely means to meet the challenges of growing demand and addressing the related environmental concerns (UNEP, 2011).

Biogas technology in Kenya has continuously been promoted by national and International organizations (both Government and NGO) over the last 50 years. One such organization is

Kenya National Federation of Agriculture Producers (KENFAP) which has set up the Kenya National Domestic Biogas Program (KENDBIP), with a goal of developing the biogas sector especially in high potential areas such as Central and Western Kenya. So far, under Kenya National Domestic Biogas Program (KENDBIP), almost 7,000 biogas digesters have been built with a target goal of 11,000 (2020 action). Special Energy Program (SEP) in conjunction with the Ministry of Energy and Regional Development (MOERD) undertook to promote biogas in Kilifi and Kwale in the late 1980's (Kandeh, 2012).

Meru County is found in the eastern region of Kenya, approximately 225 kilometers northeast of Nairobi. It covers an area of 6,936 square kilometers. Meru shares it border with five other counties; Isiolo to the North, Nyeri to the South West, Tharaka-Nithi to the South West and Laikipia to the West. The county's economy relies mostly on agriculture. Most people are engaged in subsistence farming where they grow common foods such as maize, beans, sorghum, millet cabbages and fruits. Other grow coffee and tea as cash crops and take their teas for processing in nearby factories including Weru, Kionyo, Githongo and Imenti Tea Factory. Commercial fruit growing has become popular under Bill and Melinda Gates foundation's Project Nurture. This includes small scale growing of mangoes and passion fruit in Imenti. The county is renowned for its wide scale growing of the Miraa (Khat) - a herbal plant, which turned a lucrative cash crop for the locals. The Khat is mostly grown in Maua, Igembe and Tigania and fetches millions of shilling in the export market for its farmers (Mwirigi et al., 2014).

In Central Imenti areas, most people can easily afford biomass energy as most homesteads are surrounded by woodlands, farmlands, forests and bush lands; hence, the 45% of dependability on forests for provision of this and 93% dependability on biomass as a source of energy. Biogas technology has been advanced as a renewable energy by various organizations such as government agencies, international organizations and non-governmental organizations (NGOs). The promotion has since been taken up by the energy centers under the Ministry of Energy. Mwirigi et al. (2014) cited socio-economic factors including levels of education, gender of household head, low levels of awareness of the potential uses of biogas, and the small size of land-holdings, which limits the number of different types of land use unless the uses are complimentary as some of the hindrances to biogas adoption. The future for biogas energy in Central Imenti, Meru County is bright especially in high density areas where zero grazing is practiced (Ngigi, 2010).

1.2 Statement of Problem

Renewable sources of energy have been promoted in order to meet growing demand. However, poverty levels and the nature of human settlements and dispersed populations mean that these have been unable to cope with the demand for clean energy at the household level (Mukami, 2016). In Central Imenti, Meru County, most of the rural population use kerosene for lighting and charcoal or firewood for cooking and are not using biogas despite frantic efforts to convince them to use it among other renewable energy sources, which are known to have caused many health problems due to the carbon emitted as well as burns caused by the open flames, the huge risks of house fires and suffocation from use of these traditional fuels. Despite of all these and other efforts that have been put forth in order to improve and increase the supply and use of biogas in this sub-county, very low levels of adoption has persisted in this region as most households still treasure the traditional sources of energy (REA, 2013).

Several studies have been done in relation to access to renewable energy such as; Nzai and Gitonga (2018) factors influencing access to renewable energy by rural families: A case of solar lanterns project in Isiolo County, Kenya, Bundi (2014) did an assessment of factors influencing the choice and adoption of biogas technology among the peri-urban residents of Kisii County, Keriri (2013) assessed factors influencing adoption of solar technology in Lakipia North Constituency, Kenya. Momanyi (2015) did an analysis of biogas technology adoption among households in Kilifi County. From the studies, society's reliance on fossil fuels energy represents one of the major challenges to global environmental sustainability and economic stability. However, none of these studies reviewed focused on factors influencing access to renewable energy by rural households in Kenya. Therefore, this study sought to bridge this gap by establishing the factors influencing access to renewable energy by rural households in Kenya, specifically Simgas Biogas Project in Central Imenti, Meru County.

1.3 Purpose of the Study

The study established the factors influencing access to renewable energy by rural households in Kenya. A case of Simgas Biogas Project in Central Imenti, Meru County.

1.4 Objectives of the Study

The study was guided by the following objectives:

i. To establish how household income influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

ii. To evaluate how availability of information influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya.
iii. To determine how cost of energy influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya.
iv. To establish how availability of alternative source of energy influence on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

1.5 Research Questions

The study sought answers to the following research questions:

i. How does household income influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya?
ii. To what extent does availability of information influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya?
iii. How does cost influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya?
iv. To what extent does availability of alternative source of energy influence access to renewable energy by rural households in Central Imenti, Meru County in Kenya?

1.6 Significance of the Study

The findings of the study might be useful to government and organizations who are interested in promoting biogas as an alternative source of renewable energy. Bio-energy is already making a substantial contribution to supplying global energy demand, and can make an even larger overall contribution by facilitating greenhouse gas savings and other environmental benefits. Besides contributing to the energy security and improving trade balances, encouraging biogas provides opportunities for social and economic development in rural communities, and helps the management of waste, thus improving resource management

To scholars and academicians, this study would increase body of knowledge to the scholars of performance of biogas projects. This would contribute to the pool of knowledge in the study area and it would help in shaping energy and environment policies as regards resource use and environmental conservation. Besides, findings from the study would add to the existing body of knowledge concerning performance of biogas projects. This would serve as a platform for further research into issues related to performance of biogas projects.

The community might benefit from the study through understanding how biogas could be used to improve the living conditions of the residents and the environment. Furthermore, the family members might have more input for agricultural production. This study had significance to many local people that were struggling to triumph and improve performance of biogas projects.

1.7 Limitation of the Study

There were unknown conditions or factors at the facility where the participants reside, work, or study that bias the responses of the participants. In addition, technical and financial barriers contributed to the understanding on levels of uptake of renewable energy technologies (RETs) in the region. This was a challenge in accessing information that the study sought. Meru is also prone to conflict, so security was a threat. The respondents targeted in this study were reluctant in giving information fearing that the information being sought was used to intimidate them or print a negative image about them. The researcher handled this by carrying an introduction letter from the University to assure them that the information they gave was treated with confidentially and was used purely for academic purposes.

The other limitation was that the study was based in Meru County, the study did not include more biogas projects around the Country owing to the amount of time and resources available. This study therefore suffered from generalizability of the results if the nature of projects undertaken was significantly different from those in Meru County such as non-governmental funded and performance of biogas projects.

1.8 Assumption of the Study

The study assumed that participants would answer the interview questions in an honest and candid manner. The inclusion criteria of the sample were appropriate and therefore, assured that the participants have all experienced the same or similar phenomenon of the study. Additionally, the study assumed that the participants had a sincere interest in participating in the research and did not have any other motives, because they agreed to be in this study. Finally, the study assumed that the authorities would grant the required permission to collect data.

1.9 Delimitation of the Study

The study established the factors influencing access to renewable energy by rural households in Kenya. The study specifically focused on Simgas Biogas Project in Central Imenti, Meru

County. The study was guided by the following objectives: to establish influence of household income, Availability of information, availability of information and availability of alternative source of energy. The target population included the Meru County Energy Department officials, Community leaders, Ministry of Energy, Project managers and SIMGAS Biogas Project officials. The study was carried out in a period of three and a half months.

1.10 Definition of Significant Terms Used in the Study

The following are the definitions of terms that were used throughout this study:

Adoption of modern technologies: Refers to a straightforward process whereby the best technology wins in the marketplace, satisfying consumer needs and a choice to acquire and use it is made

Availability of alternative source of energy: is any energy source that is an alternative to fossil fuel. Marine energy, hydroelectric, wind, geothermal and solar power are all alternative sources of energy.

Household income: total income from all people living in particular household.

Availability of information: is the state or ability to access information or resources in a specified location and in the correct format.

Cost: the outlay or expenditure (as of effort or sacrifice) made to achieve an object

1.11 Organization of the Study

This study is organized into five chapters. Chapter one contains the introduction to the study. It presents background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the Study, delimitations of the study, limitations of the Study and the definition of significant terms. On the other hand, chapter two reviews the literature based on the objectives of the study. It further looks at the conceptual framework and finally the summary. Chapter three covers the research methodology of the study. The chapter describes the research design, target population, sampling procedure, tools and techniques of data collection, pre-testing, data analysis, ethical considerations and finally the operational definition of variables. Chapter four presents analysis and findings of the study as set out in the research methodology. The study closed with chapter five which presents the discussion, conclusion, and recommendations for action and further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides an extensive literature and research related to factors influencing access to renewable energy by rural households. This literature review summarizes a diverse spectrum of views about access to renewable energy projects. The chapter is thus structured into theoretical, conceptual and empirical review. The study also presents the knowledge gap the chapter seeks to fulfill.

2.2 Access to Renewable Energy

Access to renewable energy can be defined as a household's ability to use alternative energy source when its available and affordable. For energy to be considered available to a household, the household must be within the economic connection and supply range of the energy network or supplier. Affordability refers to the ability of the household to pay the up-front connection cost (or first cost) and energy usage costs. A high up-front cost may discourage poor households from making a switch to a modern energy form. To increase the rate of adopting innovations and to make relative advantage more effective, direct or indirect financial payment incentives may be used to support the individuals of a social system in adopting an innovation. Incentives are part of support and motivation factors (National Agricultural Statistics Service, 2011).

The low income made it difficult for parents to enroll and retain their children in school due to costs for uniforms, books and transportation to schools. High dropout rates were another factor identified as a cause for low level of education by Muhammad and Khuram (2011). Okereke et al. (2013) revealed that early marriages undermine the achievement of universal primary education and subsequently the empowerment of women. A study carried out in Jordan by IFAD (2007) revealed that households continually earned very little due to a number of factors. These factors include: poor soil quality and topography of land, low rainfall, and limited access to alternative income sources. Unavailability of technical services could be due to biases in technology transfer such as spatial, project, professional, personal and diplomatic perpetuated by extension and professional officers (Chambers, 2013).

