DETERMINANTS OF ADOPTION OF RENEWABLE ENERGY TECHNOLOGIES AMONG RURAL HOUSEHOLDS IN NJORO SUB-COUNTY NAKURU, KENYA

MARTIN NJOROGE KIMANI

A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements for the Master of Science Degree in Environmental Science of Egerton University

EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has not been presented in this university or any other for the award of a degree.

Signature: …….. Date: ……25 June 2022……

Martin Njoroge Kimani

NM12/51517/14

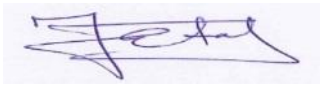
Recommendation

This thesis has been submitted for examination with our approval as University Supervisors.

Signature:  ……... Date: …04/09/2020…

Prof. Stanley M. Makindi, PhD

Machakos University

Signature: ……  …… Date: 01/09/2020

Dr. Moses Esilaba, PhD

Department of Environmental Science,

Egerton University

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DEDICATION

This work is dedicated to my wife Maureen Mumbi, my parents and siblings for their support and unwavering love throughout my Masters study.

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ABSTRACT

Kenya faces growing energy problems, for instance, losing over 5000 acres of the closed indigenous Mau Forest each year due to harvesting of firewood and charcoal to cater for the rising energy demands. There exists many renewable energy technologies (RETS) which provide alternative sources of energy which are efficient, relatively inexpensive, but rural communities which stand to gain the most from these technologies still rely on the inefficient, expensive and unsustainable non-renewable energy source for their needs. The aim of this study was therefore to assess the determinants to adoption of select RETs by rural resident of Njoro sub-County. Four potential factors that determine adoption of innovation have been amply addressed in the adoption of innovation literature and research. These include: (a) Awareness and level of use of the innovation (b) Socioeconomics of the households, (c) Policy framework supporting the adoption of the innovation, and (d) the influence of external actors (such as Non-governmental organisations, Research institutions and Universities) on the adoption of innovations. These four factors have been used in the study to constitute the specific objectives. A sociological survey, using a structured questionnaire was used for data collection. Two stage cluster sampling was used to select the 200 randomly selected households, while the Statistical Package for Social Sciences (SPSS) was used for data analysis. The findings suggest that (a) Awareness Level of RETs did not have a significant impact on Adoption of RETS (b) Socio economic status proved to be predictor for RET adoption where the higher the Status in Society the higher the likelihood for RET adoption. Age also had an influence on adoption where the older generations were less likely to adopt compared to younger generations. Gender was also shown to influence adoption where women were more likely to adopt RETs compared to men (c) Institutional framework supporting RET adoption was minimal (d) the influence of external actors did not have a significant impact on RET adoption.

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LIST OF ABBREVIATIONS AND ACRONYMS

ALRI	Acute Lower Respiratory Infections
ASALS	Arid and Semi-Arid Lands
BB	Biomass briquettes
CCAK	Clean Cooking Association of Kenya
CEEC	Centre for Energy Efficiency Conservation
CO	Carbon Monoxide
DOI	Diffusion of Innovations Theory
DRETs	Diffused Renewable Energy Technologies
EMA	Energy Management Authority
EMCA	Environmental Management and Coordination Act
EnDev	Energising Development
EPRA	Energy Petroleum Regulatory Authority
EPT	Energy Petroleum Tribunal
ERS	Economic Recovery Strategy
GDC	Geothermal Development Company
GESIP	Green Economy Strategy Implementation Plan
GoK	Government of Kenya
HILCS	High Impact Low Cost Scalable
IAP	Indoor Air Pollution
ICS	Improved cook stoves
IEA	Institute of Economic Affairs
IEBC	Independent Electoral and Boundaries Commission
IPP	Independent Power Producers
KALRO	Kenya Agriculture and Livestock Research Organization
KAM	Kenya Association of Manufacturers
KEFRI	Kenya Forestry Research Institute
KENINVEST	Kenya Investment Authority
KES	Kenya Shillings
KETRACO	Kenya Electricity and Transmission Company
KFS	Kenya Forestry Service
KIPPRA	Kenya Institute of Public Policy Research
KNBS	Kenya National Bureau of Statistics
KOSAP	Kenya Off Grid Solar Access Project

