FACTORS INFLUENCING ADOPTION OF SOLAR TECHNOLOGY IN LAKIPIA NORTH CONSTITUENCY, KENYA

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DECLARATION

I hereby confirm that this is my original work and to the best of my knowledge has not been presented for any study program in any other University.

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This project has been submitted for examination with my approval as the University supervisor.

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DEDICATION

This project is dedicated to my Husband Wanjohi, my sons Macharia and Nyanjui.

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I wish acknowledge the almighty God for the opportunity, the strength and the ability both financial and otherwise that he has availed, enabling me to undergo this course Secondly, I acknowledge and sincerely thank my supervisor Dr. Harriet Kidombo, her guidance has kept me on course while putting together this project. Thirdly, to all scholars whose ideas and works I have cited in this project, without your ideas it would not have been possible to put it together. I acknowledge the academic and administrative staff of the Nyeri Extra Mural Center, University of Nairobi for their continuous support and co operation throughout my studies there. Finally, to my family who have persevered many days of my absence while writing this project. To my spouse Wanjohi, who has been very supportive, I am indebted. To my children, Macharia and Nyanjui your inquisitiveness has kept me focused. Thank you.

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ABBREVIATIONS

COMESA	Common Market for Eastern and Southern Africa
ERC	Energy Regulatory Commission
FiT	Feed- in Tariff
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GWH	Giga Watt Hour
KETRACO	Kenya Electricity Transmission Company
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
LCPP	Least Cost Power Plan
LPG	Liquefied petroleum gas
MoE	Ministry of Energy
MW	Mega Watt
PV	Photovoltaic
REA	Rural Electrification Authority
RET	Renewable Energy Technologies
S H S	Solar Home Systems.
ST	Solar Thermal
TWh	Tetra Watt hour
UNEP	United Nations Environments program

ABSTRACT

Solar Energy is the energy from the Sun. The Sun is a big ball of heat and light resulting from nuclear fusion at its core. In one day, the sun sends 10,000 to 15,000 times more energy to the earth than we can all collectively use (Msafiri 66, 2009). Solar power is the conversion of sunlight into Electricity, either directly or using Photovoltaic panels, a method of generating electricity by converting the suns radiation into direct current electricity using semi conductors. Kenya envisions transforming itself into a newly-industrializing, middle-income country by 2030, with a globally competitive and prosperous economy and high quality of life in a clean and secure environment. To achieve this vision, energy is identified as one of the foundations and enablers of the socio-economic transformation envisaged in the country. Only 44% of Kenyans have access to Grid Electricity meaning Solar energy provides Kenyan government with the opportunity to address energy challenges without the need for expensive power generation projects, transmission and distribution networks. This objective of this study is to assess the extent to which the level of knowledge and awareness of solar technology influences adoption of domestic solar technology, to investigate the extent to which the level of income of households influences adoption, it also seeks to establish the extent Education of house hold head influence adoption of solar technology and finally to which extent the availability of substitute power source influence adoption of solar technology in laikipia North constituency This study aims at establishing the factors that influence the adoption of solar technology in Laikipia North constituency, a descriptive survey design will be used in the study, a stratified random sampling was used to identify a sample and data was collected using questionnaires and structured interview schedules. A sample of 365 households was be studied from a target population of 6733 households; only 300 household heads responded which represented 82,2% of the targeted. The findings indicate that the community has not adopted much to solar technology with only 32% using solar in the region. The findings of the study may be of use to the Ministry of Energy, to the government in general and to most Energy Solution Companies including Kenya Power and Lighting Company as Kenya looks to achieve vision 2030

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Renewable energy comes from natural resources such as sunlight, wind, rain, tides and geothermal heat. About 16% of global energy consumption comes from renewables: 10% is from traditional biomass, which is used mainly for heating and 3.4% from hydroelectricity. New renewables such as small hydro, modern biomass, wind, solar, geothermal, and bio-fuels account for about 2.8% (UNEP, 2011). There has been a rapid growth in new renewables because of increased uptake of the relevant technologies. The share of renewables in electricity is about 19%, and it is estimated that about 16% of global electricity comes from hydroelectricity and 3% from new renewable.

Global investments in renewable energy, increased by 32% in 2010, to a record US$211 billion. The increase was mainly because of wind-farm development in China and small-scale solar PV installations in Europe (UNEP, 2011). Africa achieved the largest percentage increase in investment in renewable energy among developing regions excluding the three big economies. Total investment on the continent rose from US$750 million to US$3.6 billion, largely, because of strong performance in Egypt and Kenya.

In 2008, India accounted for 17.7% of the global population but was the fifth-largest consumer of energy, accounting for 3.8% of global consumption. India’s commercial energy supply is dominated by coal and oil (most of it imported), with renewable energy contributing less than 1% overall and accounting for approximately 10% of installed capacity. As in many countries that are experiencing high economic growth, its power-generating capacity is insufficient to meet current demand, and in 2009–2010, India experienced a generation deficit of approximately 10% (84 TWh) and a corresponding peak load deficit of 12.7%, i.e. over 15 GW. As a result of frequent electricity shortages, the Indian economy lost about 6% of Gross Domestic Product (GDP) in FY2007–2008. To meet its current goals of economic growth, by 2017 India will need to increase its installed generating capacity to over 300 GW. In recent years, control over generating facilities has shifted to federal government and private entities, including those that have set up captive power plants for their industrial facilities. The private sector dominates the generation of renewable energy (Arora et al., 2010). China and India are currently two of the key drivers of world energy mainly due to their large populations and initiatives to adopt renewable energy technologies (RET).

In Egypt, which is Kenya's main competitor within the COMESA region, investment in renewable energy rose by US$800 million to just over US$1.3 billion as a result of just two deals, a 100MW solar thermal project in Kom Ombo, and a 220MW onshore wind farm in the Gulf of El Zeit. The country's next move in renewable energy is likely to be a tender for several hundred MW of wind projects in the Gulf of Suez region (UNEP, 2011).

Although Kenya has vast renewable energy resources such as solar, wind, biomass, bio-fuel, geothermal and hydropower, their use has been limited. Expansion of the sector is being catalyzed by the growing demand and cost of electricity, increasing global oil and gas prices and environmental pressure. In Kenya, biomass accounts for over 70% of total consumption. The other sources are petroleum and electricity, which account for about 22% and 9% respectively (Mwakubo et al., 2007). Currently, the Kenyan energy sector is characterized by the heavy reliance on biomass, frequent power outages, low access to modern energy, overreliance on hydroelectricity and high dependence on oil imports. Renewable energy is, therefore, an important means to meet the challenges of growing demand and addressing the related environmental concerns.

The Least Cost Power Plan (LCPP) aims to identify new generation and sources to enable the national electricity supply to respond to demand, taking into account the 15% margin required to ensure its security. In the light of frequent droughts and the increase in oil prices, there will be an emphasis on developing alternative energy resources especially geothermal, solar, wind and coal. Since power projects take time to construct, there will be measures to fast-track implementation of the power projects in the Master Plan, to ensure adequate energy supply to meet the demand over the MTP period (Ministry of Finance, 2011a)

As evidenced by good government policy and energy planning that aim to ensure a sustainable energy mix, Kenya's move towards renewable energy has been broad-based. Investment has grown from virtually zero to more than US$1.3 billion, including funding for wind, geothermal and small hydro capacity of 724MW, and for the production of 22 million litres p.a. of ethanol. Geothermal was the highlight, with the local electricity-generating company, KenGen, securing debt finance for additional units at its Olkaria project (UNEP, 2011). With the new financing arrangement, the company will add 280MW of power to the grid in the next three years. At household level, adoption of solar is still too low.

There are two types of solar technology; ‘Photovoltaic’ systems (PV) which convert light energy to electricity, and ‘Solar Thermal’ systems (ST) that utilize solar thermal energy to heat water which is then typically used for washing within the household. Benefits of solar power systems are that they can provide a proven source of energy using a clean technology that has no emissions in operation. They can be readily used in urban environments as they require no additional land use, and they can offer the opportunity for householders to make a statement about their environmental belief (BRECSU 2001).

Photovoltaic systems cost between £4,000- £9,000 per kWp (installed) whereas solar thermal systems cost up to £4,000 installed. Opportunity costs such as roof re-working can be used to offset additional installation costs such as scaffolding. Either system will typically only save £125 per annum, which may make them uneconomic for many households in simple terms such as Capital cost vs. Revenue return (BRECSU 2001).

1.2 Problem Statement

Approximately one fifth of the world’s final energy is consumed by electrical appliances, including lighting (World Bank 2010), and lighting alone accounts for 19 percent of global electricity demand (IEA 2006). In developing countries, lighting is generally thought to rank among the top three uses of energy, with cooking and television, and space heating being of even greater importance. (World Bank 2010 and IEA 2006). While cooking fuel choices have been examined in a number of empirical studies, lighting fuel choices have received less attention. In addition, the adaption of renewable energy sources is typically not placed in the context of a specific fuel choice. Yet only in this specific context can renewable adoption of fuel switching be adequately understood.

In Kenya, solar household systems seem to be used to a significant extent for lighting (Jacobson 2006). Most of the Rural Population use Kerosene for lighting and Charcoal or firewood for cooking. These have caused many health problems because of the smoke emitted and also due to burns caused by the open flames. Less than 44% of the population and 5% of the rural population in Kenya has access to electricity (World Bank, 2010). Demand is growing fast for electricity from both on- and off-grid consumers. Evidence of this includes frequent rolling blackouts due to insufficient supply and the growing popularity of off-grid solutions such as small-scale hydro generation units found all over Kisii and the Mount Kenya highlands that are largely illegal and poorly regulated energy wise.

Adoption of Solar Technology would provide the solution to the evident energy gap but this tends to be negligible in most developing countries, and in Kenya representative data on Solar Energy use at house hold level is virtually nonexistent. There has been no evident comprehensive research on the factors that influence adoption of solar energy that can explain the low use of solar in Kenya and especially in the sub arid areas where the sun is abundant. This study therefore sought to find out the factors influencing adoption of solar technology in Laikipia North constituency.

1.3 Purpose of the Study

The purpose of the study was to investigate factors affecting adoption of solar technology for households in Laikipia North constituency in Kenya.

1.4 Objectives of the Study

The study aimed at achieving the following objectives:-

1. To assess the extent to which the level of knowledge and awareness of solar technology influence the adoption of domestic solar technology in Laikipia North constituency.
2. To investigate the extent to which the level of income of households influence the adoption of domestic solar technology in Laikipia North constituency.
3. To establish to what extent the level of education of household head influence the adoption of domestic solar technology in Laikipia North constituency.
4. To determine the extent to which availability of substitute power source influence the adoption of domestic solar technology in Laikipia North constituency.

1.5 Research Questions

This study will be guided by the following research questions:-

1. To what the extent does the level of knowledge and awareness of solar technology influence the adoption of domestic solar technology in Laikipia North constituency?

2. How does the level of income of households influence the adoption of domestic solar technology in Laikipia North constituency?
3. To what extent does the level of education of household head influence the adoption of domestic solar technology in Laikipia North constituency?
4. To what extent does availability of substitute power source influence the adoption of domestic solar technology in Laikipia North constituency?

1.6 Significance of the Study

These study findings will be of importance to policy makers in the Ministry of Energy who may use it in formulation of policies regarding energy. The study findings may be used by Energy Solution companies and by Kenya Power Company as they seek to understand how to bridge the existing energy gap. The study can also be of importance to the Ministry of Forestry and Environment who may be looking at the ways of finding alternative sources of energy from bio fuel to protect the environment.

1.7 Delimitation of the Study

The study covered only Laikipia north constituency rural households. The study targeted a sample of 365 households drawn from a population of 6,733 households in Laikipia North constituency. Data was collected from household heads as respondents. Open and close ended questionnaires were be used to collect data.

1.8 Limitations of the Study

The constraints that the researcher encountered were inadequate finances and time to extensively collect data from each household and respondents. The researcher is a full time employee with other responsibilities and had made a budget for the intended research within available means and permitted time. The other challenge was the unwillingness of respondent to answer the questionnaire, some due to the fact they are illiterate and could not read and write and others due to lack of trust on how the research findings will be used. Therefore, the researcher used a lot of time to convince the respondents on the intended use of the findings. Geographical distance between the households and sparse distribution of pastoralists was also a challenge due to rainy season.

1.9 Assumptions of the Study

The researcher assumed that respondents gave correct and valid information during the study. The other assumption was that the sample was not biased and was a representative of the population.