The 2009 On-Farm Renewable Energy Production Survey (OFREPS) was the first national survey of on-farm renewable energy generation. It addressed only distributed generation of on farm renewable energy applications owned and operated as part of individual farm

operations.3 It excluded large wind systems of 100 kilowatts or more, which are generally commercial applications often located on farms but operated by other business entities under wind rights lease agreements with the farm. The number of small wind systems has almost doubled since 2001 (American Wind Energy Association 2011), while solar power has increased by 146 percent since 2000 (Sherwood, 2010). The OFREPS survey provides insights about renewable electricity in agriculture and factors that influence distributed generation.

2.3 Household income and Access to Renewable Energy

The influence of household income on renewable energy adoption has been examined on the residential (Mills & Schleich, 2009). The economics of a renewable energy installation are also dependent on the resource potential available for energy production. The more potential there is for energy production, the faster the payback period is for the initial investment in the renewable system and the larger potential savings over the life of the system. Funding plays a great role in the formulation of Renewable Energy Technologies (RETs) policies. Researchers have shown that one of the primary obstacles to carrying out renewable energy projects is frequently not the technical feasibility of these projects instead it is the absence of low cost, long term funding. This situation is complicated more by competition for limited financing by the various projects and gets critical if the nation is running under unfavorable macro-economic circumstances. Therefore, the governments and private firms must find creative means of funding RETs projects (Vanhove, 2018).

The main challenge of funding RETs projects is to come up with models that can give these technologies to consumers at affordable costs while securing that the industry stays sustainable. There is limited policy support for RETs as shown by minimum budget allotment to renewables at government level. As a result, the private sector is left to bear the weight of funding RETs. Majority of advanced and electric RETs are not affordable to most of the population in Africa who are poor, with poverty degrees of between 50 to 70% (World Bank, 1996). This is true particularly for RETs that have huge cost of imported parts, then those that can be locally produced and assembled utilizing locally available parts. The RETs with huge cost of importing parts put an extra burden on foreign exchange reserves of African economies, which are frequently little and approaching exhaustion, and needs expensive funding strategies and huge subsidies (National Agricultural Statistics Service, 2011).

The subsidies are unsustainable in the long term, except when the technologies given are planned to include income generation. Banks have unfavorable demands for RETs funding. They usually make strict terms for RETs investors and this discourages potential consumers. The terms needed include a feasibility study carried out at the applicant's costs, because of the limited know how on renewables by banking institutions. Additionally, the banking institutions require title deeds as collateral, portfolios of project sponsors and directors, information on past and current activities, a valuation report, estimate value of existing investment, raw material procurement strategy, and the marketing plans for the final product (Onasanya, 2017).

In instances where funding mechanisms are offered for consumers, they are in many times not within the reach of the most of the population. For instance, the UNDP/GEF Photovoltaic (PV) project in Zimbabwe profited mainly the wealthy rural households, due to the fact that over 80% of rural consumers could not afford the smallest unit even at the cheapest prices. Rigorous requirements for funding applications kept out the majority of the rural consumers from qualifying. Another research carried out in Manicaland, Zimbabwe on the viability of PV, 65% of the rural population could not be able to pay up the solar service fee, whereas 91.5% could not be able to pay for a credit scheme (Iqbal et al. 2013).

In rural areas, households consider electricity also as only one among various sources of energy. Most research among households registered a high willingness to pay for electricity. Once a community is electrified, the households can only make use of it if they invest in lighting gear and modern appliances like refrigerators, radios and television sets. The ability to pay for the new energy source as well as the ownership of appliances that go with it, is strongly related to income. In consequence, also in electrified villages, the usage of electricity is hampered by factors, like income, prohibitive connection fees and (lack of) appliance ownership (Louw, Conradie, Howells & Dekenah, 2008). 'In communities with electricity for more than 10 years, between 15 and 20 % of the households remain without connection', since these households cannot afford it (IEG, 2008,).

2.4 Availability of information and Access to Renewable Energy

In today's increasingly global, digital, and networked economy (Reddy, 2011), access to information represents a substantial investment for most corporations and constitutes a significant aspect of organizational work. However, its value is realized only when information systems are utilized by their intended users in a manner that contributes to the

strategic and operational goals of the firm or household. Not surprisingly, researchers and practitioners alike are concerned with the issue of understanding and managing user reactions to information technologies. In response to this concern, several theoretical models have been proposed to better understand and explain individual attitudes and behaviors

A study conducted in Bangladesh by Kabiret al. (2013) revealed that education is determinant in adoption of biogas as those who have more education want clean energy and they also recognize the importance of such energy to environmental conservation. He further asserts that government or organizational subsidies or loans make it easier for households to adopt biogas since the initial cost becomes or is made affordable and the people are given training and follow ups by the government. In Pakistan number of cattle, level of education, size of household and family income were some of the factors that influenced a household's decision to adopt biogas.

According to Wang et al. (2012) and Fei and Yu (2011) biogas use in China is affected by family size, age, gender, education level and knowledge and awareness. Support from government in terms of finances and policy also affected use of biogas in China. The International Bank for Reconstruction and Development: World Bank (2009) in Cambodia found out that, more that only 6% of rural households have access to electricity. Of these, 80% depended on kerosene as their primary source of lighting fuel and over 90% used biomass energy for sustenance. Another study by Heltberg (2003) in a number of developing countries such as Brazil, Ghana and India found out that the use of kerosene in most households came second after biomass fuels as these two were the most available sources of energy (Tian, 2013).

Information, education and social learning are also described as factors that determine rates of adoption energy systems. Lack of information regarding the energy systems and the associated benefits have been shown as a barrier towards adoption. Research has explained that outsourcing, social economic factors, physical infrastructure and financing are likely to influence connectivity to the national grid. Sustainable energy investment was $70.9 billion in 2006, an increase of 43% over that of 2005. The sectors with the highest levels of investment are wind, solar and bio-fuels, which reflects technology maturity, policy incentives and investor appetite. For instance, Nepal has made honest efforts to attract private to invest in renewable energy sector, and in Biogas sector bout 40% cost is covered by the subsidy and the rest by beneficiary households (Wanyoike, 2012).

2.5 Cost and Access to Renewable Energy

East Africa is facing growing energy demands alongside rising levels of fossil fuel consumption coupled by acerbated cost. Together with the growing urban populations and deforestation, greenhouse gas emissions are increasing, that's why there is need for renewable energies (UN Secretary-General Ban Ki-moon, 2012). For many years, there have been predictions that energy supplies particularly fossil fuels would run out and cause recessions from which the world would not recover. Production of oil, gas and coal would not be available to keep indefinitely the growing global demand (Day, 2010). According to Day, at some stage there must be a supply gap. Recent reports as quoted by Day, estimated that there would be a gap of 15% of energy supply by 2010 rising to 23% in 2015 and 32% in 2020. He further comments that as the World fields decline, the prices will rise as it was evident in the year 2008 where prices rose from 100 US dollars to 139 US dollars per barrel against a long-term trend of fewer than 50 dollars. What this data indicates is that there is an increasing energy supply gap caused by diminishing supply of non-renewable energy sources hence demand for alternative renewable energies to fill the gap.

In developed countries, energy for cooking, heating and lighting is readily available at a relatively low cost. This is due to the fact that being aware of the energy predicted energy shortages, they have invested in both the centralized sources and extensive distribution systems to make the energy available to the citizens and business (Wawa, 2012). On the other hand, developing countries, processing and cooking food is accomplished mainly by biomass energy where women spend significant part of their time during the day gathering fuel wood and are exposed to harmful smoke and other by-products of burning organic material (English Articles, 2010).

Currently, nearly 1.5 billion people worldwide are still without access to electricity because of insufficient population density and low number of potential customers in rural areas, lack of public funds and private disposable income. Therefore, electrification at affordable prices through the extension of the central electricity grid will most likely not be available in the foreseeable future so that decentralized renewable energy technologies are already the most economical option for electrification of remote regions (Denkhaus, 2004). Given the continuously rising energy and commodity prices, it can be expected that the use of decentralized renewable energies will be even more attractive and competitive in the future. This is especially relevant in Sub-Saharan Africa where only 14.3% of the population in rural areas have access to electricity (IEA, 2009).

2.6 Availability of Alternative Source of Energy and Access to Renewable Energy

Kenya has a diverse source of energy; both renewable and non-renewable. Some of the most common sources of energy include biomass (wood fuel and charcoal), wind, solar, geothermal, biogas, and coal. Although all these sources of energy exist, it is worth noting that the exploitation on large-scale of renewable energy in Kenya, apart from geothermal and to some extent, cogeneration of electricity, has largely remained low as most individuals prefer to use the traditional sources of energy as they are cheap and easily available. In addition to biomass (wood fuel and charcoal), other sources of energy that are commonly used in Kenya, more so in rural areas include solar and wind energy. In most rural households, most alternative that are used have a direct link with the socio-economic status of such households. In addition to petroleum products including gas, about 83% of the urban residents have access to kerosene and almost 76% use it for cooking and 61% for lighting. As a result of the common nature of kerosene in most households, kerosene is one of the energy sources with a very effective distribution chain that ensures that it reaches the most remote of places. This has been enabled by numerous kerosene retailers who buy kerosene for resale in small quantities, which most rural households can afford. Due to this, it has become a greater challenge to move people from using it to using cleaner sources of energy (Reddy & Srinivas, 2009).

On the other hand, as research studies show Kenya receives an estimated 4 to 6 kWh per square meter per day of solar insolation. This is equivalent to about 300 million tonnes of oil per day. Although only a tiny fraction of this resource is harnessed for commercial and household use including crop and animal products' drying, water heating, water pumping and lighting, and entertainment, still there is quite a number of individuals who prefer this to electricity due to costs. In addition to this, solar PV technologies are normally used as the main source of off-grid electricity in urban and rural areas, more so those that are far from the main electricity grid lines. As of 2004, it was estimated that more than 120, 000 units of solar PV systems had been disseminated in Kenya. Most of these were distributed by institutional and corporate entities (Disenyana, 2009).