KPC	Kenya Power Company
KPLC	Kenya Power and Lighting Company
LPG	Liquid Petroleum Gas
MEMR	Ministry for Environment and Mineral Resources
MESHA	Media for Environmental Science Health and Agriculture
MoE&P	Ministry of Energy and Petroleum
NACOSTI	National Commission for Science Technology and Innovation
NCCRS	National Climate Change Response Strategy
NDC	National Determined Contributions
NEMA	National Environmental Management Authority
NETFUND	National Environment Trust Fund
NGO	Non-Governmental Organisation
NITA	National Industrial Training Authority
OVC	Orphans and Vulnerable Children
PBC	Perceived Behavioural Control
PCA	Principal Component Analysis
PSL	Photovoltaic Solar Lamps
R&D	Research and Development
RD&D	Research Development and Dissemination
REA	Rural Electrification Authority
RERAC	Renewable Energy Resource Advisory Committee
REREC	Rural Electrification and Renewable Energy Corporation
REREC	Rural Electrification and Renewable Energy Corporation
RET	Renewable Energy Technologies
RVIST	Rift Valley Institute for Science and Technology
SES	Social Economic Standards
SME	Small and Medium Enterprises
SO2	Sulphur Dioxide
SPSS	Statistical Packages for Social Sciences
SRK	Self-reported Knowledge
TAM	Technology Acceptance Model
TBS	Tuberculosis
TIB	Theory of Interpersonal Behaviour
TPB	Theory of Planned Behaviour

TRA	Theory of Reasoned Action
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
VOC	Volatile Organic Compounds
WEF	World Economic Forum
WHO	World Health Organisation of United Nations

CHAPTER ONE
INTRODUCTION

1.1 Background information

Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development - social, economic, and environmental - including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues (Mai et al., 2012). The ambition for higher economic progress combined with an ever-increasing population has increased the global demand for energy. Where there is lack of electricity and affordable energy resources, economic and environmental constraints occur which manifest in the form of reduced investments, slow economic growth and massive deforestation (Twayigize, 2014).

Globally, concerted efforts have been made to expand existing energy sources and improve the ways in which energy is consumed. This has stimulated worldwide interest in renewable energy initiatives to address environmental challenges, such as the Kyoto Protocol (Lopez et al., 2012). Lack of affordable energy leads to massive deforestation, less economic activity in the area, causes health problems because of pollution, social friction due to poor economy and competition over few resources. As more countries shift towards renewable energy in a bid to reduce CO_2 emissions and local air pollution, additions to renewable power capacity are exceeding fossil fuel generation additions by a widening margin. A growth of 8.3% (167 Giga Watts) in 2017 over the previous year was observed and a continuation of previous growth rates since 2010 averaging 8-9% per year (IRENA, 2018). In 2019, renewable energy accounted for 11% of global primary energy generated (Ritchie & Roser, 2020). Even though dealing with climate change remains a significant driver, the energy evolution brings a much wider range of benefits than simply carbon emissions reduction. Sub-Saharan Africa has revealed significant improvement in the development of its renewable energy capacity particularly solar energy markets over the recent years, with the continent experiencing a growth of over 1.8W of new solar installations, mainly driven by five countries; Egypt, South Africa, Kenya, Namibia and Ghana (IRENA, 2020). Consequently, Africa's renewable energy mix has progressively shifted from traditional hydropower and thermal plants to renewable solutions to both accelerate energy access and support sustainable economic growth (IRENA, 2020).

In East Africa, Kenya has been on the forefront in investing in large-scale renewable energy projects, with several large and medium scale electricity generation projects having been commissioned in the past two decades (Government of Kenya, 2018). In 2016, Kenya

opened the world's largest geothermal plant at the Olkaria Geothermal field and in 2017 the country completed building the Lake Turkana Wind Power Project, touted as Africa's biggest wind energy farm to generate a fifth of her power. This has been attributed to a change in a number of policies, key being the Energy Act 2006, which allows private individuals to sell off their excess supply of energy to Kenya Power Company (KPC) and the Feed-in Tariff policy (2008, revised 2010) that legitimizes private renewable energy power generation. Nakuru County has seen the bulk of geothermal plant installations, with the Geothermal Development Company (GDC) having sunk over 43 wells, 24 of them have been tested giving 165 MW. GDC plans to pump an extra 1065 MW into the national grid in the next ten years.

On the flipside, Kenya is faced with many challenges that can be tied to access to energy. About 5,000 hectares of the Mau, a closed indigenous forest, are lost each year due to the demand for fuel wood and charcoal leading to serious deforestation and land degradation (Ministry of Forestry and Wildlife, 2013). This is paradoxical despite the fact that the tropics are blessed with strong winds, sunny skies, plant residues, heat from the earth and fast-moving water, each of which can provide a vast and constantly replenished energy resource supply. These diverse sources of renewable energy have the technical potential to provide alternative energy and electricity to cater for all peoples' needs especially rural folk. The utilization of renewable energy technologies (RETs) directly contributes to the economic, social and environmental pillars of sustainable development (Dincer, 2000). The Kenya government through the Ministry of Energy and Petroleum's Department of Renewable Energy promotes the development and use of RETs, which include but are not limited to, biomass, biodiesel, bio-ethanol, charcoal, fuel-wood, solar, wind, tidal waves, small hydropower, biogas and municipal waste (Government of Kenya, 2014).