1.10 Definition of Central Terms

Laikipia North Constituency This refers to former Laikipia North District

Availability of Solar This refers to availability of solar panels, batteries, bulbs and other gadgets used to generate solar energy for domestic use by households

Availability of Substitutes This refers to availability of other sources of energy used by households such as electricity, biogas, bio fuel, kerosene, gas and others.

Education Level This refers to the number of heads with formal education per household and also the highest education level achieved by household head.

Income Level This refers to the regular income received by the household and from other sources including asserts and shares held by the household

Solar Technology This refers to source of energy from the sun that is converted for lighting, heating water, pump water and run other household appliances.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This study focuses on factors influencing adoption of solar energy namely knowledge and awareness of the existence of the solar technology, level of education of the household heads, level of income, and the availability of alternative energy for the households.

2.2 Background to solar power systems

The literature concerning the adoption of domestic solar power systems is limited and typically paints a pessimistic picture of the potential for solar power systems; it is a mature technology that is being pushed by policy but has failed to be adopted as it is too expensive (ETSU 2001) and while solar power systems are attractive at a national or policy level as a means of reducing carbon emissions, they remain unattractive to individual householders (Timilsina 2000). Research has already suggested that to be attractive in simple financial terms, solar technologies would need to cost approximately £1000 at 2003 UK prices (BRECSU 2001). Solar energy is not being implemented at the rate that it could or should be in the United States for reasons mainly due to efficiency and cost. United States is dependent on environmentally degrading energy sources owned and operated by corporate conglomerates. Changing the way they use energy would be changing the way multinationals do business, and it may be that their non-renewable resources such as coal and natural gas must be depleted till they look for alternative sources such as solar. Currently, developing nation's use of renewable energy such as solar far outweighs developed nations such as the United States, Europe and Japan. The implementation that is happening in these countries is a model for sustainable energy development elsewhere. Jesse Jensen (2001)

PV systems are seen as an affordable technology at a commercial level, but are incompatible with personal priorities and unfortunately, 'compatibility' is a basic criterion of a consumers 'willingness to pay' for the technology (Berger 2001). ST technology is seen as a mature and proven technology and barriers to widespread individual householders (Timilsina 2000). Research has already suggested that to be attractive in simple financial terms, solar technologies would need to cost approximately £1000 at 2003 UK prices (BRECSU 2001).

The single largest trend in international solar policy circles over the past decade has been to shift solar dissemination strategies from heavily subsidized donor projects to private market-based approaches that seek to achieve—or at least move toward—‘‘full cost recovery’’ (Covell & Hansen, 1995; Martinot, Chaurey, Lew, Moreira, & Wamukonya, 2002; van der Plas & Hankins,

1998). Solar photovoltaic technology emerged as an important tool for rural electrification at a time when neo-liberal policies dominated mainstream development thinking. In the late 1980s and 1990s, a period that some have called the age of ‘‘market triumphalism’’ (Peet & Watts, 1993), mainstream development policies emphasized economic liberalization, privatization,and market-based approaches to service provision (Kapur, Lewis, & Webb, 1997). In the energy sector, donor financing for stateowned electricity infrastructure was reduced, while efforts to support liberalization, reforms, and private sector participation expanded.

In this context, public support for grid-based rural electrification was sharply curtailed in many countries (Dubash, 2003; Karekezi, Kimani, Mutiga, & Amenya, 2004). Thus, market-based solar electrification grew at a time when publicly financed rural electrification schemes were in decline. Solar PV, a small-scale technology that can be used to provide decentralized electrical service to individual homes or businesses, is particularly compatible with market-based distribution.

PV systems are seen as an affordable technology at a commercial level, but are incompatible with personal priorities and unfortunately, ‘compatibility’ is a basic criterion of a consumers ‘willingness to pay’ for the technology (Berger 2001). ST technology is seen as a mature and proven technology and barriers to widespread Kaplan (1999) showed that the adoption of renewable energy systems often requires extensive research and deliberation by the householder, and therefore, marketing activities that increase familiarity such as offering small-scale PV goods such as radios, calculators and lamps are beneficial. This concurs with other recommendations (e.g. Aggarwal 1998, Bolinger et al 2001) to develop greater awareness through customer education programmes, marketing material, and information about processes involved, including disruption that may occur during installation or operation.

Utility companies Could further incentivize the systems by providing generous prices for energy produced by householders (commonly known as a buy-back) thus reducing the time for a householder to recover the cost of the technology and installation (Bolinger et al. (2001)

Specifically, householders need information such as descriptions of the technology, methods of operation, and their overall performance with regard to energy savings and environmental benefits (Lai 1991; Berger 2001).

Caird et al's (2008) investigation into the adoption of energy efficiency and renewable energy technologies confirmed much of what has been documented in that the barriers to adoption of renewable technologies are mostly financial, as well as some practical issues regarding installation and general levels of knowledge. However, it is not clear that even if the costs were reduced and information made more available that adoption levels would increase. Neither is it clear that if an increase in adoption were to occur that it would lead to reductions in carbon emissions due to the effect known as the 'Rebound' effect (Caird et al 2008).

The rebound effect describes the phenomenon where individuals divert their spending onto equally carbon rich activities as soon as they have saved money on another; for example by spending money that has been saved as a result of energy saving in one area, on energy intensive appliances that might be perceived as improving their quality of life, for example a larger more energy intensive television (Herring 2006).

Despite the criticisms of domestic level solar power technologies, some householders are adopting the technology (BERR 2008). The literature does indicate areas of research that could be pursued if a more rounded view of the adoption of solar power systems is to be gained. Hence, a broader review of the literature concerning the adoption of innovations was undertaken and is introduced in the following section.

2.3 Overall structure of the energy sector

Kenya has one of the most developed energy sectors in East Africa. The MoE coordinates the overall policy and provides guidance on investment and development of the energy sub-sectors covering electricity, petroleum and renewable energy. The country's energy policy is guided by the 2004 Sessional Paper No. 4 on Energy and by the resulting Energy Act 2006. In August 2010, Kenya promulgated a new constitution that further promotes sustainability and the independence of the energy sector to secure supply and protect the environment. The energy policy and Act are being streamlined to incorporate the aspirations of the constitution.

The Energy Act 2006 brought the regulations affecting all the energy sub-sectors under one umbrella body, the Energy Regulatory Commission (ERC). The ERC is a single-sector regulator with responsibility for economic and technical regulation of the electric power, renewable energy, and downstream petroleum sub-sectors, including tariff-setting and review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts (Republic of Kenya, 2006a). The Act also recognizes other institutions such as the Rural Electrification Authority (REA) to oversee the implementation of the rural electrification programme (previously the role of the MoE) and the energy tribunal, and also created other key institutions such as the Geothermal Development Company (GDC) to oversee geothermal exploitation, and the Kenya Electricity Transmission Company (KETRACO) to carry out electricity transmission in addition to the existing institutions in power generation, supply and distribution. The new constitution provides for some regulatory functions to go to north constituency governments in electricity and gas networks. Nevertheless, national laws and policies supersede north constituency laws to avoid duplication.

Traditionally, modern sources of energy have been promoted in order to meet growing demand. But 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. (Gichungi Henry 2006 unpublished) This is why the National Energy Policy recognizes the broad advantages of renewable energy: potential for income and employment generation, diversification of energy supply and environmental benefits. Hence the national energy policy now incorporates strategies for promoting the contribution of renewable energy to electricity generation. For instance, section 6.3.2 of the policy shows the government’s commitment to promote co-generation in the sugar industry and other establishments to meet a target of 300 MW by 2015. Section 6.4.1 requires the government to undertake pre-feasibility and feasibility studies on the potential for Renewable Energy Technologies (RET) and for packaging and dissemination of information on these technologies to raise investor and consumer awareness.

Due to the previously low uptake of RET, the government has developed additional policies and incentives to promote these technologies. These include Feed-in Tariffs (FiT) to promote the adoption of solar, wind, small hydro and biomass as well as fiscal incentives to investors in these technologies (Ministry of Energy, 2008). For example, the import and production of solar panels are zero tax-rated.

A FiT seeks to promote the generation of electricity from renewable energy sources. It allows power producers to sell and obliges distributors to prioritize the purchase of renewable energy sources for generating electricity at a fixed tariff for a fixed period of time. Kenya's FiT policy aims to achieve two main objectives. First, it seeks to facilitate resource mobilization by providing investment security and market stability for investors using renewable energy sources to generate electricity. Second, it aims to reduce transaction and administrative costs by eliminating the conventional bidding processes.

2.4 Development of solar energy in Kenya

Countries like Kenya that are located near to the equator have great potential to harness solar energy, estimated to be 4–6KWH/M2/day. Currently about 1.2% of households in Kenya use solar energy, primarily for lighting and powering television sets. Solar energy has not yet been exploited commercially, but with rising oil prices and the concern about emissions, solar energy is a renewable source that will play a crucial role in fulfilling the world's energy demand.

Solar energy has since time immemorial been used for drying animal skins and clothes, preserving meat, drying crops and evaporating seawater to extract salt. There has been substantial research on how to exploit this huge resource. Today, solar energy is used at the household level for lighting, cooking, heating water. Medium-scale applications include water heating in hotels and irrigation. At the community level, solar energy is used for vaccine refrigeration, water pumping and purification and electrification of remote rural communities. Industries use solar energy for pre-heating boiler water and power generation, detoxification, municipal water heating, telecommunications, and, more recently, transport (solar cars) (Karekezi and Ranja, 1997; Ecosystems, 2002). In Kenya, some of these uses are still a distant dream.

Table 2.1: PV dissemination in selected sub-Saharan African Courtiers

Country	Estimated Number of Systems	Estimated kWp
Botswana	5724	286
Kenya	84,468	3600
Uganda	538	152
South Africa	150,000	11,000
Zambia	5000	400
Zimbabwe	150,000	1689

Souces: Nieuwenhout, 1991; Bachuo and Otiti, 1994; Hankins, 2001; AFREPREN, 2001.

Solar energy is provided mainly through PV systems for drying and water heating. Such systems are used in Kenya mainly for telecommunications, cathodic protection of pipelines, lighting and water pumping. Kenya is a market leader for solar energy in Eastern Africa, mainly thanks to a supportive policy environment. This market has greatly grown since 1980s largely driven by the private sector, although the data are inconclusive on this.

2.5 Solar Energy and Lighting-Fuel Choice in Kenya

Then, we investigate lighting-fuel choices and, afterwards, specifically discuss the use of SHSs in Kenya. We use data from the Kenyan Integrated Household Budget Survey (KIHBS) 2005/2006 provided by the Kenya National Bureau of Statistics (KNBS). The sample consists of 13,430 households – with 10 households randomly drawn from each of the 1,343 clusters – stratified into 136 strata , according to Kenya's 69 districts.

The clusters are drawn from a pool of 1,800 clusters with a probability, proportional to their size, based on data from the 1999 Population and Housing Census. Item non response is virtually nonexistent (less than 1 percent). The KIHBS dataset contains a unique set of information for our purposes, since it includes very detailed questions about households energy consumption and, furthermore, specifically asks for details on households' ownership and use of SHSs.

2.6 Solar Home Systems, Energy Use, and Lighting -Fuel Choices

Each household's costs for energy use over the preceding month are directly reported for

Table1 provides descriptive statistics on household energy expenditure by source. Purchased firewood, charcoal, kerosene, gas and electricity. By far the most important energy source that Kenyan households purchase is paraffin/kerosene (hereafter referred to simply as kerosene More than 80 percent of all Kenyan households have some expenditure for this type of energy source). and (non-zero) median expenditure amounts to 160 Kenyan shillings (KES) per household.

Traditional fuels, more specifically firewood and charcoal, also account for a considerable portion of household fuel expenditure. Approximately 15 percent of Kenyan households have non-zero expenditure for fire wood, and 36 percent for charcoal. With non- zero median expenditures even higher than those for kerosene (KES 200 and KES 250, respectively), these traditional sources are generally still used to a significant extent. Modern fuels are used by a smaller part of the population, 6 percent in the case of gas/LPG and 12 percent in the case of electricity. If households use these sources, their expenditure for them is much higher than for traditional or transitional fuels, with KES 780 for gas/LPG and KES 350 for electricity. Of course, these much higher costs reflect much greater energy consumption.