In addition to firewood, kerosene and solar energy, some communities in Kenya are served by wind energy, although it harnessing is at the lowest levels. In rural areas, this form of energy is normally used to pump water. Additionally, in some areas wind energy is used for lighting and other process that require low amounts of electricity. For example, there some electricity generating generators that have been installed in Ngong Hills Nairobi, Marsabit,

and some parts of North Eastern. From this, such energy is transmitted to the national grid, after which it is distributed. This basically means that, although these areas are able to generate their own electricity, most of them do not enjoy its benefits as it has to go through the national grid before it is distributed back to these areas by Kenya Power and Lighting Company

Moreover, there is also geothermal energy which feeds quite a number of megawatts to the national grid. In Kenya, this form of energy is mainly used for electricity generation and to some level for greenhouse heating. It is worth noting that, geothermal energy is arguably, the most successfully exploited renewable energy source/technology in the country. The country's experience in the development of the technology has not only made Kenya a market leader in geothermal related issues in the region, but also a world leader. Its implementation started in the early 80's with a 45 MW installation and has gradually grown with time to produce about 130MW of electricity; about slightly over 10% of the total electricity generated in the country (KPLC, 2016).

The availability of numerous sources of energy has a great effect on the electrification of rural households, as most individuals have a tendency of selecting a source of energy that is mostly available and cheap. As research studies show, although most rural households use biomass as their main source of energy, there is quite a number who have started to adopt the usage of LPG gas. Although this is the case, it is worth noting that most of the households that have adopted the usage of LPG are much better social-economically; hence, the transition. Otherwise, the availability of biomass sources of energy had made most rural households to stick to their traditional sources of energy. In addition to biomass, kerosene is another commonly used source of energy in rural areas because of its availability. Most rural households use kerosene for lighting and cooking (Veenis, 2013).

2.7 Theoretical Review

This section discusses the theoretical foundation on which the study is anchored. The study was grounded on resource dependence theory.

2.7.1 Resource Dependence Theory

This theory was developed by Pfeffer and Salancik (2014). In employing this theory to this study, the researcher looks at how the dependence on external resources organizations influences the modern technologies adoption among small scale agriculture projects. Further, the author argues that the wildlife conservation projects under study are dependent on

resources, these resources ultimately originate from the environment of donors, the environment to a considerable extent contains other organizations, the resources one organization needs are thus often in the hand of other organizations, resources are a basis of power, legally independent organizations can therefore be dependent on each other (Jakachira, 2013).

In addition, organization should move through the principle of criticality and principle of scarcity, therefore by adopting this theory, the researcher also argues that; in as much as organizations are inter-dependent, the theory of Resource Dependence needs a closer examination. Its' very weakness lies in its very assertions of dependence. According to this theory, organization depends on resources for their survival; therefore, for any organization to achieve sustainability, resources are indispensable. For community-based organizations to achieve performance, resources are important. The researcher therefore argues that these resources will not only come in the form of financial resources but for project sustainability, other resources of human for example volunteers and land should be considered.

2.8 Conceptual Framework

A conceptual framework considers the theoretical and conceptual issues surrounding research work and form a coherent and consistent foundation that underpinned the development and identification of existing variables. The independent variables include household income, availability of information and availability of alternative source of energy while the dependent variable access to renewable energy projects.

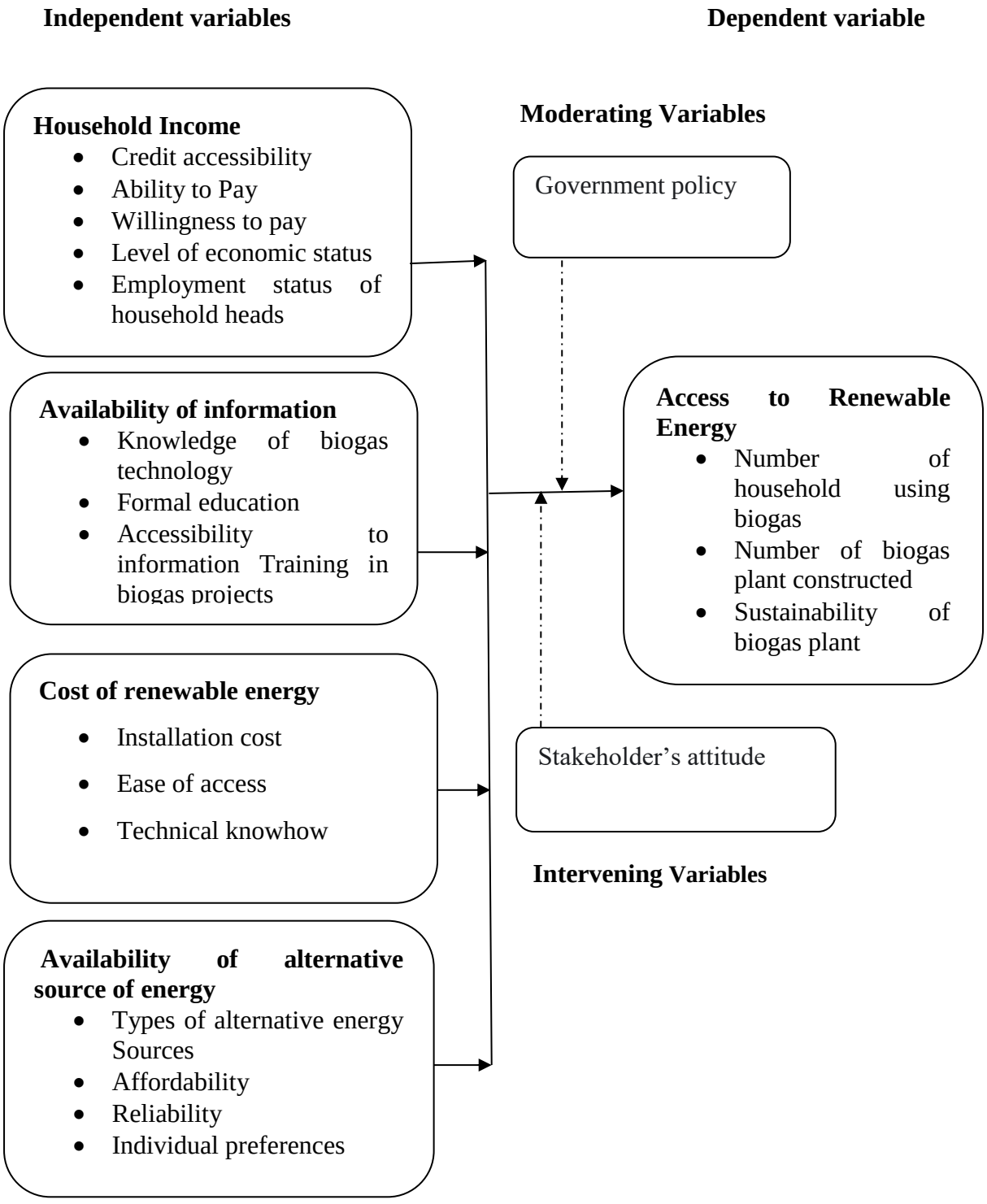

Figure 1: Conceptual Framework

2.9 Research Gaps

Previously, studies have been done in relation to access to renewable energy such as; Nzai and Gitonga (2018) factors influencing access to renewable energy by rural families: A case of solar lanterns project in Isiolo County, Kenya. Although the study had almost similar

variables to the current study, its focus was in Isiolo county and was done specifically on solar lantern projects.

Bundi (2014) did an assessment of factors influencing the choice and adoption of biogas technology among the peri-urban residents of Kisii County. The study sought to assess the level of people's awareness and attitude towards biogas technology, to explore the root causes of low technology adoption in relation to the efforts so far executed in biogas promotion, to assess the efficacy of biogas technology in comparison to other sources of household energy and sought to explain the roles and challenges stakeholders face in their effort to promote biogas technology in Kisii county. The study used multiple sampling procedure which involved purposive selection.

Keriri (2013) assessed factors influencing adoption of solar technology in Lakipia North Constituency, Kenya. This study dwells on the solar technology and target population is mainly the farmers of Laikipia North constituency. Momanyi (2015) did an analysis of biogas technology adoption among households in Kilifi County. The study examined the underlying factors of non-adoption of biogas among households in Kilifi County. The study has different variables such as Unavailability of Technical services, Average household monthly income, Household head's level of education, Cattle ownership, Lack of credit facilities, Non-availability of household labor, Gender of household head, Age of household head and Land Size owned. However, none of these studies reviewed focused on factors influencing access to renewable energy by rural households in Kenya. Therefore, this study seeks to bridge this gap by establishing the factors influencing access to renewable energy by rural households in Kenya, specifically Simgas Biogas Project in Central Imenti, Meru County

2.10 Summary

In summary, most insights on fuel choice stem from the empirical analysis of cooking and lighting fuel choices. In addition, the determinants for the adoption of solar energy technologies are typically examined without putting them into the context of a particular fuel choice and often based on non-representative samples and case studies. As lighting fuel choices and the role of lighting in energy use in developing countries have not been investigated as thoroughly as cooking fuel choices, the researcher focused the analysis on the fraction of household energy consumption that goes to lighting.

Due to non-sustainable use of fossil fuels and traditional biomass fuels have led to increased awareness and widespread research on the accessibility of new and renewable energy

resources, such as biogas. Consequently, there are calls from governments, private sector and the scientific community to develop and adopt alternative energy sources that couple reductions in the use of fossil fuels with decreased greenhouse gas emissions. Renewable energy has the potential to play a major role in reducing Africa's acute power supply gap. Hence increasing energy supply from renewable sources not only reduces the risks from rising and volatile prices for fossil fuels, but also brings climate change mitigation benefits. Biogas which is produced from renewable sources can play an important role in meeting both energy and environmental problems.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the researcher identified the procedures and techniques that were used in the collection, processing and analysis of data. Specifically, the following subsections were included; research design, target population, sample size and sampling procedures, data collection instruments, pilot testing, data collection procedures, data analysis techniques, ethical considerations and operationalization of variables.