Despite various interventions, adoption of RETs and related innovations remains low and poorly documented in Kenya, yet it could catalyse significant advancement in sustainable development, poverty eradication and gender mainstreaming. According to the Union of Concerned Scientists (2013), high RETs adoption rates will increase investments in renewable energy projects and scaling up of new technologies which can afford new prospects for employment and business opportunities amongst local manufacturers and service providers. It will also increase access to clean energy, reduce greenhouse gas emissions, make renewable energy technologies achieve economies of scale and bring down costs.

1.2 Statement of the Problem

Kenya is faced by a growing energy problem; it is losing over 5000 acres of the closed indigenous Mau forest each year due to harvesting of firewood and charcoal to cater for the rising demand of the products. In the same breath there exists many renewable energy technology alternatives which are efficient, relatively inexpensive, but rural households which stand to gain most from these technologies still rely on the inefficient, expensive and unsustainable non-renewable energy sources for their needs. There is need to assess the determinants of adoption of RETs by rural households if we are to solve part of Kenya's energy crisis.

1.3 Broad Objective of the Study

The primary objective of this study was to assess the determinants to adoption of RETs by rural households in Njoro Sub-County, Nakuru County.

1.3.1 Specific Objectives

Interest to this study were four factors representing adoption thus to accomplish the primary objective of the study, the following specific objectives were used:

i. To assess the level of awareness of households of renewable energy technologies (RETs).
ii. To determine the influence of socio-economic status of households on adoption of RETs.
iii. To determine the influence of policy framework on the adoption of RETs.
iv. To examine the influence of external actors including Non-Governmental Organisations (NGO), universities and research institutes on the adoption of RETs.

1.4 Research Questions

i. What is the household level of awareness to the existence of alternative RETs?
ii. What is the influence of socio-economic factors of households on the adoption of RETs?
iii. What is the influence of policy framework on the adoption of RETs?
iv. What is the influence of external actors in promotion of RETs?

1.5 Significance of the study

In order to promote sustainable development, there is a need to mitigate the high cost of energy such that it is affordable and available to rural households. Kenya's spirited pursuit of

cheaper energy has put renewable energy in the spotlight. Not only are renewable energy sources, such as biomass briquettes, biogas, solar lanterns just to mention a few, considered cleaner, but there seems to be a general consensus among stakeholders that they will lower the long-term cost of energy. Despite this, adoption of these technologies has been low (Padding et al., 2012). Households in rural Kenya still rely heavily on fuel wood, charcoal and paraffin as their main sources of energy for cooking and lighting. This is despite the negative effects associated with their use especially on the environment and the health of the users.

The results from this study are expected to provide policy makers, from the government and private sectors, with relevant information to plan on methods of promotion of RETs for adoption by rural households which would improve the beneficiaries' quality of life and contribute to conservation of the Mau Forest on top of getting the country closer to achieving Vision 2030 and the Sustainable Development Goals.

This study will inform the planning and investment decision making by government implementing agencies and Non-Governmental Organizations (NGOs) on renewable energy technology options and alternatives to delivering energy services; the formulation of policies by relevant Energy Authority such as the Energy and Petroleum Regulatory Authority (EPRA) regarding energy usage and planning; the planning and investment decision making by energy solution investors and other energy sector stakeholders as in a bid to bridge the existing energy gap; and future useful reference material on the same for readers and other researchers on similar topics.

1.6 Scope of the Study

The study covered rural households in Njoro Sub-County. Rural in this case refers to areas with low population density, minimal access to infrastructure and social services, where on-farm income is the main source of livelihood for majority of the residents. Through observation, the researcher was able to discern whether a specific locality matched the description and proceed with data collection. The study targeted a sample of 200 households drawn from a population of 38,686 households (184,859 people). Data was collected from one individual per household as respondents using open and closed ended questionnaires.

1.7 Assumption of the Study

Respondents for the study have been residents of Njoro Sub-County for the past 15 years.

1.8 Definition of Terms

Level of awareness: the degree of knowledge and understanding (by the head of household) of the RETs and the benefits accruing from their use by the household

Renewable Energy: Technologies in this study refer to Improved Cook Stoves ICS, Solar, Biomass Briquettes and other renewable technologies that can be acquired and used by households.