2.7 Factors influencing Adoption of Solar Technology

There is need to study several fields so as to narrow down on the factors influencing solar adoption in Kenya. I have chosen to narrow down to the few areas below

2.7.1 Alternative Sources of Energy and adoption of Solar

According to KNBS (2011), Kenya's installed electric power capacity was 1,412.2MW as of 31 December 2010. The effective installed capacity was not enough to meet demand, so the government contracted for 60MW of emergency power. This was needed in order to meet the growing demand and reduce load-shedding, particularly during peak periods. Hydropower is the main source, accounting for 51.55% of total installed capacity. Petrol thermal, geothermal, co-generation and wind account for 33.2%, 13.38%, 1.84% and 0.36% respectively, as shown in Table 1.1. Renewable energy accounts for about 67.1%, which means that power generation in

Kenya is now largely ‘green’. Although installed capacity in hydropower has not seen much growth in the last decade, there have been increased initiatives in geothermal exploitation, sustaining the level of clean electricity in the national grid.

Table 2.2: Installed Effective Electricity Capacity in Kenya in 2010

Year	**Hydro**	**Thermal Oil**	**Geothermal**	**Co-generation**	**Wind**	**Total**	**Total Renewable energy**	**renewable energy (%0f total**
2006	677.3	369.8	128	2	-	1,177.10	807.3	68.6
2007	677.3	389.3	128	2	-	1,196.60	807.3	67.5
2008	719	518.9	128	2	-	1,267.90	849.0	67.0
2009	730	421.5	158	2	5.1	1,311.50	895.1	68.3
2010	728	469.2	189	26	5.1	1,412.20	948.1	67.1
%in 2010	51.55	33,22	13.38	1.84	0.36	100.00		

Source KNBS 2011

The solar market in Kenya is among the largest and its usage per capita is the highest among developing countries. Cumulative solar sales in Kenya (since the mid-1980s) are in excess of 200,000 systems, and annual sales growth has regularly topped 15% over the past decade (Jacobson, 2006). Much of this activity is related to the sale of household solar systems, which account for an estimated 75% of solar equipment sales in the country (KEREA, 2009). Compared to countries such as Germany, the existing solar PV market in Kenya remains small. This market is, however, relatively well established compared to other countries in East Africa, such as Tanzania and Uganda. In 2006, the total installed base was about 250,000 units or 5 MW. New installations have averaged about 25,000–30,000 units p.a (KEREA, 2009).

Further growth in the solar sub-sector is likely to be held back by market failures and other barriers. Most demand for PV systems is driven by the rural non-electrified private sector, with cash sales being the usual method of transaction. Changes in Kenya’s power sector since the adoption of the Sessional Paper No. 4, 2004 on a blueprint for the country’s energy policy have led to new interest in renewable energy. Recent policies have focused on geothermal, hydropower and co-generation technologies with much less emphasis on PV technology, although the government is currently implementing an electrification scheme for remote schools using solar energy (Ngigi, 2006).

In addition to its energy policy, interest in renewable energy in Kenya has risen due to renewed initiatives in rural electrification and environmental concerns about global warming and air quality. The previous focus on renewable energy responded to two main orientations. Large-scale renewables, such as large hydropower and geothermal projects, were developed in order to improve the security of supply through diversification and reduced exposure to external shocks such as high oil prices.

Recently, there has been growing interest in new renewable energy technologies (RET) such as wind, small hydro, and PV energy. These technologies have been developed to expand access to modern energy services, especially in rural and marginalized areas such as Laikipia district which is arid.

Although Kenya is well endowed with renewable energy resources, only geothermal, wind and co-generation (generation from bagasse) have been seriously exploited and connected to the national electricity grid (KNBS, 2011). Solar energy is relatively well developed and has enormous potential due to the country's proximity to the equator. Kenya is the third largest market for domestic solar systems after India and China. In fact, Kenya and China are the fastest growing markets, with annual growth rates of 10%–12% in recent years, with private dealers providing most solar systems (Arora et al., 2010) although the government has also taken measures to increase uptake of these technologies. The initial markets received donor seed money in the 1980s (Mwakubo et al., 2007), which allowed PV system components to become accepted and available. The government has recently intensified measures to increase the uptake of renewable energy by championing initiatives to adopt these technologies. Some of these initiatives include the fitting of the Ministry of Energy (MoE) offices (Nyayo House), the Office of the President (Harambee House), the Office of the Prime Minister and the Ministry of Finance (Treasury) with solar PV and natural lighting. Funds for this were factored in the National Budget 2011/2012, demonstrating government commitment to these initiatives (Ministry of Finance, 2011b).

2.7.2 Level of Knowledge and Awareness of Solar

The adoption of innovations describes a point in time when the adopter of an innovation decides to use the innovation in question. Rogers (2003) theorises that the process of adoption commences with an individual driven by precedent conditions such as a felt need to adopt an innovative product or service. The individual will pass along an innovation decision process at a pace that is influenced by their own level of innovativeness and by the perceived characteristics of the innovation. The decision making process is aided by communication channels; either mass-media communications or by local channels such as word-of-mouth (see Figure 1, below).

The diffusion of innovations theory has been used to explain the adoption of various innovations; Hubbard and Mulvey (2003) and Heimburger et al. (2002) used the process to evaluate the implementation of a diffusion project, and found that the adoption rate was positively related to the level of knowledge potential adopters demonstrated, and despite some adopters rejecting the innovation due to its attributes, they remained open minded to later adoption. Morris et al. (2000) mapped the decision process that farmers took to adopt a government funded grant project. From their findings, the authors were able to identify where weaknesses lay with the marketing approach the government agency took.

The model of adoption that Caird et al. (2008) propose is more directly related to the context of energy efficiency than any of the models discussed in this review and it draws on many elements common to the Diffusion of innovations model, for example the element of communication (see Figure 2). The results of research by Caird et al (2008) into the use and adoption of renewable energy systems by householders extends the categorisation of adopters depending on their level of engagement with the technology and motivation to reduce energy use. The model they propose presents the consumer as an agent influenced by various sources such as the socio-economic context, consumer variables, communication sources, and product and system properties. Within the two models proposed by Rogers (2003) and Caird et al (2008), there are common factors that inform the decision making process, namely the innovation attributes, and the categorisation of adopters.

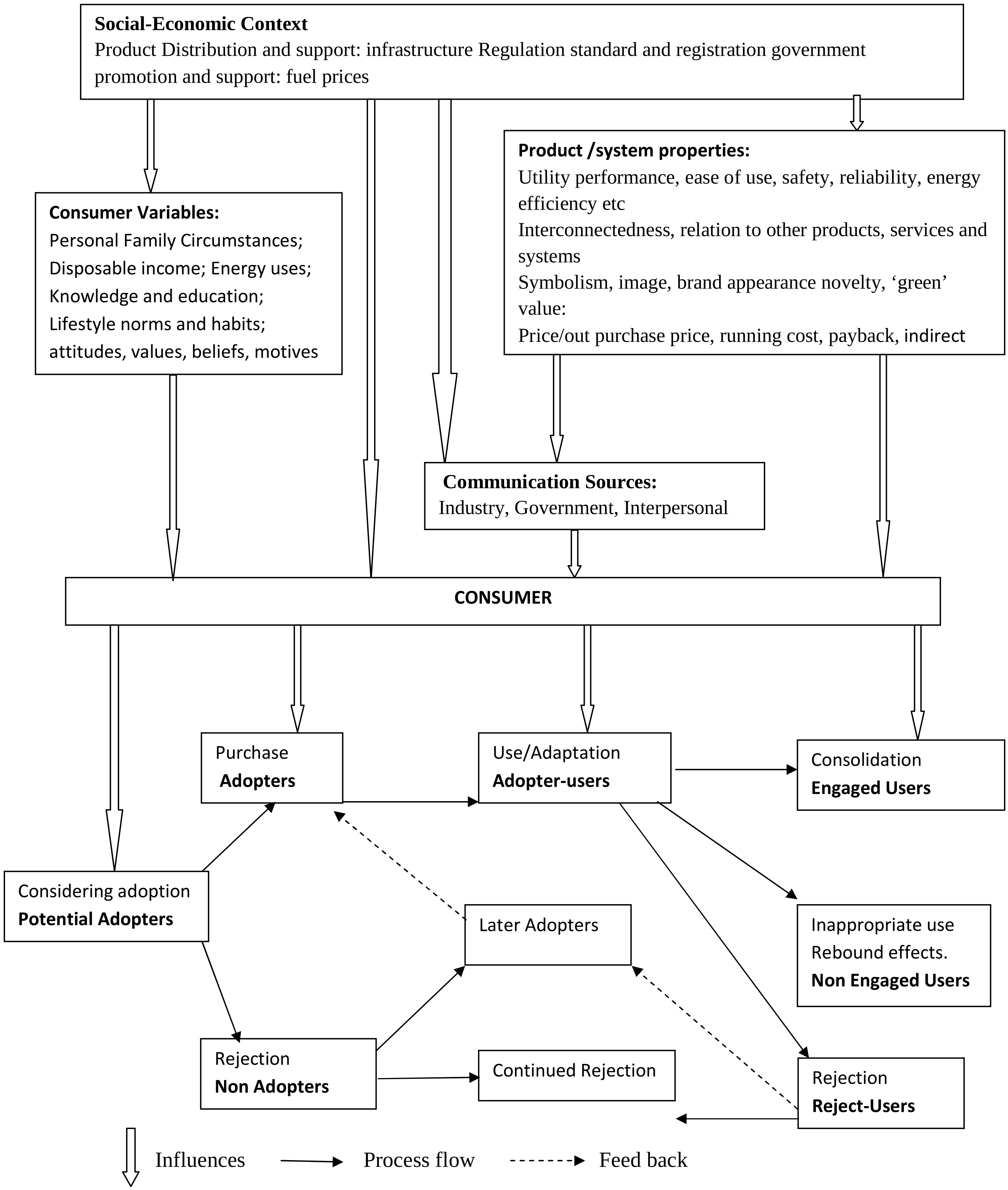
Social-Economic Context
Product Distribution and support: infrastructure Regulation standard and registration government promotion and support: fuel prices
Consumer Variables:
Personal Family Circumstances;
Disposable income; Energy uses;
Knowledge and education;
Lifestyle norms and habits;
attitudes, values, beliefs, motives
Product /system properties:
Utility performance, ease of use, safety, reliability, energy efficiency etc
Interconnectedness, relation to other products, services and systems
Symbolism, image, brand appearance novelty, 'green' value:
Price/out purchase price, running cost, payback, indirect
Communication Sources:
Industry, Government, Interpersonal
CONSUMER
Purchase
Adopters
Use/Adaptation
Adopter-users
Consolidation
Engaged Users
Considering adoption
Potential Adopters
Later Adopters
Inappropriate use
Rebound effects.
Non Engaged Users
Rejection
Non Adopters
Continued Rejection
Rejection
Reject-Users
Influences
Process flow
Feed back

Figure 1: Model of adoption and use of renewable energy systems (from Caird Et al 2008)

2.7.3 Income Level and Adoption of Solar Technology

One important element of our conceptual framework is the energy -ladder hypothesis. This hypothesis assumes that a household's fuel (or energy source) choice depends crucially on the household's income level.As income rises, households move first from using traditional fuels, such as wood, to transitional fuels, like kerosene, and then to modern fuels, such as electricity from the grid (Leach 1992). Modern fuels are generally perceived to be superior to traditional or transitional fuels in efficiency, comfort and ease of use (Farsi et al. 2007). The concept can thus be seen as a stylized extension of the economic theory of the consumer: as income rises, consumers not only demand a larger amount of the good but also change their consumption pattern in favor of higher quality goods (Hosier and Dowd 1987).

The stark differences observed in energy -use patterns between poor and rich countries (e.g. Leach 1992) as well as between households with differing income levels within many (developing) countries motivated the energy-ladder hypothesis, which has since served as the basis formany empirical applications in the literature (e.g. Heltberg2004; Gebreegziabher et al. 2011). Indeed, the empirical literature has confirmed that income is one of the main demand-side factors determining household fuel choice. This can be partly explained by the fact that modern fuels often involve a relatively large upfront investment in equipment, which hinders credit -constrained poorer households from using it.

In addition, the adoption of modern fuels may require knowledge and a certain level of education as demand-side factors. On the supply side, there is often a lack of access to markets for modern fuels and the required equipment may not be supplied. All these factors together may explain why so many poor households are prevented from climbing up the energy ladder.

For this household activity the majority of households use firewood, charcoal, kerosene or electricity, with the specific mix varying depending on the setting (e.g Heltberg 2004;Hosierand Dowd 1987; Farsi et al., 2007; Njong,and Johannes 2011). Each household faces a number of mutually exclusive options for cooking fuels and chooses the fuel that maximizes its utility. So-called *fuel stacking* – that is, a household's combining of different fuels for one purpose (in this case cooking) – is an aspect that is often discussed in the literature (e.g. Acker and Kammen 1996).