3.2 Research Design

A research design is the overall strategy that you choose to integrate the different components of the study in a coherent and logical way, thereby, ensuring the researcher effectively addresses the research problem; it constitutes the blueprint for the collection, measurement, and analysis of data (Gorard, 2013). For this study, a descriptive research design was undertaken to ascertain and be able to describe the characteristics of variables of interest. Descriptive research design is the process of collecting data in order to answer questions concerning the current status of the subject of the study. Thus, this approach was suitable for this study, since the study intended to collect comprehensive information through descriptions which was helpful for identifying variables (Bryman & Bell, 2011). Descriptive studies describe characteristics associated with the subject population portraying an accurate profile of persons, events or situations (Saunders, Lewis & Thornhill, 2009). According to Avoke (2015), descriptive surveys are designed to portray accurately the characteristics of individuals, situations or groups. It is used as a needs assessment tool to provide information on which to base sound decisions and to prepare the background for more constructive programmed of educational research.

3.3 Target population

Target population is described by Borg and Grall (2009) as a universal set of study of all members of real or hypothetical set of people, events or objects to which an investigator wishes to generalize the result. Rubin and Rubin (2005) emphasized that to ensure credibility of research, the researcher should interview people who understand and have deeper information about the issue. This is because the credibility of the interviews depends on the knowledgeability of the interviewees or participants of the study. The target population

included the Meru County Energy Department officials, Community leaders, Ministry of Energy, Project managers and SIMGAS Biogas Project officials.

Table 3.1: Target Population

Categories	Population	Percentage
Meru County Energy Department officials	98	19.1
Community leaders	234	45.7
Ministry of Energy	66	12.9
Project managers	78	15.2
SIMGAS Biogas Project officials	36	7.1
Total	**512**	**100.0**

3.4 Sample Size and Sampling Procedure

According to Cooper and Schinder (2014), sample frame is the list in the population from which the sample is actually drawn. A working sampling frame was developed, which consisted of Meru County Energy Department officials, Community leaders, Ministry of Energy, Project managers and SIMGAS Biogas Project officials.

3.4.1 Sample Size

Sample size has an effect on how the sample findings accurately represent the populations (Burns & Bush, 2009). The sample size is a subset of the population that is taken to be representatives of the entire population (Kumar, 2011).

To obtain the desired sample size for the study with the population of 512, Nassiuma (2000) formula was used as shown;

$$n = \frac{N\,(cv^2)}{Cv^2 + (N-1)\,e^2}$$

Where ***n***= sample size

N = population (512)

Cv= coefficient of variation (take 0.6)

e= tolerance of desired level of confidence (take 0.05) at 95% confidence level)

$$\mathbf{n} = \frac{\mathbf{512\,(0.6^2)}}{\mathbf{0.6^2 + (512-1)\,0.05^2}} = \mathbf{216.12}$$ (rounded to **216**)

Table 3.2: Sample size and procedure

Categories	Population	Sampling Ratio	Sample
Meru County Energy Department officials	98	0.422	41
Community leaders	234	0.422	99
Ministry of Energy	66	0.422	28
Project managers	78	0.422	33
SIMGAS Biogas Project officials	36	0.422	15
Total	**512**		**216**

3.4.2 Sampling Procedures

Sampling is a deliberate choice of a number of people who are to provide the data from which a study draws conclusions about some larger group whom these people represent. Stratified random sampling is unbiased sampling method of grouping heterogeneous population into homogenous subsets then making a selection within the individual subset to ensure representativeness. The goal of stratified random sampling is to achieve the desired representation from various sub-groups in the population. In stratified random sampling subjects are selected in such a way that the existing sub-groups in the population are more or less represented in the sample (Marshall & Rossman, 2015).

3.5 Data collection Instruments

Primary data was obtained using self-administered questionnaires. The questionnaire was made up of both open ended and closed ended questions. The open-ended questions were used so as to encourage the respondent to give an in-depth and felt response without feeling held back in illuminating of any information and the closed ended questions allowed the respondent to respond from limited options that had been stated. According to Saunders (2011), the open ended or unstructured questions allow profound response from the respondents while the closed or structured questions are generally easier to evaluate. The questionnaires were used in an effort to conserve time and money as well as to facilitate an easier analysis as they are in immediate usable form and also, they are the preferred instruments for collecting data in survey studies

3.5.1 Pilot Testing

Pilot testing refers to putting of the research questions into test to a different study population but with similar characteristics as the study population to be studied (Gillham, 2011). The researcher carried out a pilot study to pretest the validity and reliability of data collected using the questionnaire. 21 questionnaires were administered to the pilot survey respondents

who were chosen at random. After one day the same participants were requested to respond to the same questionnaires but without prior notification in order to ascertain any variation in responses of the first and the second test. This is very important in the research process because it assists in identification and correction of vague questions and unclear instructions. It is also a great opportunity to capture the important comments and suggestions from the participants. This helped to improve on the efficiency of the instrument. This process was repeated until the researcher was satisfied that the instrument did not have variations or vagueness.

3.5.2 Validity of Research Instruments

According to Golafshani (2012), validity is the accuracy and meaningfulness of inferences, based on the research results. One of the main reasons for conducting the pilot study is to ascertain the validity of the questionnaire. The study used content validity which draws an inference from test scores to a large domain of items similar to those on the test. Content validity is concerned with sample-population representativeness. The knowledge and skills covered by the test items should be representative to the larger domain of knowledge and skills. Expert opinion was requested to comment on the representativeness and suitability of questions and give suggestions of corrections to be made to the structure of the research tools. Content validity was obtained by asking for the opinion of the supervisor, lecturers and other professionals on whether the questionnaire was adequate.

3.5.3 Reliability of Research Instruments

Reliability analysis measures the extent to which the research instruments are without bias and the consistency of results over time using an identical data collection method (Revelle & Zinbarg, 2008). Reliability is achieved when the same research process is repeated and reproduces results within stated confidence limits. Keller (2010) states that the reliability of an investigation is satisfying if another researcher can conduct the same research and draw the same conclusions. Reliability is concerned with estimates of the degree to which a measurement is free of random or unstable error. Reliable instruments are robust and they work well at different times under different conditions (Welman & Kruger, 2014). This has to do with the ability of a research finding to replicate itself if a parallel study is conducted. Thus, in order to ensure the finding of this research the Cronbach Alpha was used to test the reliability of questions asked for this research. The alpha value ranges between 0 and 1 with reliability increasing with the increase in value. Coefficient of 0.7 is a commonly accepted rule of thumb that indicates acceptable reliability (Zikmund, Babin, Carr & Griffin, 2012).

3.6 Data Collection Procedures

The researcher obtained an introduction letter from the university which was presented to each manager so as to be allowed to collect the necessary data from the respondents. The drop and pick method was preferred for questionnaire administration so as to give respondents enough time to give well thought out responses. The researcher personally administered the research instruments to the respondents. This enabled the researcher to establish rapport, explain the purpose of the study and the meaning of items that were not clear as observed by Brewer (2010).

3.7 Data Analysis Techniques

Data analysis gives a mechanism of coming up with inductive conclusions from data and distinguishing the issue under study from statistical for fluctuations that are in the research data (Manikandan, 2011). Data was analyzed using Statistical Package for Social Sciences (SPSS Version 25.0). All the questionnaires received were referenced and items in the questionnaire was coded to facilitate data entry. After data cleaning which entailed checking for errors in entry, descriptive statistics such as frequencies, percentages, mean score, standard deviation and coefficient of variation were estimated for all the quantitative variables and information presented inform of tables. The qualitative data from the open-ended questions were analyzed using conceptual content analysis.

Inferential data analysis was done using multiple regression analysis. Multiple regression analysis was used to establish the relations between the independent and dependent variables. The multiple regression model was chosen because it is useful in establishing the relative importance of independent variables to the dependent variable (Bryman & Cramer, 2012). Such importance is deduced from standardized regression coefficients (beta-weights), whose magnitudes show how much relative impact the independent variables have on the dependent variable, while the negative and positive signs associated with the coefficients show negative and positive impacts respectively (Park, 2008). Also, it is ideal for the dependent variable to be recorded at a continuous level of measurement**.** Since there are four independent variables in this study the multiple regression model generally assumes the following equation;

$$\boldsymbol{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon}$$

Where: -

Y= Access to renewable energy

β_0=constant

$\beta_1, \beta_2, \beta_3, \beta_4$ and β_5 = Regression coefficients

X_1= Household income

X_2= Availability of information

X_3= Technological factors

X_4= Availability of alternative source of energy

ε=Error Term

3.8 Ethical Considerations

Ethical considerations in research are critical. First, in dealing with the participants, they were informed of the objective of the study and the confidentiality of obtained information, through a letter to enable them give informed consent. Once consent was granted, the participants maintained their right, which entailed but is not limited to withdraw or decline to take part in some aspect of the research including rights not to answer any question or set of questions and/or not to provide any data requested; and possibly to withdraw data they had provided. Caution was observed to ensure that no participant was coerced into taking part in the study and, the researcher sought to use minimum time and resources in acquiring the information required. Secondly, the study adopted quantitative research methods for reliability, objectivity and independence of the researcher. While conducting the study, the researcher ensured that research ethics were observed. Participation in the study was voluntary. Privacy and confidentiality were also observed. The objectives of the study were explained to the respondents with an assurance that the data provided was used for academic purpose only.

3.9 Operationalization of Variables

The operationalization of variables is shown in Table 3.3.

Table 3. 3: Operationalization of Variables

Objectives	Type of Variable	Variable	Indicators	Measurement scale	Tools of analysis	Type of analysis
To establish influence of household income on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.	Independent	Household income	Credit accessibility Ability to Pay Willingness to pay Level of household income Employment status of household heads	Interval Interval Nominal Interval Nominal Nominal	Percentages Mean score	Descriptive statistics Regression analysis
To evaluate influence of Availability of information on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.	Independent	Availability of information	Knowledge of biogas technology Formal education Accessibility to information Training in biogas projects Social learning capabilities	Nominal Nominal Interval	Percentages Mean score	Descriptive statistics Regression analysis
To determine the influence of cost analysis on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.	Independent	Cost Analysis	Installation cost Ease of access Technical knowhow	Interval Nominal Nominal	To determine the influence of cost on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.	Independent
To establish influence of availability of alternative source of energy on access to renewable energy by	Independent	Availability of alternative source of	Types of alternative energy Sources Affordability	Nominal Nominal	Percentages Mean score	Descriptive statistics Regression analysis

rural households in Central Imenti, Meru County in Kenya.		energy	Reliability Individual preferences			
	Dependent	Access to renewable energy	Number of households using biogas Number of biogas plant constructed Sustainability of biogas plant	Interval Interval Nominal	Mean score	Descriptive statistics Regression analysis

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION OF FINDINGS

4.1 Introduction

This chapter contains sections that have the analysis of the data collected concerning the subject under study, its presentation (in tables containing the means, standard deviation, frequencies and percentages) and its interpretation which is given in prose. The chapter is organized to present the findings by first looking at the response rate, the demographic variables and objectives. In order to simplify the discussions, the researcher provided tables that summarize the collective reactions of the respondents. It discusses the characteristics of the respondents, their opinions on the factors influencing access to renewable energy by rural households in Kenya: a case of SimGas biogas project in central Imenti, Meru county.