Rural household: households which exist in areas with low population density, minimal access to infrastructure and social services, where on farm income is the main source of livelihood for majority of the residents.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The supply of energy is a crucial element in the economic growth of societies, where the way this energy is produced, supplied, and consumed is a critical issue to ensure that the current generation does not prevent future generations from prospering (Doner, 2007). Kenya has made significant strides towards modernizing its energy infrastructure network, increasing the share of energy generated from renewable energy sources, and providing energy that is affordable and reliable to businesses and homes. With initiatives, such as, the Rural Electrification Program and The Last Mile Project, grid connectivity has improved, the country seems to be well on its way to solving most if not all its energy problems. But the statistics paint a grim picture, we are losing about 5,000 hectares of closed indigenous forests each year due to the demand for fuel wood and charcoal leading to serious deforestation and land degradation (Ministry of Forestry and Wildlife, 2013) Many rural households still rely on inefficient and environmentally hazardous unprocessed biomass fuels for their energy needs leading to increasing amounts of environmental pollution, greenhouse gases production and environmental degradation through deforestation. To tackle this, two main methods have been suggested by Doner (2007); (1) improving energy efficiency standards, and, (2) increasing the usage of renewable energy technologies. This study focuses on the latter.

2.2 Awareness

In medical science for instance psychiatry, lack of self-awareness means that a patient is oblivious to aspects of an illness that is obvious to social contacts (Schipper, 2014). This is arguably closer to “not knowing", but it also implies that the patient lacks introspection of her/his lack of knowledge of the illness. While the precise connotations of all those uses of awareness are different, they have in common that the agent is able to conceive something. Being unaware means then the lack of conception of something. Describing properties of awareness and unawareness informally with words like “knowing", “not knowing", “lack of conception", “not thinking about it" etc. does not make awareness open to formal analysis (Schipper, C, 2014; Timmermans & Cleeremans, 2014).

2.2.1 Measuring awareness

The study of awareness is challenging because it attempts to develop an objective approach to a phenomenon that is subjective (Timmermans & Cleeremans, 2014). Objectively having access to what another person thinks or experiences is tantamount to

impossible. As well, having a person objectively assessing or reporting what he/she thinks is rife with complications (Qutoshi, 2018). These challenges, present themselves severely when it comes to establishing unconscious information processing, reflect the fact that the study of awareness requires a solution to the following fundamental—and as yet unsolved—problem: How can one measure awareness? While there has been substantial progress in measuring the level of awareness (Casali et al., 2013), there are no instruments or methods that makes it possible to measure the contents of awareness directly (Seth et al., 2008). Having such instruments would make it possible to establish clear relationships between an external state of affairs, people's subjective experience of this state of affairs (say their experience with renewable energy technologies?), and their overt behaviour (have they adopted/ not adopted the RETs due to their experiences?)(Timmermans & Cleeremans, 2014). Today, the best that can be done is to ask someone to produce a report about their experiences. Verbal report is the most direct method to find out if a person is aware of some knowledge. This becomes a complex task because: people may refrain from or simply be unable to report on vague experiences; reports are typically not obtained at the time the experience occurs; and lastly people may be biased in different ways that often interact with each other (Newell & Shanks, 2014). For these reasons, many authors have rejected subjective methods altogether and have instead turned to using objective methods.

Such methods typically involve asking people to choose between different carefully constructed alternatives rather than describing what they saw or felt. Objective methods, however, while they present the obvious advantage of producing third-person, objective data, make the arguable assumption that there is a clear difference between direct and indirect measurement of knowledge (Timmermans & Cleeremans, 2014). Further, many studies have questioned the conceptual foundations of such methods for they presuppose, unlike subjective methods, that awareness of some information and (behavioural) sensitivity to that same information involve the very same processes. This approach, takes it as a given that there is a perfect overlap between performance on a certain well-defined task and awareness. And yet, it is easy to imagine counter-examples. For instance, one can find oneself in a situation where one experiences a feeling of familiarity when seeing a word yet remains unable to ascertain with confidence whether one actually saw that word on a list sometime earlier. Is one's memory of that word implicit or explicit? (Newell & Shanks, 2014). Choosing a behavioural marker as being indicative of either of those processes requires making a priori assumption about the relationships between observable behaviour and awareness, and there are but few empirical grounds to make such assumptions with reasonable confidence. For these and

further reasons, recent years have seen an upsurge of interest in reinvented subjective measures, as well as wider adoption of subjective threshold approaches, through which one seeks to compare performance and self-reported awareness, the above illustrates how difficult it is to devise an appropriate measure of awareness (Timmermans & Cleeremans, 2014).