In this case, a single option can be a combination of different fuels. Fuel stacking is therefore addressed in some cases by using typical fuel combinations as choices (e.g. Heltberg 2004) and ignored in other cases by considering only the main fuel used by the household (e.g. Farsi et al. 2007).

The literature on cooking -fuel choice often stem from national house - hold surveys and typically do not include a time dimension. The studies therefore investigate a kind of "cross-sectional energy ladder," as they do not discuss economic development over time, but rather variations in cross-sectional data – that is, between rich and poor households. In the following, we review some evidence on the determinants of fuel choices for cooking fuels in developing-country contexts. Heltberg (2004), for example, investigates fuel switching in urban areas for eight developing countries. He finds a strong link between electrification and the uptake of modern cooking fuels. Other factors that are associated with an increased likelihood of choosing modern fuels are consumption expenditure and education, as well as , in some specifications , the size of the household. In a similar investigation in\ Guatemala, Heltberg(2004) confirms the relevance of income for fuel choice. He also emphasizes the importa nce of non-income factors, such as the cost of fire wood (as firewood is a widely used cooking fuel in Guatemala).

The study shows the widespread prevalence of fuel stacking for cooking purposes in Guatemala and therefore explicitly incorporates two-fuel options into the empirical analysis (for example, joint wood -liquefied petroleum gas (LPG) use). Farsi et al. (2007) take a slightly different approach and also find that income is one of the main factors that prevent households from using modern and cleaner fuels in an application for India based on a household expenditure survey. Additionally, they find that the education level and gender of the household head as well as LPG prices impact fuel choice. In contrast to Heltberg (2004, 2005) the authors use the fuel that provides the highest share of total useful cooking energy as the dependent variable and order the fuels in terms of efficiency, comfort and ease of use, strictly in line with the energy ladder.

Gebreegziabher et al. (2011) assess the determinants of the adoption of electric *mitad* cooking appliances for baking bread, among other energy uses, in Northern Ethiopia and the effects of this adoption on urban energy transition The authors' analyze the factors that explain urban households' choice of fuel among five options: wood, charcoal, dung, kerosene and electricity. Based on survey data the paper finds that the likelihood of the electric *mitad* adoption increases with household expenditure, age of household head and family size. Further more, fuel choices more generally are found tobedetermined bythe prices of substitutes, household expenditure, age and education of household head, and family size, with the probability of using t ransitional and modern fuels (such as kerosene and electricity) positively correlated with the price of wood and charcoal, household expenditure,the age and education of the household head.

All of the studies presented abovefind income or household expenditure to be a key determinant of cooking -fuel choice, in line with the energy-ladder hypothesis. Most authors additionally stress the importance of non -income factors, which vary slightly from case to case but typically include both socioeconomic demand-side factors and supply -side factors, such as fuel prices or electrification rates. While some of these factors are specific to cooking (for example, gender of household head), most are likely to affect lighting -fuel choices as well (for example, education).

The above literature on the determinants of cooking -fuel choices is closely linked to empirical studies that analyze SHS adoption. The factors that are of special relevance to SHS up- take should also be included in our lighting-fuel choice analysis, in addition to the more general fuel -choice determinants.

2.7.4 Level of Education of house hold head and adoption of Solar

Due to its early development, quite a number of studies have examined adoption in the case of the Kenyan consumer market for SHSs. Acker and Kammen (1996) track the emergence of the Kenyan SHSs market from the 1980s to the mid1990s. They also report results from a (not representative) survey of approximately 40 SHSs users interviewed near urban centers. This initial analysis of the Kenyan SHSs market finds that SHSs are purchased by affluent households with above average income that are located near the electricity grid. The authors admit that this counterintuitive finding may be due to a selection bias given that they largely surveyed households in the vicinity of urban centers and hence near the grid.

A more thorough quantitative analysis of the Kenyan SHSs market was carried out by Jacobson (2006), who describes various aspects of the Kenyan SHSs market and presents analyses based on two cross-sectional surveys among rural Kenyan households which were conducted in 2000 and 2001. Jacobson finds that the benefits of solar electrification are captured,primarily by the rural middle class, that solar playsonly a modest role in supporting prod uctive activities and education, and that solar electrification is more related to general market forces than to poverty alleviation and sustainable development. Based on the 2000 survey, Jacobson further finds that most SHSs are owned by households in the first three wealth deciles. He characterizes these households as belonging to the rural middle class, with annual household incomes well above USD 2,000 (in current USD). In the paper the further argues that the data suggests a trend towards a deepening of access beyond the middle class, with smaller systems becoming affordable for lower-income households as well.

Rebane and Barham (2011) analyze the determinants of SHSs awareness and adoption in Nicaragua. They identify the determinants of four measures of SHSs knowledge. This is followed by an investigation of factors that predict SHSs adoption conditional upon sufficient awareness about SHSs. They use survey data from 158 households in rural Nicaragua, 40 of which had adopted SHSs. Knowledge is predicted most strongly by the presence of other installed SHSs, being male, being young and having a high-quality residence (as a proxy for wealth). Income , having learned about SHSs from a business or NGO and not living in the Caribbean lowlands (where SHSs were very rare at the time the survey was carried out) are all positive determinants of SHSs adoption, while living near a dealer reduces the likelihood of adoption. The authors presume that the latter is due to the proximity of dealers to urban areas, which would suggest that the households near a dealer might have higher expectations of grid extension in the near future Reba ne and Barham (ibid.) argue that knowledge about SHSs is important in the adoption process, that the presence of other SHSs is a very important educational tool, and that women should be included in education about SHSs.

Komatsu et al. (2011) also assess the determining characteristics for household purchases of SHSS in a case study for three regions in rural Bangladesh that comprises around 600 households. They model a twostep decision, where the household first faces the (binary) decision of whether to purchase a system and then in a second step decides on the size of the panel. The authors find household income, ownership of rechargeable batteries, kerosene consumption, and the number of mobile phones to bekey determinants of SHS s purchases. They especially highlight the level of kerosene consumption as a key determinant.

It is worth noting that while the studies on cooking -fuel choice mostly draw on national household surveys, the SHSs adoption literature cited above typically uses smaller surveys, often tailoredto one specific research question(e.g. Jacobson 2006; Komatsu et al. 2011). By using the KIHBS household budget survey we thus try to achieve convergence between household budget survey we thus try to achieve convergence between both strands of literature.

2.8 Theoretical Framework

The study is guided by several theories that relates to adoption of domestic solar technology.

2.8.1 Innovative Diffusion Theory (IDT)

The theory of diffusion of innovation by Rogers, (1995) provides perceptions that individuals may have of adopting an innovation such as solar technology. The theory explains, predicts, and accounts for the factors which influence adoption of an innovation. This is in line with the studied variables. According to Rogers,(2003) individuals technology adoption behavior such as solar technology is determined by his or her perceptions regarding relative advantage, compatibility, complexity and observability of an innovation,(Hikmet 2007).These constructs have relationship with the studied variables . This relates to attitude towards use of solar technology.

2.8.2 Resource Based Theory

The resource based theory states that the basis for competitive advantage of a firm lies primarily in the application of the bundle of valuable resources at the firms disposal (Wernerfelt, 1984), including technology such as solar technology. According to (Manoney and Pandian 1992) firm`s ability to reach competitive advantage when different resources are employed and these resources cannot be imitated by competitors. This relates to access to solar technology resources , tools and funds. From this theory when households have enough resources of funds and access to solar tools they can easily adopt solar technology in their homes.

2.8.3 Theory of Reasoned Action

According to Brown, Massey and Burkman,(2002) the theory states that both attitude and subjective norm are important determinants of peoples intention to adopt and use technology in enterprises. Further the intention to adopt and to continue using technology is influenced by ones attitude. The theory states that an individual behavior is influenced by his or her behavior`s intention which is influenced by his or her attitude towards behavior of subjective norm (Venkalesh and Davis, 2000).

2.9 Conceptual Framework

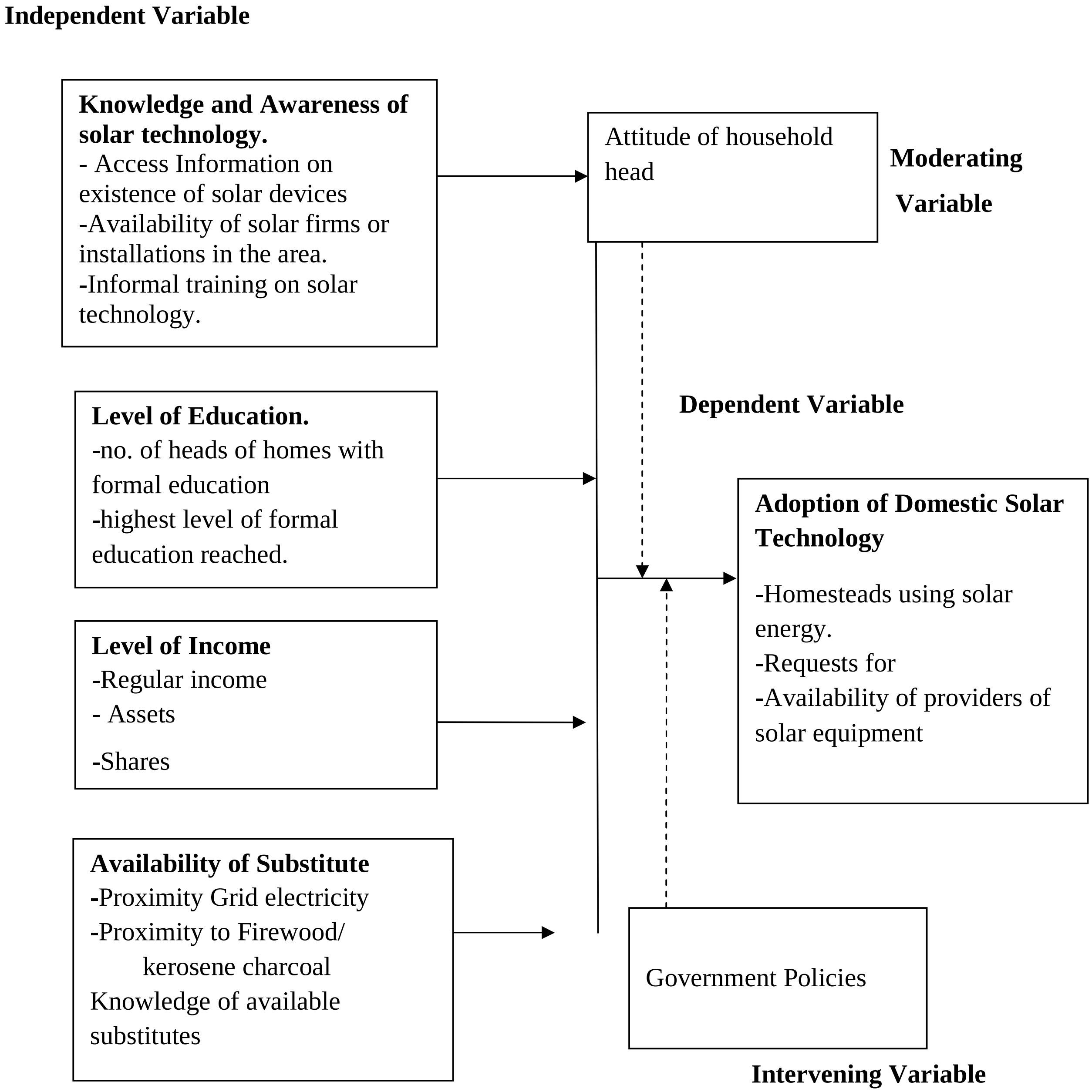

Figure2: Conceptual Framework

Fig 2.9 shows that the sturdy considered the Dependent variable to be the adoption of domestic solar technology. This was influenced by the independent variables are the household heads knowledge and awareness of solar technology availability, the level of education of the house head, level of income and the availability of substitutes. It was expected that the afore mentioned variables greatly affected the adoption or lark of adoption of solar energy use in households if

Laikipia north constituency. This study sought to establish to what extent the level of knowledge and awareness affects adoption of solar energy in households, access to information, informal training and even the presence of solar technology providers, if available does it influence the level of adoption? Similarly, this sturdy sought to find out the influence of the disposable income per household on adoption, the highest level of education per household and its influence and also the influence of availability of alternative source of energy.

There are some government policies on use of solar energy in Kenya and though they are relatively new the study will consider then as intervenening variables as they may have influence the adoption of solar in households to some extent.