4.2 Response Rate

The respondents who were sampled were 216 and questionnaires were administered to them all but only 171 questionnaires were returned. This gave a response rate of 79.2% which is above 50% and is considered significant response rate for as statistical analysis as prescribed by Sekaran (2011).

Table 4. 1: Response Rate

	Number of informants	**Percent**
Response	171	79.2
Non- Response	45	20.8
Total	**216**	**100.0**

4.3 Reliability Analysis

A pilot study was carried out to determine reliability of the questionnaires. The pilot study involved 14 respondents. Reliability analysis was subsequently done using Cronbach's Alpha which measures the internal consistency by establishing if certain items within a scale measure the same construct. Kothari (2004) established the Alpha value threshold at 0.7.

Table 4. 2: Reliability Analysis

	Reliability Cronbach's Alpha
Household Income	.896
Availability of Information	.838
Availability of Alternative Source of Energy	.731

Cronbach Alpha was established for every objective which formed a scale. The Household Income was the most reliable with an alpha value of 0.896, followed by Availability of Information with an alpha value of 0. 838 and Availability of Alternative Source of Energy was the least reliable with an alpha value of 0.731. This illustrates that all the three variables were reliable as their reliability values exceeded the prescribed threshold of 0.7 (Kothari, 2004). This, therefore, depicts that the research instrument was reliable and therefore required no amendments.

4.4 Background Information

The study sought to know background information of the respondents by examining their gender, highest level of education and age group. This was of great importance for it gave the researcher a clue of who is filling the questionnaires and be able to know if the respondents are the targeted ones and whether the information given is the correct one they're seeking.

4.4.1 Gender of the Respondents

The researcher asked the respondents questions concerning their gender. Their answers were tabulated in table 4.3.

Table 4.3: Gender of the Respondents

	Frequency	Percent
Male	98	57.3
Female	73	42.7
Total	171	**100.0**

The findings reveal that majority of the respondents were male as shown by 57.3% while female respondents were 42.7%. This shows that the researcher was not gender biased in collection of data.

4.4.2 Highest Level of Education

The respondents were further asked to indicate their highest level of education. Their responses were as presented in table 4.4.

Table 4.4: Highest Level of Education

	Frequency	Percent
Certificate	8	4.7
Diploma	34	19.9
Degree	94	55.0
Masters	24	14.0
PhD	11	6.4
Total	**171**	**100**

As per table 4.4, 55.0% of the respondents indicated that they had attained a degree, 19.9% of the respondents indicated that they had a diploma, 14.0% of the respondents showed that they had a Masters, 6.4% of the respondents indicated that they had PhD while 4.7% indicated that they had attained a certificate. This implies that majority of the respondents were learned enough to understand the subject of the study.

4.4.3 Age bracket of the Respondent

The respondents were also asked to indicate their age bracket. Their responses were as presented in table 4.5.

Table 4.5: Age Bracket

	Frequency	Percent
20-30 yrs	28	16.4
31-40 yrs	74	43.3
41-50 yrs	37	21.6
51 – 60yrs	32	18.7
Total	**171**	**100.0**

Table 4.5 shows that most of the respondents (43.3%) were aged between 31-40 yrs. On the same, 21.6% were aged between 41-50 yrs., 18.7% were aged between 51-60 yrs. while 16.4% were aged between 20-30 yrs. This shows that respondents were of mature people who could cooperate in giving out information.

4.5 Household income

The study sought to establish influence of household income on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

4.5.1 Extent of Household Income Influence on Access to Renewable Energy

The researcher asked the respondents using a Likert scale of 1-5 to indicate the extent to which household income influences access to renewable energy by rural households in Meru County in Kenya. Their responses were presented in Table 4.6.

Table 4.6: Extent of Household Income Influence on Access to Renewable Energy

	Frequency	Percent
Not at all	6	3.5
Little extent	21	12.3
Moderate extent	15	8.8
Great extent	74	43.3
Very great extent	55	32.2
Total	**171**	**100**

The respondents indicated that household income influences access to renewable energy by rural households in Meru County to a great extent as shown by 43.3%, to a very great extent as shown by 32.2%, to a little extent as shown by 12.3%, to a moderate extent as shown by 8.8% and not at all as shown by 3.5%. These findings are in line with Mills and Schleich, (2009) who state that the economics of a renewable energy installation are also dependent on the resource potential available for energy production.

4.5.2 Influence of The Aspects of Household Income on Access to Renewable Energy

The study further sought the respondents' opinions on the extent of the influence of aspects of household income on access to renewable energy by rural households in Meru County in Kenya. Table 4.7 illustrates the responses.

Table 4.7: Aspects of Household Income

	Mean	Std. Dev.
Credit accessibility	4.103	0.828
Ability to Pay	3.595	0.813
Willingness to pay	2.293	0.942
Level of household income	3.638	0.651
Employment status of household heads	3.974	0.611

As per the findings, the respondents indicated that credit accessibility influenced access to renewable energy by rural households to a very great extent as shown by a mean of 4.103. They further specified employment status of household heads as shown by mean of 3.974, level of household income as shown by a mean of 3.638 and the ability to pay as shown by a mean of 3.595 influenced the access to renewable energy to a great extent. Whereas, willingness to pay as shown by a mean of 2.293 had low influence. This conforms to World Bank (1996) that notes that there is limited policy support for RETs as shown by minimum budget allotment to renewables at government level. As a result, the private sector is left to bear the weight of funding RETs. Majority of advanced and electric RETs are not affordable to most of the population in Africa who are poor, with poverty degrees of between 50 to 70%.

The study further sought the respondents' views on how the aspects of household income influence access to renewable energy by rural households in Meru County in Kenya. They indicated that energy access tends to benefit primarily the wealthy households, most households are willing to pay for electricity as making a shift from one energy source to another is very hard and that the purchasing power of a household mainly depends on affordability and whether the energy source is able to perform basic functions such as lighting, cooking and heating. Also, that people shift from one source to another with increase in income. In relation to the findings, Vanhove (2018) asserts that one of the primary obstacles to carrying out renewable energy projects is frequently not the technical feasibility of these projects instead it is the absence of low cost, long term funding.

4.6 Availability of Information

The research also sought to evaluate the influence of availability of information on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

4.6.1 Extent the Availability of Information Influences Access to Renewable Energy

The respondents were asked to specify the extent to which the availability of information influence access to renewable energy by rural households in Central Imenti. Table 4.8 presents the results.

Table 4.8: Extent the Availability of Information Influences Access to Renewable Energy

	Frequency	Percent
No Extent	13	7.6
Little extent	11	6.4
Moderate extent	3	1.8
Great extent	84	49.1
Very great extent	60	35.1
Total	**171**	**100**

The findings show that 49.1% of the respondents indicated that availability of information influenced access to renewable energy by rural households to a great extent, 35.1% of them indicated to a very great extent, 7.6% of them indicated to no extent, 6.4% indicated to a little extent while 1.8% indicated to a moderate extent. This concurs with Reddy (2011) who asserts that access to information represents a substantial investment for most corporations and constitutes a significant aspect of organizational work.

4.6.2 Influence of The Aspects of Availability of Information on Access to Renewable Energy

The respondents indicated their opinions on the extent of influence that the aspects of availability of information have on access to renewable energy. Table 4.9 illustrates the findings.

Table 4.9: Aspects of Availability of Information

	Mean	Std. Dev.
Knowledge of biogas technology	4.164	0.645
Formal education	3.966	0.603
Accessibility to information Training in biogas projects	3.483	1.091
Social learning capabilities	3.845	0.891

As per the findings, the respondents asserted that Knowledge of biogas technology as illustrated by a mean score of 4.164 influenced access to renewable energy to a very great extent. While formal education as illustrated by a mean score of 3.966 and social learning capabilities as illustrated by a mean score of 3.845 influenced access to renewable energy to a great extent. accessibility to information training in biogas projects as illustrated by a mean score of 3.483 influenced access to renewable energy to a moderate extent. In relation to these findings, Wanyoike (2012) states that lack of information regarding the energy systems and the associated benefits have been shown as a barrier towards adoption.

The respondents further gave their opinions on how the aspects of availability of information influenced the access to renewable energy in rural households where they indicated that it increases uncertainty, and hence costs also increase. Having information about renewable energy would influence the household's choice to use reliable fuels and observe the health impacts some cause. This is in line with Kabiret al. (2013) who states that education is determinant in adoption of biogas as those who have more education want clean energy and they also recognize the importance of such energy to environmental conservation.

4.7 Cost Analysis

The study sought to determine the influence of cost analysis on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

4.7.1 Extent of Cost Analysis Influence on Access to Renewable Energy

The respondents were required to indicate the extent to which cost analysis influences access to renewable energy by rural households in Meru County in Kenya. Table 4.10 illustrates the findings.

Table 4.10: Extent of Cost Analysis Influence on Access to Renewable Energy

	Frequency	**Percent**
No Extent	2	1.2
Little extent	7	4.1
Moderate	8	4.7
Great extent	56	32.7
Very great extent	98	57.3
Total	**171**	**100**

The findings reveal that 57.3% of the respondents indicated that cost analysis influenced access to renewable energy by rural households in Meru County to a very great extent, to a great extent as shown by 32.7%, to a moderate extent as shown by 4.7%, to a little extent as shown by 4.1% and not at all as shown by 1.2%. This is in line with IEA (2009) who notes that given the continuously rising energy and commodity prices, it can be expected that the use of decentralized renewable energies will be even more attractive and competitive in the future.

4.7.2 Influence of The Aspects of Cost Analysis on Access to Renewable Energy

The study further sought the respondents' opinions on the extent to which various aspects of cost analysis influence access to renewable energy by rural households in Meru County. The results are as shown in Table 4.11.

Table 4. 11: Aspects of Cost Analysis

	Mean	Std. Dev.
Installation cost	3.63	1.501
Ease of access	3.86	1.426
Technical knowhow	4.28	1.338

From the findings above, the respondents indicated that technical knowhow influenced access to renewable energy by rural households in Meru County very greatly as shown by a mean of 4.28. Also, the ease of access and installation cost were indicated to influence access to renewable energy by rural households in Meru County greatly as shown by a mean of 3.86 and 3.63 respectively. This is in line with Denkhaus (2004) who notes that electrification at affordable prices through the extension of the central electricity grid will most likely not be available in the foreseeable future so that decentralized renewable energy technologies are already the most economical option for electrification of remote regions.

Further, the respondents added on the ways the aspects of cost analysis influence access to renewable energy by rural households in Meru County. The respondents indicated that many of the rural households were poor and therefore could not afford the high initial installation cost, the inability of finding the sources of energy leads to lack of interest, scarcity of technical expertise does not encourage adoption of the renewable energy, the few personnel who are knowledgeable on the installation process are very expensive and in the rural parts that can easily access the RET products, they tend to be cheap. This conforms to Day (2010) who argues that there is an increasing energy supply gap caused by diminishing supply of non-renewable energy sources hence demand for alternative renewable energies to fill the gap.

4.8 Availability of Alternative Source of Energy

The study sought to establish the influence of availability of alternative source of energy on access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

4.8.1 Extent the Availability of Alternative Source of Energy Influences Access to Renewable Energy

The study sought the respondents' opinions on the extent to which the availability of alternative source of energy influences access to renewable energy by rural households in Central Imenti. The findings are as shown in Table 4.12.

Table 4.12: Extent the Availability of Alternative Source of Energy Influences Access to Renewable Energy

	Frequency	Percent
No Extent	10	5.8
Little extent	7	4.1
Moderate extent	5	2.9
Great extent	88	51.5
Very great extent	61	35.7
Total	**171**	**100**

From the above table, 51.5% of the respondents indicated that availability of alternative source of energy influences access to renewable energy greatly, 35.7% of them indicated that very greatly, 5.8% to no extent, 4.1% indicated to a little extent while 2.9% indicted to a moderate extent. This is in line with Veenis (2013) who argues that the availability of numerous sources of energy has a great effect on the electrification of rural households, as most individuals have a tendency of selecting a source of energy that is mostly available and cheap.

4.8.2 Influence of The Aspects of Availability of Alternative Source of Energy on Access to Renewable Energy

The respondents indicated their opinions on the extent of influence that the aspects of availability of alternative source of energy have on access to renewable energy. The findings are shown in Table 4.13 below.

Table 4.13: Aspects of Availability of Alternative Source of Energy

	Mean	Std. Dev.
Types of alternative energy Sources	4.129	0.598
Affordability	3.966	0.757
Reliability	3.974	0.567
Individual preferences	3.647	0.608

The results reveal that types of alternative energy sources as shown by a mean of 4.129 influence the access to renewable energy by rural households in Meru County very greatly. While reliability, affordability and Individual preferences as shown by a means of 3.974, 3.966 and 3.647 respectively influence the access to renewable energy by rural households in Meru County greatly. In correspondence with the findings, Reddy and Srinivas (2009) note that exploitation on large-scale of renewable energy in Kenya, apart from geothermal and to some extent, cogeneration of electricity, has largely remained low as most individuals prefer to use the traditional sources of energy as they are cheap and easily available. Further, in most rural households, most alternative that are used have a direct link with the socio-economic status of such households.

The study sought opinions from the respondents on how availability of alternative source of energy influences access to renewable energy by rural households in Meru County in Kenya. The study found that personal perception was based on limited knowledge or inability to access renewable energy. Also, if another type of energy source is easily available and cheap it would probably be the most preferred. This concurs with Veenis (2013) who notes that the availability of numerous sources of energy has a great effect on the electrification of rural households, as most individuals have a tendency of selecting a source of energy that is mostly available and cheap.

4.9 Access to Renewable Energy

The respondents were further asked to indicate the trend of various aspects of access to renewable energy by rural households in Meru County in Kenya for the last 5 years. Their responses were as shown in Table 4.14.

Table 4. 14: Aspects of Access to Renewable Energy

	Mean	Std. Dev.
Number of households using biogas	3.8929	0.6404
Number of biogas plant constructed	4.1231	0.9651
Sustainability of biogas plant	3.7857	0.6779

As per the findings, the respondents indicated that the number of biogas plant constructed had greatly improved as shown by a mean of 4.1231. The number of households using biogas had also improved as shown by a mean of 3.89. Similarly, the sustainability of biogas plant had

improved as shown by a mean of 3.7857. The findings are in line with National Agricultural Statistics Service (2011) who state that for energy to be considered available to a household, the household must be within the economic connection and supply range of the energy network or supplier.

4.7 Regression Analysis

The study used a regression model to test the hypothesis between household income, availability of information and availability of alternative source of energy and access to renewable energy by rural households in Central Imenti, Meru County in Kenya.

Table 4. 15: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.834	0.696	0.688	0.582

The outcome of Table 4.15 found that R-Square value (coefficient of determination) is 0.688, which indicates that the independent variables (household income, availability of information, cost analysis and availability of alternative source of energy) explain 68.8% of the variation in the dependent variable (access to renewable energy by rural households in Central Imenti).

Table 4. 16: Analysis of Variance

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	128.81	4	32.203	93.200	.000
Residual	56.32	166	0.346		
Total	**185.13**	**170**			

The results shown in Table 4.16 found that the model had predictive value and thus it was significant. This was because its p-value was less than 0.05, p=.000 and F calculated (93.2) was significantly larger than the critical F value (2.3719).

Model coefficients provide unstandardized and standardized coefficients to explain the direction of the regression model and to establish the level of significance of the study variables. The results are captured in Table 4.17.

Table 4.17: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.123	0.217		5.175	.000
Household Income	0.783	0.249	0.760	3.145	.003
Availability of Information	0.817	0.281	0.792	2.907	.006
Cost Analysis	0.796	0.359	0.737	2.217	0.028
Availability of Alternative Source of Energy	0.746	0.334	0.724	2.234	.031

As per the SPSS generated Table above, the equation ($\mathbf{Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon}$) becomes:

$$\mathbf{Y= 1.123 + 0.783X_1+ 0.817X_2+ 0.796X_3 + 0.746X_4 + \varepsilon}$$

The findings showed that if all factors (household income, availability of information, cost analysis and availability of alternative source of energy) were held constant at zero access to renewable energy by rural households in Central Imenti will be 1.123. The findings presented also show that taking all other independent variables at zero, a unit increase in the Household Income would lead to a 0.783 increase in the scores of access to renewable energy by rural households in Central Imenti. This variable was significant since 0.003<0.05. This conforms to Louw, Conradie, Howells and Dekenah (2008) who state that the ability to pay for the new energy source as well as the ownership of appliances that go with it, is strongly related to income.

The findings also show that a unit increase in availability of information would lead to a 0.817 increase in the scores of access to renewable energy by rural households in Central Imenti. This variable was significant since 0.006<0.05. This is similar to Reddy (2011) who notes that access to information's value is realized only when information systems are utilized by their intended users in a manner that contributes to the strategic and operational goals of the firm or household.

Results further indicate that cost analysis had a positive and significant relationship with access to renewable energy by rural households in Central Imenti since the p value= 0.028<0.005. This implies that an increase in cost analysis by 1 unit leads to an increase in access to renewable energy by rural households in Central Imenti by 0.796 units. This conforms to Wawa (2012) who

states that being aware of the energy predicted energy shortages, has led to investments in both the centralized sources and extensive distribution systems to make the energy available to the citizens and business.

Further, the findings show that a unit increases in the scores of availability of alternative source of energy would lead to a 0.746 increase in the scores of access to renewable energy by rural households in Central Imenti. This variable was significant since 0.031<0.05. This correlate with with. Reddy and Srinivas (2009) who argue that in most rural households, most alternative that are used have a direct link with the socio-economic status of such households.

As per the findings, at 95% confidence level, all the variables were significant as the p-value was less than 0.05. The study inferred that availability of information had the greatest effect on the access to renewable energy by rural households in Central Imenti, followed by cost analysis, then household income while availability of alternative source of energy had the least effect to the access to renewable energy by rural households in Central Imenti.

CHAPTER FIVE

SUMMARY, DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides the summary of the findings from chapter four, and also it gives the conclusions and recommendations of the study based on the objectives of the study. The objective of this study was to establish the factors influencing access to renewable energy by rural households in Kenya.

5.2 Summary of the Findings

The study found that household income influences access to renewable energy by rural households in Meru County greatly. Further, credit accessibility influenced access to renewable energy by rural households to a very great extent. Also, employment status of household heads, level of household income and the ability to pay influenced the access to renewable energy to a great extent. Whereas, willingness to pay had low influence.

On the availability of information, the study established that Knowledge of biogas technology proved to be of very great influence on the access to renewable energy while formal education and social learning capabilities influenced access to renewable energy to a great extent. However, accessibility to information training in biogas projects influenced access to renewable energy moderately.

The study found that cost analysis influenced access to renewable energy by rural households in Meru County to a very great extent. From the findings technical knowhow influenced access to renewable energy in rural households very greatly while the ease of access and installation cost influence access to renewable energy in rural households greatly.

Further, the study found that availability of alternative source of energy greatly influenced access to renewable energy by rural households in Central Imenti, Meru County in Kenya. The types of alternative energy sources influence the access to renewable energy by rural households in Meru County very greatly while reliability, affordability and Individual preferences greatly influence the access to renewable energy by rural households in Meru County.

Concerning the trend of aspects of access to renewable energy for the last 5 years, the study also found that the number of biogas plant constructed had greatly improved. Also, the number of households using biogas and sustainability of biogas plant had also improved.

5.3 Discussion of the Findings

This section entails further literature discussions on the findings of each variable.

5.3.1 Household Income

The study established that willingness to pay was not of much influence. As stated by Louw, Conradie, Howells and Dekenah (2008), rural areas households consider electricity also as only one among various sources of energy. This is because most households registered are willing to pay for electricity since the ability to pay for the new energy source as well as the ownership of appliances that go with it, is strongly related to income.