2.10 Summary of the Research Gap

The literature concerning the adoption of domestic solar power systems is limited and typically paints a pessimistic picture of the potential for solar power systems. In summary, most insights on fuel choice stem from the empirical analysis of cooking 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 cookingfuel choices, we focus our analysis on the fraction of household energy consumption that goes to lighting. This investigation is important not only due to the role of lighting in household energy use, but also as increased access to lighting is expected to contribute to better adoption of solar technology, the achievement of the UN’s Millennium Development Goals (IEA 2008) and to Kenya’s vision 2030

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the type of research methodology that was applied. It covers the type of research design, sample and sampling procedure method, target population, Accessible population and sample size. Further data collection procedure and analysis, research instruments the study adopted. It has also focused on validity and reliability of instruments and ethical issues.

3.2 Research Design

The research adopted a descriptive survey design. According to Kothari, (1985), descriptive design allows the researcher to describe record, analyze and report conditions that exist or existed. The research study will use both quantitative and qualitative approaches. The data was collected to study the factors influencing adoption of household solar technology in Laikipia North constituency . The quantitative approach was used in this study because it provides in depth understanding of information while the quantitative approach provides summary information on many characteristics: Hair, Money, Samuel and Page (2007).

3.3 The Target Population

The target population was that which researcher wanted to generalize the results of the study (Mugenda and Mugenda, (2003) .The population for the study comprised of the households in Laikipia north constituency.

Population was 32,762 (Male – 16,928 and Female – 15,834, The number of Households in the Constituency was 6,733

The Data above was given by the ministry of planning and vision 2030

This study was concerned with the adoption of solar especially in households. The target population in consideration was 6,733 households as recorded by the ministry of planning based on 2009 Census.

3.4 Sample Size and Sampling Procedure

The study adopted a stratified random sampling method. The reason for the choice of this method is because the target population is divided into districts, divisions, locations and villages. In this case the target population was divided into sub locations. The sample size was to be 364 according to Krejcie, Robert V., Morgan, Daryle W (1970)

3.4.2 Sample Size

The decisions about sample size should take into consideration the size of the target population being researched (e.g. all residents in a particular community, members of a particular club or association, people in a particular occupation.) and the level of accuracy one require from the research (Fleiss, 1981). Hence the consideration of all the households, whether headed by women or men of any age group.

Table 3.1: Sampling Frame

No	Sublocation	Households	Sample Size
1	ARJIJO	272	15
2	EWASO	549	30
3	ILMOTIOK	473	26
4	ILPOLEI	793	43
5	IMPALA	486	26
6	KIRIMON	1299	70
7	KURI KURI	705	38
8	MAKURIAN	223	12
9	MUMUNYOT	350	19
10	NGARE NDARE	250	14
11	SANGAA	236	13
12	SEEK	265	14
13	SIEKU	354	19
14	TURA	478	26
TOTAL		**6733**	**365**

3.5 Data Collection Method

A self administered questionnaire was used as a data collection instrument. It comprised of both open ended and closed ended questions. The use of questionnaires was to enable the respondents to remain anonymous and be honest in their responses (Cooper and Schindler, 2003).The choice of the questionnaire was based on the fact that it is easy to analyze the collected data statistically. Further it is not biased and the responses were gathered in a standardized manner so they would be more objective in their results.

Focused interview were used to explore and understand the beliefs, education levels, levels of income and there after availability of funding for adaption of new ideas. The data was non numerical to a great extent and allowed the interviewee to talk freely thus generating a discussion that generated valuable insights into the factors that influence the adoption of solar technology.

The questionnaire was divided into sections that examined the different variables that assisted in the discovery of what the real factors are that influences the adoption or lack of adoption of the technology by the Laikipia North constituency people

3.7 Instrument Validity

Validity is the degree to which an instrument measures what is supposed to measure. Kothari, (1998) It is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study. The validity was enhanced through appraisal of the tools and verification by the supervisor who is an expert. Furthermore, the questionnaire was subjected to pre-test to detect any deficiencies in it. The necessary improvements were made.

3.8 Instrument Reliability

Mugenda and Mugenda, (2003) define reliability as a measure of a research instrument yields consistent results or data after repeated trials. According to Joppe, (2000) reliability is the extent to which results are consistent overtime. To test reliability a test re-test method was employed to the same categories of respondents after a period of two weeks to examine the consistency of response between the two tests in a pilot study. The test retest sample comprised of 7% of the intended sample. This was done in the neighboring district of Laikipia East where a 10% of the intended sample was submitted to the instrument. This was a sample of 37 households selected randomly.

3.9 Data Analysis

Data analysis consists of examining categorizing; tabulating or otherwise recombining the evidence to address the initial prepositions of the study (Yin, 1994).The data collected was cleaned and coded. This was to enhance basic statistical analysis. The data analysis involved quantitative and qualitative methods (numerical and descriptive). Qualitative data was analyzed based on content analysis while quantitative data was analyzed using descriptive and inferential statistics. Data was analyzed with the help of electronic spreadsheet SPSS Program which has analysis tools. The collected data is presented using statistical techniques which included percentages and frequency distribution tables.

3.10 Ethical Issues

The principle of voluntary participation was strictly adhered to. The respondents were not coerced into participating in the research. They were informed about the purpose of the study. The researcher guaranteed the participants confidentiality in the entire research process. The researcher will seek authority from all the relevant authorities for conformity and in ensuring the study is not discontinued in the process. Authority will also be sought from the University of Nairobi to be allowed to carry out the research. The authority given from the University will assist to seek consequent permissions. Permits for the study will also be sought from the National Council of Science and Technology through an application form designed by the Council. The researcher will also seek authority from the District Commissioners in Laikipia North Constituency plus the divisional officers, chiefs and elders in the area of study by visiting their offices and presenting relevant documents required by each one of them. The researcher obtained permission to carry out the research from the relevant authority.

Table 3.2: Operationalisation of Variables

OBJECTIVES	**Variable-Independent**	**Indicator**	**measurement**	**Measurement scale**	**Methods of data analysis**
1. To assess the extent to which the level of knowledge and awareness of solar technology influence the adoption of household solar technology in Laikipia North constituency .	Level of Knowledge and Awareness of solar technology	-- Access to Information on existence of solar devices -Availability of solar firms or installations in the area. -Informal training on solar technology.	-No of Solar installations seen in the area. -No. of solar traders or providers available. -no of informal trainers in the region.	Ordinal Ordinal Ordinal Nominal	Descriptive-Correlation analysis -frequencies distribution tables
2. To establish to what extent the level of education of household head influence the adoption of household solar technology in Laikipia North constituency .	Level of Education	-Highest level of formal education reached -formal training	- no. of heads of homes with formal education -Certificates attained.	Ordinal Nominal Ordinal Ordinal	Descriptive-Correlation analysis, frequencies Inferential-hypothesis testing -correlation analysis

3. To investigate the extent to which the level of income influence the adoption of Solar technology in home in Laikipia north constituency	Level of Income	-Regular income - assets -shares	-Ksh. Per month -No of tangible of assets -No of shares held.	Ordinal Ordinal Nominal	Descriptive-frequencies Inferential-correlation analysis, hypothesis testing
4. To determine the extent to which availability of substitute power source influence the adoption of household solar technology in Laikipia North constituency.	Availability of Substitute power source	- Proximity Grid electricity - Proximity to Firewood/ kerosene charcoal - Knowledge of available substitutes	-distance from the grid electricity, -distance to the Kerosene shops -No of people aware of alternative available	Ordinal Ordinal Ordinal	Descriptive-frequencies Inferential-correlation analysis
Factors influencing the adoption of solar Energy in Laikipa north constituency	Adoption of Solar.	-. home stead using solar energy. -requests for installations. -availability of providers of solar equipment	-No. of homesteads using solar -No. of applications for solar installations -No. of solar equipment providers in the region.	Ordinal	Descriptive

3.12 Summary

This Chapter presents a detailed look at the research methodology; a descriptive design was adopted. This allowed an in depth study into the way of life of the intended target group. The methodology allowed recording, analysis, and the ability to get a wholesome picture of the knowledge, income levels, education levels and the general attitude of the community towards adopting solar technology for their use. The target population consisted of the heads of the households as these were considered to be the decision makers in most homes. These are the people who determine how money will be used and in what proportions. They also determine what technology will be used for the different functions that need energy at homes.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter focused on data analysis, interpretation and presentation. The purpose of this study was to investigate the factors influencing adoption of solar technology in Laikipia North Constituency. The objectives of the study were to assess the extent to which the level of knowledge and awareness of solar technology influence the adoption of domestic solar technology, to investigate the extent to which the level of income of households influence the adoption of domestic solar technology, to establish to what extent the level of education of household head influence the adoption of domestic solar technology and to determine the extent to which availability of substitute power source influence the adoption of domestic solar technology in Laikipia North constituency.

4.2 Response Rate

The response rate of the of respondents is presented in Table 4.1

Table 4.1: Response Rate

Category	Frequency	Percentage
Responded	300	82.2
Did not respond	65	17.8
Total	365	100

From table 4.1 above, the researcher distributed 365 self-administered questionnaires to the sampled respondents, 301 questionnaires were returned and this represents an 82.5% response rate which the researcher found sufficient to proceed with data analysis. The high response rate is attributed to the fact that the researcher personally administered the questionnaires to the respondents.

4.3 Background Information of the Respondents

The researcher asked the respondents to indicate their gender, marital status, age, if they were the household head and if they were connected to electricity.

4.3.1 Gender of the Respondents

In this section the researcher sought to establish the gender of the respondents. Their responses are shown in table 4.2.

Table 4.2 Gender of the Household heads (n=300)

Category	Frequency	Percentage
Male	162	53.9
Female	138	46.1

53.9% of the household heads were males while as 46.1% of the household heads were females. This implies that there were more male respondents than females. This might be so because most homes are dominated by males as household heads. This however will not affect the responses from the respondents thereby creating any form of biasness.

4.3.2 Marital status of the Household Heads

In this section the researcher sought to establish the marital status of the household heads. Their responses are highlighted in the Table 4.3.

Table 4.3 Marital status of the Household Heads (n=300)

Category	Frequency	Percentage
Married	132	43.9
Single	150	49.8
Divorced	9	3.0
Separated	0	0.0
Widower	10	3.3

49.8% of the household heads were single, 43.9% of the household heads were married, 3.3% of the household heads were widowed while as 3.0% of the household heads were divorced. This implies that most of those who responded were single. This did not affect the results collected from the respondents.

4.3.3 Age of the Household Heads

In this section the researcher sought to establish the age of the household heads. Their responses are highlighted in the Table 4.4

Table 4.4Age of the Household Heads (n=300)

Category	Frequency	Percentage
18 to 24 yrs	152	50.6
25 to 30 yrs	81	26.9
31 to 35 yrs	37	12.3
36 to 40 yrs	10	3.3
41 to 45 yrs	4	1.3
46 to 50 yrs	4	1.3
Over 50 yrs	13	4.3

50.6% of the household heads were aged between 18 years to 24 years, 26.9% of the household heads were aged between 25 years to 30 years, 12.3% of the household heads were aged between 31 years to 35 years, 1.3% of the household heads were aged between 41 years to 45 years, 1.3% of the household heads were aged between 46 years to 50 years and 4.3% of the household heads were aged over 50 years. This shows that the largest population of the respondents was young enough as a result they were able to understand issues related to solar technology.

4.3.4 Head of the Household

Here the goal was to know if the respondent was the head of the household. Their responses are highlighted in the Table 4.5.

Table 4.5 Head of the Household (n=300)

Category	Frequency	Percentage
Household heads	147	48.8
Not Household heads	154	51.2

51.2% of the respondents were not the household heads while as 48.8% of the respondents were the household heads. This implies that most of the respondents were not the household heads. This might be so because by the time the questionnaires were given out most of the heads were not at home. This however will not affect the responses from the respondents since they have enough information about their homes.

4.4 Level of Knowledge and Awareness of Solar

The researcher sought to address the first objective that looked at the extent to which the level of knowledge and awareness of solar technology influence the adoption of domestic solar technology in Laikipia North constituency. The respondents were asked questions regarding to their energy source of lighting, if they had a solar system installed in their household, ever seen a solar lamp and solar power in use, if they were aware of solar technology providers, received any training on solar system and if they had received informal training on solar systems.

4.4.1 Energy choice for Lighting

The researcher wanted to know the respondents energy choice for lighting. Their responses are highlighted in the Table 4.6.