The study also established that it is quite difficult for a household to change from a source that they are used to another source of energy. This depends on the head of the household income since he/she deals with the household expenditure. This then brings about the point of affordability which is the ability of the household to pay for the renewable energy. This is asserted by IEG (2008) that argues that in communities with electricity for more than 10 years, between 15 and 20 % of the households remain without connection, since these households cannot afford it. However, the study found that a household shifts from one source to another with increase in income.

5.3.2 Availability of information

The study found out that formal education was required to enhance the use of renewable energy. This is supported by Kabiret al. (2013) who revealed that education is determinant in adoption of biogas as those who have more education want clean energy and they also recognize the importance of such energy to environmental conservation. According to Reddy (2011), access to information represents a substantial investment for most corporations and constitutes a significant aspect of organizational work this is because lack of information regarding the energy systems and the associated benefits have been shown as a barrier towards adoption just as proven in the study findings.

5.3.3 Cost

Day (2010) argues that there is an increasing energy supply gap caused by diminishing supply of non-renewable energy sources hence demand for alternative renewable energies to fill the gap. The study found that in rural areas the most used fuels are kerosene and fuel wood as most of the households are poor and the mentioned fuels are easily accessible. The fire wood use encourages deforestation which is a cheaper option for most of the households. The introduction of RET in the rural areas has not been adopted at a higher rate due to the high initial installation cost and further by the lack of technical expertise in the villages.

Denkhaus (2004) notes that electrification at affordable prices through the extension of the central electricity grid will most likely not be available in the foreseeable future so that decentralized renewable energy technologies are already the most economical option for electrification of remote regions. This is evident as places where RET is easily accessible, the product tends to be cheaper and hence encourage the induction of training and education centres in the communities. IEA (2009) further notes that given the continuously rising energy and commodity prices, it can be expected that the use of decentralized renewable energies will be even more attractive and competitive in the future.

5.3.4 Availability of Alternative Source of Energy

The availability of numerous sources of energy has a great effect on the electrification of rural households, as most individuals have a tendency of selecting a source of energy that is mostly available and cheap. In most rural households, most alternative that are used have a direct link with the socio-economic status of such households. Due to this, it has become a greater challenge to move people from using it to using cleaner sources of energy (Reddy & Srinivas, 2009).

According to Veenis (2013), the availability of biomass sources of energy had made most rural households to stick to their traditional sources of energy as most individuals have a tendency of selecting a source of energy that is mostly available and cheap. This is proven as individual preferences influence the access to renewable energy by rural households in Meru County greatly.

5.3.5 Access to Renewable Energy

National Agricultural Statistics Service (2011) argues that for energy to be considered available to a household, the household must be within the economic connection and supply range of the energy network or supplier. Also, a high up-front cost may discourage poor households from making a switch to a modern energy form and therefore to increase the rate of adopting innovations and to make relative advantage more effective, direct or indirect financial payment incentives may be used to support the individuals of a social system in adopting an innovation.

According to Chambers (2013), the unavailability of technical services could be due to biases in technology transfer such as spatial, project, professional, personal and diplomatic perpetuated by extension and professional officers. The study therefore found that to improve the quality of life with renewable energy, there is need to finance sustainable ways of producing and also educating and training the communities on how to use and access these sources of energy. Also, the choice of the renewable energy to be used in a household depends on the ease of access and its cost.

5.4 Conclusion

The study concludes that the use of biogas technology has a significant impact on financial and time saving among the households. It also saves tree cover thereby protecting biodiversity. The study further deduces that household income and education level are major impediments to the accessibility of renewable energy. Low levels of education and average household monthly income are explained by: Poverty occasioned by low agricultural productivity which is the rural areas' main livelihood; low school enrollment rates and high school dropout rates consequently low economic status and inability to afford the cost of renewable energy.

The study also concludes that adoption of the use of renewable energy can positively change the lives of rural population in Meru. The availability of other sources of energy such as kerosene and gas however, affects the adoption of renewable energy. Thus, the study concludes that renewable energy should be easily accessible with able technical expertise in order for the communities to change its perception about adoption of the new sources of energy.

The study further concludes that training is important in the process of renewable energy adoption and thus should be used. The government and other stakeholders should fund the renewable energy projects in order to educate and equip the communities with the knowledge they need to be able access or even produce this energy. The study also concludes that the

adoption of renewable energy will be of great importance as it conserves the environment and also has health benefits.

The study concludes that more of the RETs should be taken to the rural areas to increase the awareness of the communities. This will encourage the community to know about it and since it would be easy to access, the renewable energy products will be available at a cheaper rate. Installation will thus be easier as more people will have been educated and trained in handling the equipment.

5.5 Recommendations

The study recommends that the government and other stakeholders should create awareness and sensitize the learned people regarding the benefits of adopting renewable energy. This would ultimately increase adoption of renewable energy among the educated people. The study recommends that Government of Kenya and especially the Ministry of Energy should provide training and education to increase the availability of information and awareness on the use of renewable energy. This can be done through seminars, workshops and public barazas where members are invited for training and demonstration on the use and benefits of renewable energy

The study also recommends that the government should consider zero rating tax on renewable energy equipment so as to influence lower pricing thus making it more affordable for purchase and installation of solar system. This would be of assistance especially for the people living in the rural areas. Alternatively, the government could arrange for a plan that allows households to pay an agreeable small amount of money per month in a bid to increase the use of renewable energy.

The study recommends that there should be timely release of funds as a way to ensure completion of projects within the stipulated time. In order to create a sense of ownership and ensure sustainability of the renewable energy projects, project implementers need to build in community participation in their project designs, implementation and other decision-making processes. To be able to implement effective and sustainable projects that are evidence based, project implementers also need to ensure that monitoring is an integral part of their projects and that lessons learnt are properly documented and used to inform future projects.

5.6 Recommendations for Further Studies

The study further recommends that a study should be done on the impact of renewable energy use on indoor air quality and health benefits to the users. Further research is needed on the amount of tree cover that can be saved by renewable energy use locally. Further research also needs to be done on impacts of renewable energy technology use on people's livelihoods. A similar study should be conducted but with different variables and a different county.

REFERENCES

Amigun, B., Gorgens, J. & Knoetze, H. (2010). Bio methanol production from gasification of non-woody plant in South Africa: Optimum scale and economic performance. *Energy Policy*, *38*(1), 312-322.

Atuahene, F. (2011). Re-thinking the missing mission of higher education: An anatomy of the research challenge of African universities. *Journal of Asian and African studies*, *46*(4), 321-341.

Bazilian, M., Onyeji, I., Liebreich, M., MacGill, I., Chase, J., Shah, J. & Zhengrong, S. (2013). Re-considering the economics of photovoltaic power. *Renewable Energy*, *53*, 329-338.

Berman, R. J. (2016). K-polystability of Q-Fano varieties admitting Kähler-Einstein metrics. *Inventiones mathematicae*, *203*(3), 973-1025.

Brewer, M. B. & Miller, N. (2010). Intergroup relations. *Advanced social psychology: The state of the science*, *1*, 531-567.

Bryman, A. & Bell, E. (2011). Ethics in business research. *Business Research Methods*, *7*(5), 23-56.

Bryman, A. & Cramer, D. (2012). *Quantitative data analysis with IBM SPSS 17, 18 & 19: A guide for social scientists*. Abingdon: Routledge.

Chambers, R. (2013). *Ideas for development*. Abingdon: Routledge.

Cooper, D. R. & Schindler, P. (2014). *Business research methods*. New York: McGraw-Hill Education.

Day, A. (2010). *The Economic Consequences of a Global energy crisis*. Abingdon: Routledge.

Denkhaus, A. A. (2004). An Application of Tobit Analysis to the Adoption of Tractor Hiring Services Scheme in Nigeria. *Oxford Agrarian Studies* 16(2), 70-82.

Disenyana, T. (2009). *China in the African Solar Energy Sector: Kenya Case Study*. South African Institute of International Affairs.

EIA, U. (2013). Annual energy outlook 2013. *US Energy Information Administration, Washington, DC*, 60-62.

English Articles (2010). World Energy Crisis. [http://www.englisharticles.info] site visited 19/10/ 2010.

Freeman, R. & Kokotovic, P. V. (2008). *Robust nonlinear control design: state-space and Lyapunov techniques*. Berlin: Springer Science & Business Media.

Gillham, P. F. (2011). Securitizing America: strategic incapacitation and the policing of protest since the 11 September 2001 terrorist attacks. *Sociology Compass*, *5*(7), 636-652.

Girotto, F. (2017). *Food waste to bio-energy through anaerobic digestion under different management scenarios.*

Golafshani, A. A. S. (2012). The relationship between spiritual well-being and quality of life in nurses. *J North KhorasanUniv Med Sci*, *3*(4), 10.

Gorard, S. (2013). *Research design: Creating robust approaches for the social sciences*. Thousand Oaks: Sage.

IEA (2009). *Biogas technology in Developing Countries: Vietnam Case study*. Proceedings Biodigester Workshop, University of Agriculture and Forestry.

Iqbal, H. M. N., Kyazze, G. & Keshavarz, T. (2013). Advances in the valorization of lignocellulosic materials by biotechnology: an overview. *BioResources*, *8*(2), 3157-3176.

Jacques, M. (2012). *When China rules the world: The rise of the middle kingdom and the end of the western world [Greatly updated and expanded]*. City of Westminster: Penguin UK.

Jakachira, G. (2013). An exploratory study of the interface of child-headed households and academic performance: A case of primary school students in Beatrice resettlement area, Zimbabwe.

Johnson, N. G. & Bryden, K. M. (2012). Energy supply and use in a rural West African village. *Energy*, *43*(1), 283-292.

Kabir, M. S., Salam, M. U., Chowdhury, A., Rahman, N. M. F., Iftekharuddaula, K. M., Rahman, M. S. & Islam, A. S. (2015). Rice vision for Bangladesh: 2050 and beyond. *Bangladesh Rice Journal*, *19*(2), 1-18.

Kandeh, J. (2012). Intervention and Peacebuilding in Sierra Leone: A Critical Perspective. *When the State Fails: Studies on Intervention in the Sierra Leone Civil War*, 89-113.