Table 4.6 Energy choice for Lighting (n=300)

Category	Frequency	Percentage
Electricity	40	13.3
Paraffin	71	23.6
Gas	5	7.1
Firewood	40	13.3
Dry cells	23	7.6
Solar	122	40.5

Household heads were asked what was their energy choice for lighting; 40.5% of the households used solar energy as their choice for lighting, 23.6% of the households used paraffin as their choice for lighting, 13.3% of the households used electricity and firewood respectively as choice for lighting while as 7.6% of the households used dry cells as choice for lighting. This implies that most of the households used solar energy as their choice for lighting.

4.4.2 Solar System Installation

In this section the researcher wanted to know if the respondents had installed Solar systems in their households. Their responses are highlighted in the Table 4.7.

Table 4.7 Solar System Installation (n=300)

Category	Frequency	Percentage
Installed Solar	99	33
Not Installed Solar	201	67

Household heads were asked if they had installed solar systems in their household; 33% of the households had installed solar systems while as 67% of the households had not installed solar systems. This implies that most of the households had not installed solar systems in their homes

4.4.3 Solar Lamp Use

Here, the researcher wanted to know if the respondents had seen a solar lamp in use. Their responses are highlighted in the Table 4.8.

Table 4.8 Solar Lamp Use (n=300)

Category	Frequency	Percentage
Aware of Solar Technology Providers	226	75.1
Not seen of Solar Technology Providers	74	24.9

Household heads were asked if they had ever seen a solar lamp in use; 75.1% of the household heads indicated that they have seen a solar lamp in use while as 24.9% of the household heads indicated that they have never seen a solar lamp in use. This implies that most of the household heads had seen solar lamp in use.

4.4.4 Solar Power Use

On solar power use, the researcher wanted to know if the respondents had seen a solar power in use. Their responses are highlighted in the Table 4.9.

Table 4.9 Solar Power Use (n=300)

Category	Frequency	Percentage
have seen Solar power in use	254	84.7
Have not seen Solar power in use	46	15.3

Household heads were asked if they had ever seen a solar power in use; 84.7% of the household heads indicated that they have seen a solar power in use while as 15.3% of the household heads indicated that they have never seen a solar power in use. This implies that most of the household heads had seen solar power in use.

4.4.5 Solar Technology Providers

The researcher sought to know if the respondents were aware of any Solar Technology providers in the area. Their responses are highlighted in the Table 4.10.

Table 4.10 Solar Technology Providers (n=300)

Category	Frequency	Percentage
Aware of Solar Technology Providers	171	57.1
unaware of Solar Technology Providers	129	42.9

Household heads were asked if they were aware of any solar technology providers in the area; 57.1% of the household heads indicated they were aware of solar technology providers in the area while as 42.9% of the household heads indicated they were not aware of solar technology providers in the area. This implies that most of the household heads were aware of solar technology providers in the area.

4.4.6 Training on Solar Systems

In this section, the researcher sought to know if the respondents had received any formal or informal training on solar systems. Their responses are highlighted in the Table 4.11.

Table 4.11 Training on Solar Systems (n=300)

Category	Frequency	Percentage
Received Training	60	20.3
Have not received Training	240	79.7

Household heads were asked if they had received any formal or informal training on solar systems; 79.7% of the household heads indicated they have never received any formal or informal training on solar systems while as 20.3% of the household heads indicated they have received formal or informal training on solar systems. This implies that most of the household heads have never received any formal or informal training on solar systems

4.4.7 Level of Training

On Training, the researcher wanted to know the level of training the respondent had on solar systems. Their responses are highlighted in the Table 4.12.

Table 4.12 Level of Training (n=61)

Category	Frequency	Percentage
Degree	0	0
Diploma	2	1.7
Certificate	59	98.3

Household heads were asked to give the level of training they had received on solar system; 98.34% of the household heads indicated they have been trained up to the certificate level on solar systems, 1.7% of the household heads, indicated they have been trained up to the diploma level on solar systems while none of the household heads indicated they have been trained up to the degree level on solar system. This implies that out of the 60 household heads who indicated training, most have been trained up to the certificate level on solar systems.

4.4.8 Informal Training on Solar Systems

In this section the researcher sought to know if the respondents had received any informal training on solar systems. Their responses are highlighted in the Table 4.13.

Table 4.13 Informal Training on Solar Systems (n=300)

Category	Frequency	Percentage
Have Informal Training	81	27.2
Have no Informal Training	219	72.8

Household heads were asked if they had received any informal training on solar systems; 72.8% of the household heads indicated they have never received any informal training on solar systems while as 27.2% of the household heads indicated they have received informal training on solar systems. This implies that most of the household heads have never received any informal training on solar systems.

4.5 Level of Income

The researcher addressed the second objective that looked at the extent to which the levels of income of households influence the adoption of domestic solar technology in Laikipia North constituency. They were asked questions on the kind of income have a savings account, have any shares, loan from a bank/microfinance institute and if there was a notable improvement to their living standards since becoming a member of SHS.

4.5.1 Everyday Income

The Researchers' goal was to know the kind of income the respondent got on everyday life. Their responses are highlighted in the Table 4.14.

Table 4.14 Everyday Income (n=300)

Category	Frequency	Percentage
Monthly salary (regular)	17	4.9
Monthly salary (Business)	75	25.6
Regular income	24	8.0
No regular income	90	28.6
No income	94	32.9

Household heads were asked to indicate the kind of income they got on everyday bases; 32.9% of the household heads got no income on everyday life, 28.6% of the household heads got no regular income on everyday life, 25.6% of the household heads got monthly salary through the business 8.0% of the household heads got regular income but not monthly while as 4.9% of the household heads got monthly salary regularly. This implies that most of the household heads got no income on everyday life.

4.5.2 Savings Account

In this section the researcher sought to know if the respondents had savings account. Their responses are highlighted in the Table 4.15.

Table 4.15 Savings Account (n=300)

Category	Frequency	Percentage
Have Bank Accounts	86	29.7
Have no Bank Accounts	214	71.3

Household heads were asked if they had savings account; 54.2% of the household heads indicated they had savings account while as 45.8% of the household heads indicated they did not have savings account. This implies that most of the household heads had savings account.

4.5.3 Shares

In this section the researcher sought to know if the respondents had any shares. Their responses are highlighted in the Table 4.16.

Table 4.16 Shares (n=300)

Category	Frequency	Percentage
Have Shares	29	9.6
Have no shares	272	90.4

Household heads were asked if they had shares; 90.4% of the household heads indicated they did not have shares while as 9.6% of the household heads indicated they had shares. This implies that most of the household heads did not have shares.

4.5.4 Loan

The researcher sought to know if the respondents had any loan in a bank or any microfinance institute. Their responses are highlighted in the Table 4.17.

Table 4.17 Loan (n=300)

Category	Frequency	Percentage
Have Loans	50	16.7
No Loans	250	83.3

Household heads were asked if they had any loans in the banks or in any microfinance institute; 83.3% of the household heads indicated they did not have any loans in the banks or in any microfinance institute while as 16.7% of the household heads indicated they had loans in the banks or in any microfinance institute. This implies that most of the household heads did not have any loans in the banks or in any microfinance institute.

4.6 Level of Education

On Education, the researcher sought to address the second objective that aimed at establishing to what extent the level of education of household head influence the adoption of domestic solar technology in Laikipia North constituency. The researcher asked the respondents to indicate level of education attained by the household head, if anyone in the household had higher education and the level attained.

4.6.1 Level of Education Attained

In this section the researcher sought to know the level of education attained by the respondents who were the household heads. Their responses are highlighted in the Table 4.18.

Table 4.18 Level of Education Attained (n=300)

Category	Frequency	Percentage
College	28	9.3
Secondary	133	44.2
Primary	135	44.9
None	4	1.6

Household heads were asked to indicate the level of education they had attained; Forty four percent (44.9%) of the household heads indicated they had Secondary education, 44.2% of the household heads indicated they had Primary education, 9.3%of the household heads indicated they had College education while as 1.6% of the respondents indicated they had no education at all. This implies that most of the household heads had attained college education.

4.6.2 Higher Education

On higher Education, the researcher sought to know if the respondents had any loan in a bank or any microfinance institute. Their responses are highlighted in the Table 4.19.

Table 4.19 Higher Education (n=300) (higher than the household head)

Category	Frequency	Percentage
Attained Higher Education	20	6.7
Didn't attain higher Education	280	93.3

Household heads were asked if there was anyone in the household holding higher than them; 6.7% of the household heads indicated that there were members in the household who had higher education than them while as 93.3% of the household heads indicated that there were members in the household who had higher education than them. This implies that most of the household members had higher education than the household heads.

4.6.3 Level of Education Attained by Other Household Members

The researcher sought to know the level of education attained by the respondents who were the household heads. Their responses are highlighted in the Table 4.20.

Table 4.20 Level of Education Attained by Other Household Members (n=300)

Category	Frequency	Percentage
College	42	8.5
Secondary	92	30.6
Primary	166	60.9

Household heads were asked to indicate the level of education attained by the other household members; 60.9% of the household heads indicated they had attained primary education, 30.6% of the household heads indicated they had attained secondary education and 8.5%of the household heads indicated they had attained College education. This implies that most of the household members had attained Primary education.

4.7 Availability of Substitute

The aim of this section was to address the last objective that aimed at determining the extent to which availability of substitute power source influence the adoption of domestic solar technology in Laikipia North constituency. The researcher asked the respondents to indicate if they were using any other source of energy, distance to the vendors place, distance from the grid electricity and cost of installing a solar unit.

4.7.1 Distance of Vendor from Home

On the Vendor distance, the researcher sought to know from the respondents how far the vendor was from their homes. Their responses are highlighted in the Table 4.21.

Table 4.21 Distance Of Vendor from Home (n=300)

Category	Frequency	Percentage
Less than 5 km	180	60.1
Less than 10 km	50	16.6
Less than 15 km	43	14.3
Over 15 km	27	9.0

Household heads were asked to indicate how far the vendor was from home; 60.1% of the household heads indicated that the vendor was less than 5 km from home, 16.6% of the household heads indicated that the vendor was less than 10 km from home, 14.3%of the household heads indicated that the vendor was less than 15 km from home while as 9.0% of the respondents indicated that the vendor was over 15 km from home. This implies that most of the households were less than 5 km from home.

4.7.2 Distance of Grid Electricity from Home

In this section the researcher sought to know from the respondents how far Grid electricity was from their homes. Their responses are highlighted in the Table 4.22.

Table 4.22 Distance of Grid Electricity from Home (n=300)

Category	Frequency	Percentage
Less than 600 m	36	11.3
Over 600 m	266	88.7

Household heads were asked to indicate how far grid electricity was from home; 88.7% of the household heads indicated that grid electricity was more than 600 m from home while as 11.3% of the respondents indicated that grid electricity was less than 600 m from home. This implies that most of the households were more than 600 m from grid electricity. This means that the majority of the community members were far from Grid Electricity and had low chances of electricity connection in the near future.

4.7.3 Cost of Installing Solar Unit in the Household

The researcher wanted to know from the respondents if they knew the cost of installing solar unit in their household .Their responses are highlighted in the Table 4.23.

Table 4.23 Cost of Installing Solar Unit in the Household (n=300)

Category	Frequency	Percentage
Knew of Installing cost	184	61.5
Did Not know the cost of Installing	116	38.5

Household heads were asked if they knew the cost of installing solar unit in their household; 61.5% of the household heads indicated that they knew the cost of installing solar unit in the household while as 38.5% of the household heads indicated that they did not know the cost of installing solar unit in the household. This implies that most of the household heads knew the cost of installing solar unit in the household.

4.8 Adoption of Solar

The researcher wanted to know about respondents' adoption of Solar Technology in Laikipia County; the household heads were asked if they use solar energy in their homes and if they would recommend the use of solar technology to others.

4.8.1 Use of Solar Energy At Home

On Use of Solar Energy, the researcher wanted to know from the respondents if they use solar energy in their homes. Their responses are highlighted in the Table 4.24.

Table 4.24 Use of Solar Energy At Home (n=300)

Category	Frequency	Percentage
Use Solar Energy	118	39.4
Don't Use Solar Energy	182	60.6

Household heads were asked if they use solar energy in their homes; 60.6.5% of the household heads indicated that they did not use solar energy in their homes while as 39.4% of the household heads indicated that they used solar energy in their homes. This implies that most of the households do not use solar energy.

4.8.2 Recommend Use of Solar Technology to Others

In this section the researcher wanted to know from the respondents if they would recommend use of solar technology to others. Their responses are highlighted in the Table 4.25.

Table 4.25 Recommend Use of Solar Technology to Others (n =300)

Category	Frequency	Percentage
Would Recommend	252	84.1
Would not Recommend	48	15.9

Household heads were asked if they would recommend use of solar technology to others; 84.1% of the household heads indicated that they would recommend use of solar technology to others while as 15.9% of the household heads indicated that they would recommend use of solar technology to others. This implies that most of the household heads would recommend use of solar technology to others.

4.9 Correlation Analysis

The researcher conducted a correlation analysis to establish if there was a positive or negative relationship between independent and dependent variables in a bid to recognize whether adoption of solar is influenced by the level of knowledge/awareness/level of income, level of education and availability of substitute power source.

4.9.1 Correlation between Level of Knowledge/Awareness of Solar with Adoption of Solar

The researcher sought to find out if there was a relationship between the level of knowledge/awareness of solar with adoption of solar. The findings are illustrated in table 4.26 below.

Table 4.26: Correlation between Level of Knowledge/Awareness of Solar with Adoption of Solar

		Installed solar system	Seen solar lamp	Solar power in use	Aware of solar technology providers	Formal or informal training on solar systems	Use solar energy
Installed solar system	Pearson Correlation	1	.604**	.510**	.506**	.487**	.905**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	301	301	301	301	301	301
Seen solar lamp	Pearson Correlation	.604**	1	.801**	.383**	.396**	.578**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	301	301	301	301	301	301
Solar power in use	Pearson Correlation	.510**	.801**	1	.377**	.359**	.469**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	301	301	301	301	301	301
Aware of solar technology providers	Pearson Correlation	.506**	.383**	.377**	1	.521**	.542**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	301	301	301	301	301	301
Formal or informal training on solar systems	Pearson Correlation	.487**	.396**	.359**	.521**	1	.497**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	301	301	301	301	301	301
Use solar energy	Pearson Correlation	.905**	.578**	.469**	.542**	.497**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	301	301	301	301	301	301

**. Correlation is significant at the 0.01 level (2-tailed).

From the table 4.26, The findings showed that there was a positive relationships between the individuals who had installed solar systems in their household,(The Pearson Correlation Pearson was positive 0.905) those who had seen a solar lamp in use, who had seen solar power in use, those who were aware of solar technology providers and those who had received informal or formal training on solar systems against adaption and use of solar. This implies that the level of knowledge and awareness from the individuals had installed solar system in their household, had seen a solar lamp in use, were aware of solar technology providers and had received both formal and informal training influenced the adoption of solar.

4.9.2: Correlation between Level of Income with Adoption of Solar

The researcher sought to find out if there was a relationship between the level of income with adoption of solar. The findings are illustrated in table 4.27 below.

Table 4.27: Correlation between Level of Income with Adoption of Solar

		Savings account	Shares	Loan	Use solar energy
Savings account	Pearson Correlation	1	.354**	.467**	.140*
	Sig. (2-tailed)		.000	.000	.015
	N	301	301	301	301
Shares	Pearson Correlation	.354**	1	.506**	.122*
	Sig. (2-tailed)	.000		.000	.035
	N	301	301	301	301
Loan	Pearson Correlation	.467**	.506**	1	.089
	Sig. (2-tailed)	.000	.000		.125
	N	301	301	301	301
Use solar energy	Pearson Correlation	.140*	.122*	.089	1
	Sig. (2-tailed)	.015	.035	.125	
	N	301	301	301	301

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From the table 4.27, the findings show that there was a positive relationship (The Pearson Correlation Pearson was positive 0.104) between individuals having a savings account, shares, ability to secure a loan and the use of solar energy. This means that individuals who had savings account, had shares, were able to secure loans easily adopted the use of solar.

4.9.3: Correlation between Level of Education with Adoption of Solar

The researcher sought to find out if there was a relationship between the level of education with adoption of solar. The findings are illustrated in table 4.28 below.

Table 4.28: Correlation between the Level of Education with Adoption of Solar

		Level of education	Higher education	Use solar energy
Level of education	Pearson Correlation	1	.255**	.243**
	Sig. (2-tailed)		.000	.000
	N	301	301	301
Higher education	Pearson Correlation	.255**	1	.132*
	Sig. (2-tailed)	.000		.022
	N	301	301	301
Use solar energy	Pearson Correlation	.243**	.132*	1
	Sig. (2-tailed)	.000	.022	
	N	301	301	301

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From the table 4.28, the findings of the study showed that the there was a positive relationship between the level of education of the household head and the adoption of solar. ,(The Pearson Correlation Pearson was positive 0.243) This implies that more of the educated people tended to adopt the use of solar and the higher their education level the more the adopted to the use of solar energy.

4.9.4: Correlation between Availability of Substitute with Adoption of Solar

The researcher sought to find out if there was a relationship between the availability of substitute with adoption of solar. The findings are illustrated in table 4.29 below.

Table 4.29: Correlation between Availability of Substitute with Adoption of Solar

		Vendor from home	Install solar unit	Use solar energy
Vendor from home	Pearson Correlation	1	-.010	.029
	Sig. (2-tailed)		.865	.618
	N	301	301	301
Install solar unit	Pearson Correlation	-.010	1	.662**
	Sig. (2-tailed)	.865		.000
	N	301	301	301
Use solar energy	Pearson Correlation	.029	.662**	1
	Sig. (2-tailed)	.618	.000	
	N	301	301	301

**. Correlation is significant at the 0.01 level (2-tailed).

From the table 4.29, the findings of the study showed that there was a positive relationship (The Pearson Correlation Pearson was positive 0.029) between the distance from the vendors to the households' home and the cost of installing a solar unit against the use of solar energy. This means that longer the distance is from the vendors home, the higher the chances of adopting to use of solar and the more the household heads knew of the cost of installing a solar unit, the more the chances of them adopting to use of solar energy.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of findings, discussion and conclusions drawn from the findings and recommendations made. The conclusions and recommendations drawn were focused on addressing the purpose of the study, which was to investigate the factors influencing adoption of Solar Technology in Laikipia North Constituency.

5.2 Summary of the Major Findings

5.2.1 Influence of the level of knowledge and awareness of solar technology on adoption of domestic solar technology in Laikipia North constituency

The first Objective of the study sought to establish the extent to which Knowledge and Awareness of solar technology influenced adoption. The Study established that, 84.7% of the household heads have seen solar power in use; Most of them 74% have seen solar lamps. Awareness of the existence of solar technology in lighting is high in the community although, 79.7% of the household heads indicated they have never received any formal or informal training on solar systems, 91.4% of the 30.3% who indicated some training indicated they have been trained up to the certificate level on solar systems by the Service providers. Knowledge and awareness of the availability of solar technology has positive effect on adoption on solar.

5.2.2 Influence of level of income of households on the adoption of domestic solar technology in Laikipia North constituency

The second objective sought to investigate the extent to which the level of income of households influence the adoption of domestic solar technology in Laikipia North constituency and the findings of the study showed that the Majority of the people, 32.9% of the household heads have no regular income, 54.2% of the household heads indicated they had saving accounts. The income is irregular and Majority of them had no loans, no access to bank loans, no shares and no to bank accounts. this indicates that the level of income has a negative influence on solar technology adoption.

5.2.3 Influence of education of household head influence the adoption of domestic solar technology in Laikipia North constituency.

The third objective sought to establish to what extent the level of education of household head influence the adoption of domestic solar technology in Laikipia North constituency and the results from the finding showed that 60.9% of the household heads indicated they had attained college education, education at all. A small number of people had not attained any virtually no formal education. it was clear that Education has a positive influence on adoption of solar though minimal.

5.2.4 Influence of availability of substitute energy source influence the adoption of domestic solar technology in Laikipia North constituency.

The fourth objective sought to determine the extent to which availability of substitute power source influence the adoption of domestic solar technology in Laikipia North constituency and the findings showed that 60.1% of the household heads indicated that the vendor and the grid Electricity was less than 5 km from home, However less than half of them knew the cost of installing Electricity in their home or of using any other energy source apart from what they were used to. This indicates that the distance of alternative source of energy does not positively influence adoption of solar technology.

5.3 Discussions

The Study finds that the level of knowledge and awareness of solar technology influence the adoption of domestic solar technology in Laikipia North constituency Positively. The findings showed that most of the residents in Laikipia North Constituency used solar energy mainly for lighting. Majority of the residents here had seen a solar lamp and solar power in use and were aware of the solar technology providers in the area. This is supported by Rogers (2003) who theorizes that the process of adoption commences with an individual driven by precedent conditions such as a felt need to adopt an innovative product or service. The individual will pass along an innovation decision process at a pace that is influenced by their own level of innovativeness and by the perceived characteristics of the innovation. The decision making process is aided by communication channels; either mass-media communications or by local channels such as word-of-mouth However, most of the people who used or did not use solar energy indicated they had not received any formal or informal training on solar systems and for those who had received the training they had gone up to certificate level. This findings agree with earlier studies on integration of new concepts that state that, Prior knowledge is generally considered of high importance as it is deemed to serve both as the foundation for integration of new concepts and as a potential obstacle to conceptual change (Mason, 2002; Vosniadou, 2002; Chi and Roscoe, 2002).

The findings from the study showed that the level of income of households influences the adoption of domestic solar technology in Laikipia North constituency in a positive way. although the technology is only adopted in a very basic way. This is supported by This hypothesis assumes that a household's fuel (or energy source) choice depends crucially on the household's income level.As income rises, households move first from using traditional fuels, such as wood, to transitional fuels, like kerosene, and then to modern fuels, such as electricity from the grid (Leach 1992). the study revealed that most of the residents in Laikipia North constituency had no regular income, but were able to make some savings probably at different seasons of the year. this may have contributed to the high number of residents who have solar lamps or phone charging equipment powered by solar. Majority of the respondents did not have loans in the banks or in any microfinance institutions. The findings show that most of the residents did not have enough money to purchase and install solar energy and this consequently, the lack of daily income influenced their ability to secure loans from banks and microfinance institution. Indeed, the empirical literature has confirmed that income is one of the main demand sidefactors determining household fuel choice.(e.g. Heltberg2004; Gebreegziabher et al. 2011).

The third research question looked at the how the level of education of household heads influences adoption of domestic solar technology in Laikipia North constituency. The findings from the study showed that most of the residents in Laikipia North Constituency were more likely to adopt solar energy as they were knowledgeable on the benefits they would receive from solar. these have attained Secondary education. More than half of other members in the household had completed primary education as compared to the head of the household since most of them had attained college education. These findings agree with earlier studies on integration of new concepts that state that, Prior knowledge is generally considered of high importance as it is deemed to serve both as the foundation for integration of new concepts and as a potential obstacle to conceptual change (Mason, 2002; Vosniadou, 2002; Chi and Roscoe, 2002).The findings show that most household heads had attained college education and as a result had more knowledge on solar technology.

The fourth research question looked at the extent to which availability of substitute power source influences adoption of domestic solar technology in Laikipia North constituency. The findings from the study showed that convenience or easy availability influences adoption of products. in this case solar energy. most of the residents in Laikipia North Constituency were less than five kilometers from the charcoal vendor and the nearest electricity grid was more than 600 meters from their homes. the fact that they are familiar with the current energy source and its availability affects adoption of solar technology negatively. this is supported by Lee, J. and Eastwood, D. (2003), where he states that adoption of new technology is dictated by accessibility and need in A Two-Step Estimation of Consumer Adoption of Technology. The cost of installing small solar units in the households was known. Given these key factors that is availability of charcoal vendors and close electricity grids limited the full exploitation of solar energy. The residents knowing the cost of solar installation might have deterred them from adopting solar energy given that it was probably expensive to purchase and install the solar system.

The study also established that there is a positive correlation between the level of Knowledge and awareness and adoption of solar technology. This was the same for the level of income, the availability of alternative source of energy, and the level of education. this means that the more the community is knowledgeable and aware about solar technology, the higher the level of income, and the more the community is educated the more likely they would adopt to solar technology. on the other hand the more the availability of alternative source of energy the less likely the community would be likely to adopt to solar technology.

Given the above factors that influence the adoption of solar technology, most of the respondents were categorical that they would recommend the use of solar technology to others.

5.4 Conclusions

In light of the above findings the study concludes that there people of Laikipia east have not adopted much to solar Energy. Those who have are using solar for charging their Mobile phones and for lighting only. This may be due to the fact that they have never received any formal or informal training on solar systems and those who had, were trained up to the certificate level on solar systems by the Solar technology providers who only train on their products and are not based in the area but make visits from time to time.

This implies that the level of knowledge and awareness of solar energy and its use was relatively low. The level of knowledge and awareness from the individuals who had installed solar system in their household, had seen a solar lamp in use, had seen solar power in use, were aware of solar technology providers and had received both formal and informal training influenced the adoption of solar.