Karplus, V. J., Paltsev, S. & Reilly, J. M. (2010). Prospects for plug-in hybrid electric vehicles in the United States and Japan: A general equilibrium analysis. *Transportation Research Part A: Policy and Practice*, *44*(8), 620-641.

Keller, E. F. (2010). *The mirage of a space between nature and nurture*. Durham: Duke University Press.

Keriri, H. (2013). Prevalence and risk factors of low back pain among nurses in operating rooms, Taif, Saudi Arabia. *Am J Res Commun*, *1*(11), 25.

Ki-Moon, B. (2012). *Address to Stanley Foundation Conference on the Responsibility to Protect*. New York City.

Kshetri, N. (2010). Cloud computing in developing economies. *Computer*, *43*(10), 47-55.

Kwamboka, M. (2015). *Analysis of biogas technology adoption among households in Kilifi County.* Doctoral dissertation..

Manikandan, S. (2011). Measures of central tendency: Median and mode. *Journal of pharmacology and pharmacotherapeutics*, *2*(3), 214.

Marshall, C. & Rossman, G. B. (2014). *Designing qualitative research*. Thousand Oaks: Sage publications.

Mills, B., & Schleich, J. (2012). Residential energy-efficient technology adoption, energy conservation, knowledge, and attitudes: An analysis of European countries. *Energy Policy*, *49*, 616-628.

Mukami, M. (2016). *Teen questions why education isn't enough for Kenyan girls*. Retrieved October 23, 2017.

Mwakaje, A. G. (2012). Dairy farming and the stagnated biogas use in Rungwe district, Tanzania: An investigation of the constraining factors. In *Biogas*. IntechOpen.

Mwirigi, J., Balana, B. B., Mugisha, J., Walekhwa, P., Melamu, R., Nakami, S. & Makenzi, P. (2014). Socio-economic hurdles to widespread adoption of small-scale biogas digesters in Sub-Saharan Africa: A review. *biomass and bioenergy*, *70*, 17-25.

Nassiuma, D. K. (2000). *Survey sampling: Theory and methods*. Nairobi.

National Agricultural Statistics Service. (2011). *Acreage. Washington, DC*. Department of Agriculture, U. S.

Ndegwa, G., Breuer, T. & Hamhaber, J. (2011). Woodfuels in Kenya and Rwanda: powering and driving the economy of the rural areas. *Rural*, *45*(2), 26-30.

Ngigi, M. W., Okello, J. J., Lagerkvist, C. L., Karanja, N. K. & Mburu, J. (2011). Urban consumers' willingness to pay for quality of leafy vegetables along the value chain: The case of Nairobi Kale consumers, Kenya. *International Journal of Business and Social Science*, *2*(7), 208-216.

Nzai, P. C. K. & Gitonga, A. K. (2018). Factors influencing access to renewable energy by rural families: A case of solar lanterns project in Isiolo County, Kenya. *International Academic Journal of Information Sciences and Project Management*, *3*(2), 169-185.

Onasanya, M. (2017). An evaluation and development of the potentials of photovoltaic systems for water pumping and electricity services in rural areas of Nigeria.

Reddy, T. B. (2011). *Linden's handbook of batteries* (Vol. 4). New York: McGraw-hill.

Revelle, W. & Zinbarg, R. E. (2009). Coefficients alpha, beta, omega, and the glb: Comments on Sijtsma. *Psychometrika*, *74*(1), 145.

Rogers, E. M. (1995). Lessons for guidelines from the diffusion of innovations. *Joint Commission Journal on Quality and Patient Safety*, *21*(7), 324-328.

Rogers, R. (2013). *Digital methods*. Cambridge: MIT press.

Saunders, M. L. & Lewis, P. (2009). P. & Thornhill, A.(2009). *Research methods for business students*, *4*.

Saunders, M. N. (2011). *Research methods for business students, 5/e*. London: Pearson Education.

Tian, Y. & Zhao, C. Y. (2013). A review of solar collectors and thermal energy storage in solar thermal applications. *Applied energy*, *104*, 538-553.

Tietenberg, T. H. & Lewis, L. (2016). *Environmental and natural resource economics*. Abingdon: Routledge.

UNEP, A. (2011). Towards a green economy: Pathways to sustainable development and poverty eradication. *Nairobi, Kenya: UNEP*.

Vanhove, N. (2018). *Regional policy: A European approach*. Abingdon: Routledge.

Veenis, B. J. (2013). *Achieving Narrative*. Master's thesis

Venort, T. (2017). *Biogas Technology Application in Western Kenya—A Field Investigation in Nandi and Bomet Counties*(Doctoral dissertation, Purdue University).

Wang, Z., Tchernev, J. M. & Solloway, T. (2012). A dynamic longitudinal examination of social media use, needs, and gratifications among college students. *Computers in Human Behavior*, *28*(5), 1829-1839.

Wanyoike, S. W. (2013). *Effect of compliance to SASRA regulations on financial performance of savings and credit co-operatives in Kenya: a survey of deposit taking SACCOs in Nairobi County*. Doctoral dissertation, University of Nairobi.

Wawa, A. I. (2012). *The challenges of promoting and adopting biogas technology as alternative energy source in semi-arid areas of Tanzania: The case of Kongwa and Bahi districts of Dodoma region*. A Doctoral dissertation, The Open University Of Tanzania.

Welman, C. K. & Kruger, F. F. & Mitchell, B. 2005. *Research methodology*, 3(3), 23-26.

World Bank, W. B. (2014). *Building integrated markets within the East African Community: EAC opportunities in public-private partnership approaches to the region's infrastructure needs*. The World Bank.

World Bank. Environmentally Sustainable Development (1996). *The World Bank Participation Sourcebook* (Vol. 19). World Bank Publications.

Zikmund, W., Babin, B., Carr, J. & Griffin, M. (2012). Business research methods: Cengage Learning. *H4 B. Journal of Small Business Management*, 44(2), 268-284.

APPENDICES

Appendix I: Letter of Transmittal

Dear Sir/ Madam,

RE: ACADEMIC RESEARCH PROJECT

I am a Master of Arts in Project Planning and Management student at University of Nairobi. I wish to conduct a research entitled Factors Influencing Access to Renewable Energy by Rural Households in Kenya. A Case of Simgas Biogas Project in Central Imenti, Meru County. A questionnaire has been designed and will be used to gather relevant information to address the research objective of the study. The purpose of writing to you is to kindly request you to grant me permission to collect information on this important subject from your organization.

Please note that the study will be conducted as an academic research ant the information provided will be treated in strict confidence. Strict ethical principles will be observed to ensure confidentiality and the study outcomes and reports will not include reference to any individuals.

Your acceptance will be highly appreciated.

Yours faithfully,

Joy Nkatha Kimathi

L50/9681/2017

Appendix II: Research Questionnaire

This questionnaire is to collect data for purely academic purposes. The study seeks to investigate the *factors influencing access to renewable energy by rural households in Kenya. a case of Simgas biogas project in Central Imenti, Meru County.* All information will be treated with strict confidence. Do not put any name or identification on this questionnaire.

Answer all questions as indicated by either filling in the blank or ticking the option that applies.

Section A: Background Information (Please tick (√) appropriate answer)

1) Please indicate your gender: Female [ ] Male [ ]
2) State your highest level of education

Certificate [ ] Diploma [ ] Degree [ ] Masters [ ] PhD [ ]

Others (Specify) ----------

3) Please Indicate your age bracket 20-30 yrs [ ] 31-40 yrs [ ]
   41-50 yrs [ ] 51 – 60 [ ]

SECTION B: FACTORS INFLUENCING ACCESS TO RENEWABLE ENERGY BY RURAL HOUSEHOLDS IN KENYA

Household income

4) To what extent does household income influence access to renewable energy by rural households in Meru County in Kenya?

Not at all	[ ]	Low extent	[ ]
Moderate extent	[ ]	Great extent	[ ]
Very great extent	[ ]		

5) To what extent do the following influence access to renewable energy by rural households in Meru County in Kenya?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Credit accessibility					
Ability to Pay					
Willingness to pay					

Level of household income					
Employment status of household heads					

6) In your view, how do the above aspects of household income influence access to renewable energy by rural households in Meru County in Kenya?

……

……

……

Availability of information

7) To what extent do Availability of information influence access to renewable energy by rural households in Meru County in Kenya?

Not at all	[ ]	Low extent	[ ]
Moderate extent	[ ]	Great extent	[ ]
Very great extent	[ ]		

8) To what extent do the following influence access to renewable energy by rural households in Meru County in Kenya?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Knowledge of biogas technology					
Formal education					
Accessibility to information Training in biogas projects					
Social learning capabilities					

9) In what ways do the aspects of availability of information influence access to renewable energy by rural households in Meru County in Kenya?

……

……

……

Cost

10) To what extent does cost influence access to renewable energy by rural households in Meru County in Kenya?

Not at all [ ] Low extent [ ]
Moderate extent [ ] Great extent [ ] Very great extent [ ]

11) To what extent do the following influence access to renewable energy by rural households in Meru County in Kenya?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Installation cost					
Ease of access					
Technical knowhow					

12) In what way do the aspects of cost analysis influence access to renewable energy by rural households in Meru County in Kenya?

……
……
……

Availability of alternative source of energy

13) To what extent does availability of alternative source of energy influence access to renewable energy by rural households in Meru County in Kenya?

Not at all [ ]
Low extent [ ]
Moderate extent [ ]
Great extent [ ]
Very great extent [ ]

14) To what extent do the following influence access to renewable energy by rural households in Meru County in Kenya?

	Very great	Great	Moderate	Low	Not at

	extent	extent	extent	extent	all
Types of alternative energy sources					
Affordability					
Reliability					
Individual preferences					

15) In your view how do the aspects of availability of alternative source of energy influence access to renewable energy by rural households in Meru County in Kenya?

……

……

Access to Renewable Energy

16) What is the trend of the following aspects of access to renewable energy by rural households in Meru County in Kenya for the last 5 years? Where, 5 = greatly improved, 4= improved, 3= constant, 2= decreased, 1 = greatly decreased

	1	**2**	**3**	**4**	**5**
Number of households using biogas					
Number of biogas plant constructed					
Sustainability of biogas plant					

Thank you for participating