The study also concludes that lack of daily income and access to secured loans from banks and microfinance institution influenced the adoption of solar technology. The individuals who had savings account, had shares, were able to secure loans easily adopted the use of solar. More of the educated people tended to adopt the use of solar and the higher their education level the more the adopted to the use of solar energy.

The level of education is relatively low given that only a few people have received college education. With free primary education it is possible to conclude that the level of solar technology adoption will greatly improve with time as education of the household is likely to adapt to new technology

Finally, the study concluded that the presence of substitute sources of energy that may be cheaper to install might have deterred them from adoption of solar technology. The longer the distance is from the vendors home, the higher the chances of adopting to use of solar and the more the household heads knew of the cost of installing a solar unit, the more the chances of them adopting to use of solar energy.

5.5 Recommendations

Based on the above findings the researcher recommends that

1. The Study showed that the there was a relationship between training and solar adoption. Those who were trained on solar use and installation are more likely to start using solar Energy.

   The Government of Kenya and especially the Ministry of Energy needs to provide training and education to increase the level of knowledge and awareness on the use of solar 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 solar energy.

2. The study further found that the high cost of the solar equipment and the fact most of the people did not have regular income and therefore had very low chances of accessing loans meant that they were unable to afford solar equipment.

   Is The Government should consider zero rating tax on Solar 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 arrange for a plan that allows them to pay an agreeable small amount of money per month in a bid to increase the use of solar energy.

3. The Community used other sources of Energy, which were mostly wood based. The county Councils Need to get involved as energy solution providers regardless of the availability of alternative/substitute of other sources of energy, Solar power will

eventually help the councils achieve better forest cover as Communities turn to solar and use less and less wood based fuel. The community should be encouraged to harness solar energy since it is cheaper and easily accessible than the other sources of energy given that the community comes from a remote area where the sun is abundant.

4. The Grid Electricity in most of Laikipia North Constituency is far from the community settlements and the likelihood of Majority of the people living here getting grid electricity in the near future is slim.

   This means that Kenya Power needs to identify the opportunity provided by the gap in Laikipia District and indeed in Kenya and import, sell and install solar systems that provide more than just lighting as the opportunity is there to assist other Kenyans who are not served by the Grid Electricity to access better energy solutions

5.6 Areas of Further Researcher

The researcher recommends that more research needs to be done on

1. The relationship between training and adoption of solar technology.
2. How Gender affects Solar adoption.
3. The relationship between Culture, Convenience and adoption of new technology.

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APPENDICES

APPENDIX I: LETTER OF REQUEST TO CONDUCT RESEARCH

Irene Kahaki Keriri

P.O Box 2404

Nyeri

The,Head of Department

Ministry of Energy

Laikipia County

Dear Sir/Madam,

RE:<u>PERMIT TO CONDUCT RESEARCH ON SOLAR ADAPTION LAIKIPIA NORTH CONSTITUENCY .</u>

I am an MA Project planning and management student with University of Nairobi. I wish to under take research on, “Factors influencing Adoption of Solar Technology in Laikipia North Constituency, Kenya. The research will be conducted in the month of June 2010.

I am therefore seeking your permission and assistance to conduct the research.

Thank you.

Yours faithfully

Irene Kahaki Keriri

Researcher

APPENDIX 2: LETTER OF TRANSMITTAL

Irene Kahaki Wanjohi

P.O. Box 2404 -10401

Nyeri, Kenya

Date……………

To:……………………………………………………………………………………………

…………………………………………………………………………………………………

Dear respondent,

RE: Data collection

I wish to inform that I am undertaking research for my Masters of Arts in Project Planning and Management in the University of Nairobi. The study deals with the factors influencing Adoption Solar Technology in Laikipia North County. Your assistance on data collection will be appreciated as the study will benefit dairy farmers and other stake holders. The information will be treated with confidentiality and I therefore request you to answer the questions honestly. Attached please find the questionnaires which you are required to fill and provide information by answering the questions.

Please treat this as urgent and important.

Kind regards.

Yours faithfully,

Irene Kahaki Wanjohi

Reg. No. L/50/74561/2012

APPENDIX 3: RESEARCH INSTRUMENTS

I. Questionnaire for Laikipia North constituency household Head Members

The research instrument has been formulated to collect data for the purpose of the research meant to create greater understanding on factors influencing adoption of solar technology.

Please note that your response to these questions will be confidential and shall be used for the purpose of this research only.

INSTRUCTIONS

Please tick where appropriate and for explanation, please be brief

Part One: Background Information

1. Please indicate your gender

   Male ☐ Female ☐

2. Marital status

   Married ☐

   Single ☐

   Divorced ☐

   Separated ☐

   widower ☐

3. Age (i) 18-24yrs ☐ (ii) 25-30yrs ☐ (iii) 30-35yrs ☐ (iv) 36-40yrs ☐

   (v) 41-45yrs ☐ (vi) 46- 50yrs ☐ (vii) Over 50 yrs ☐

4. Are you the household head?

   Yes ☐ No ☐

Other specify…………………………………………………………………...

5. Are you connected to electricity? …………………………………………………

…………………………………………………………………………………………

PART TWO. **Level of Knowledge and Awareness of Solar**

6. What is your energy choice for lighting?
   a) Electricity ☐
   b) parafine ☐
   c) gas ☐
   d) firewood ☐
   e) Dry cells ☐
   f) Solar ☐

7. Do you have a Solar system installed in your household?

Yes ☐ No ☐

8. Have you ever seen a solar lamp in use?

Yes ☐ No. ☐

9. Have you ever seen solar power in use? E.g. charging a phone or in any other use.

Yes ☐ No. ☐

10. Are you aware of any Solar Technology Providers in the area?

Yes ☐ No. ☐

11. Have you received any formal or informal training on Solar systems?

Yes ☐ No. ☐

12. If yes what was the level of the training?

Degree ☐ diploma ☐ ertificate ☐

13. Other please explain briefly ……………………………………………..

14. Have you had any informal training on Solar Systems?

Yes ☐ No. ☐

15. If yes what form of training did you receive?..

16. How did that training help you? …………………………………………………..

17. Are you planning on acquiring a solar household system any time soon? Please explain

....

Part Two: Level of income

1. Please indicate with a tick or an **x** in the box provided the kind if income you get in your everyday life.

______ A. Monthly salary. Through a regular.

______ B. Monthly salary. Through own business

______ C. Regular income but not monthly –bi-monthly or otherwise.

______ D. no regular income but there is some staggered income

______ E. no income

2. Do you have a savings account?

   Yes ☐ No. ☐

3. Do you have any shares

   Yes ☐ No. ☐

If yes what kind of Capital Authority shares? Please explain……………………………………………………………………………………

3.(b) Do you belong to a "chama" that involves contribution of money? If yes please explain what type of Chama it is and briefly what the "chama" goals or aims are…………………………………………………………………………………………………

……………………………………………………………………………… …………………

4. Do you have a loan for anything in the bank or with any microfinance institute?

   Yes ☐ No. ☐

5. Would you invest in a solar system for your house?

   Yes ☐ NO ☐

Give reason --

PART THREE: LEVEL OF EDUCATION.

The level of education of the household head

1. What is the level of education attained by the household head?

   College ☐ secondary ☐ primary ☐ none ☐

2. Is there anyone in the household holding a higher education?

   Yes ☐ No ☐

   What level has this member of the house hold attained?

College ☐ secondary ☐ primary ☐

2. What position does the household member hold in the household?

…………………………………………………………………………………………..

3. Is there any other person who influences how money is spent in the home? If yes explain………………………………………………………………………………………

………………………………………………………………………………………………

PART THREE: AVAILABILITY OF SUBSITUTE

1. (a) What are you currently using for lighting ………………………………………….

(b) For cooking ………………………………………………………………………..

(c) For water heating……………………………………………………………………..

2. If you are using any other energy than grid Electricity or Solar,

(a) Do you buy the wood, charcoal, others wood based fuels………………………..……………………………..

(b) How far is vendor from your home?

More than 5 km ☐

Less than 10 km ☐

Less than 15 km ☐

Over 15km ☐

3. How far is the Grid Electricity from you?

Less than 600 m ☐

over 600 m ☐

4.Is there hope of getting electricity come near you the near future through schemes like REA? (Rural Electrification authority) If yes,

Explain………………………………………………………………………………...

3. Are you aware of any other alternative energy sources that can be available to you in the near future? If yes please explain

   ……………………………………………………………………………………….

4. Do you know how much it would cost you to install a solar unit in your house hold

   Yes ☐

   No ☐

   If yes is it affordable?

   Yes ☐

   No ☐

   If No, please briefly explain

   …………………………………………………………………......................................

   ....

PART FOUR: ADOPTION OF SOLAR

1. Do you already use solar energy in your home?

   Yes ☐

   No ☐

   If no, please answer the next questions.

   Would you like to own a solar system?

   Yes ☐

   No ☐

2. If yes when do you see this happening?

…………………..………………………………………………………………………

…………………………………………………………………………………………

3. Why don't you have it installed yet?...

4. Is there anything that may have prevented you from acquiring the use of Solar Technology? Please explain briefly……………………………………………………………………………

……………………………………………………………………………………..

5.Would you recommend the use to solar technology to others?

Yes ☐

No ☐

If no, why not? Please explain briefly

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Thank you for responding to the questionnaire. Your time is highly appreciated.

<u>Irene Kahaki Keriri -Researcher</u> (Mobile Phone No.0734 70854

APPENDIX 4: INTERVIEW GUIDE FOR SOLAR TECHNLOGY PROVIDERS

Instructions

Kindly use tick (√) inside the relevant box to indicate the correct answer where choices are given. Write your answer in the spaces provided where choices are not given.

SECTION A Demographic Data

1. Gender

   Male ☐

   Female ☐

2. What is your age in years?

   18 – 29 ☐

   30 - 39 ☐

   40 - 49 ☐

   50 - 59 ☐

   60 and above ☐

3. Indicate the highest educational level attained

   Adult Education ☐

   Primary ☐

   Secondary ☐

   Certificate ☐

   ☐

Diploma

Degree and above

Section B Level of Knowledge and awareness of solar technology in the Area

4. In your opinion, do think there is a future for solar in this region?

   Yes

   No

   I don't know

5. Please explain your answer above…………………..

   ………………………………………………………………………….

…………………………………………………………………

6. How many Customers have you installed solar in the last 12 months?

   Less than 500

   500 - 800

   Above 800

7. Do you offer training on Solar Installations and Equipment?

   Yes

   No

8. If yes explain your answer above and indicate the amount/ Cost…………………..

   ………………………………………………………………………….

   …………………………………………………………………

Section C Level of Income

9. The society in this area of Laikipia North are financially able to afford solar installations. Do you agree with this statement?

Strongly Agree

Agree

Neutral

Disagree

Strongly Disagree

10. Are there any agreements with financial institutions to fund the community members through soft loans tied to solar products?

Yes

No

11. If yes How Many people have bought solar systems through these arrangements?

Less than 500

500 - 800

Above 800

12. If no, to your knowledge, are there other funding Methods or ways that the community uses to help them buy solar system/ equipment?

Explain…………………………………………………………………………………………………
………
………

Section D LEVEL OF EDUCATION

13. Who are the main Solar Customer players in order of priority? Mark 1, 2 ,3 the lowest number marking the best players

Employed Customers

Children of Pastoralists

Heads of households.

Others (please specify)……………………………………………………………………

14. What instructions are delivered with the solar devises?

    User Manuals from the Manufacturer ☐

    Verbal Instructions at the point of sale ☐

    Demonstration at the household level upon sale or installation ☐

15. The Customers from Laikipia North will mostly read and keep the user manuals

    Yes ☐

    No ☐

SECTION E: AVAILABILITY OF SUBSTITUTE

16. A) Do you think competition affect use of solar installations in the area?

    Yes ☐

    No ☐

    b) If yes, do you think competition from other players influence the choice to use solar energy as source of energy?

    Strongly Agree ☐

    Agree ☐

    Neutral ☐

    Disagree ☐

    Strongly Disagree ☐

17. In your own opinion, what can be done to overcome this competition?

    ……

    ……..

APPENDIX 5: SAMPLING TABLE: TABLE FOR DETERMINING SAMPLE SIZE FROM A GIVEN POPULATION.

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note:’N’ is Population size

‘S’ is the sample size

Krejcie, Robert V., Morgan, Daryle W,”Determining Sample Size for Research Activities”Educational&Psychological Measurement, 1970.