2.2.2 Renewable energy and awareness

Renewable energy is a fairly dynamic concept all factors considered. Due to the various advances in science, newer technologies are increasing the number of items on the list of renewables. From the previous paragraph, it has been established that measurement of awareness has some difficulties especially when selecting whether to use a subjective or objective methods of appraisal. According to the National Renewable Energy Laboratory (NREL, 2011) generating market interest in renewable energy starts with raising awareness of commonly used terms. From looking at the methodologies employed in various studies covering awareness of renewable energy technologies, majority used both objective and subjective approaches. Khambalkar et al. (2010) forwarded the querying on users on types of energy sources, information of sources, knowledge of renewable energy sources and power generation, in order to get a general picture of awareness, while Ali et al. (2019) asked questions related to energy use, energy saving awareness to get a feel for renewable energy use. Various authors Alawin et al. (2016), Kacan (2015) and Zyadin et al. (2012), employed open ended questions, where their subject were asked to list what they knew about renewable energy, in the case of Zyadin et al. (2014) it was on the source of information on renewable energy. All these studies indicate the general picture that the target group determined whether to use objective or subjective approaches to measure awareness.

2.2.3 Gaps observed in awareness measurement

Despite the varying methodologies used to measure awareness of RETs, most measured positive knowledge, without considering any negative biases that might exist. A study by Vaish et al. (2008), established that 'Negative bias' forms a core component of human cognitive development. According to Vaish et al. (2008), negativity bias refers to human proclivity to "attend to, learn from, and use negative information far more than positive information". It can be conceived of as an 'asymmetry' in how humans process negative and positive occurrences to understand the world, one in which "negative events elicit more rapid and more prominent responses than non-negative events" (Luis Carretie et al., 2001, p.75). Holroyd (2015) further posits that a person might have introspective awareness with respect to whether certain beliefs or feelings are playing a role in one's decisions i.e. one can ask

oneself, and on reflection give an answer. But, the claim goes, one cannot simply introspect and discern if an implicit bias is operating in the production of action. To counter this domain, hence prodding on both the positive and negative aspects of a technology will yield far much deeper insights into the awareness level the respondents have and might not be explicitly aware of.

2.3 Adoption Studies

Humans, being sentient learn new modes of action, incorporate them into daily and commit themselves to further improve their lives. To be innovative is to be human. Population heterogeneity is also a common phenomenon, where despite all belonging to the human race, differences will manifest due to varying reasons and at various resolutions, which could be at the individual level, household, country, regional and continental level, all due to intrinsic or extrinsic circumstances. Moreover, before one can examine how a particular innovation disperses and distributes within a population, one needs to operationalize what is meant by the term innovation. At the broadest sense, an innovation can be any new idea to a population. Rogers (1983, p. 11) defined an innovation as "an idea, practice or object that is perceived as new by an individual or other unit of adoption". It does not matter if the idea, practice, or object is objectively new; rather, it is the perception of novelty. In addition, innovation also does not necessarily mean better or that the new idea is more beneficial to an individual. Whereas innovation can refer to something abstract, like an idea, it can also be concrete, like a new piece of technology (Straub, 2009). That is why adoption studies play an important role in social science. According to Farmer (2008), adoption is the stage at which a technology is mentally accepted by an individual or an organization. This is further elaborated by Rogers (1983) who states that adoption is "the extent by which a given technology becomes accepted and incorporated into approved social practices".

2.3.1 Theories surrounding technology adoption

According to Rogers (1993) an important factor regarding the adoption rate of an innovation is its compatibility with the values, beliefs and past experiences of individuals in the social system. Due to the varying contextualities and phenomenological realities when it comes to technologies, adoption becomes both a social process as well as a technical matter. A number of models and frameworks have been developed to explain user adoption of new technologies and these models introduce factors that can affect the user acceptance. User acceptance and confidence are crucial for the further development of any new technology.

Acceptance has been viewed as a function of user involvement in systems development (Taherdoost, 2018b).

Adoption theories examine the individuals and the choices individuals make to accept or reject innovations. In some models, adoption is not only the choice to accept an innovation but also the extent to which that innovation is integrated into the appropriate context. Adoption theory then becomes a micro perspective on change, focusing not on the whole but rather the pieces that make up the whole. In contrast, diffusion theory describes how an innovation spreads through a population. It may consider factors like time and social pressures to explain the process of how a population adopts, adapts to, or rejects a particular innovation. Diffusion theory takes a macro perspective on the spread of an innovation across time. **Error! Reference source not found.**Figure 2.1 is a representation of a diffusion curve, hich is a graphical representation of cumulative frequency of individual adoptions. It illustrates how the diffusion over time is composed of individuals making adoption decisions.

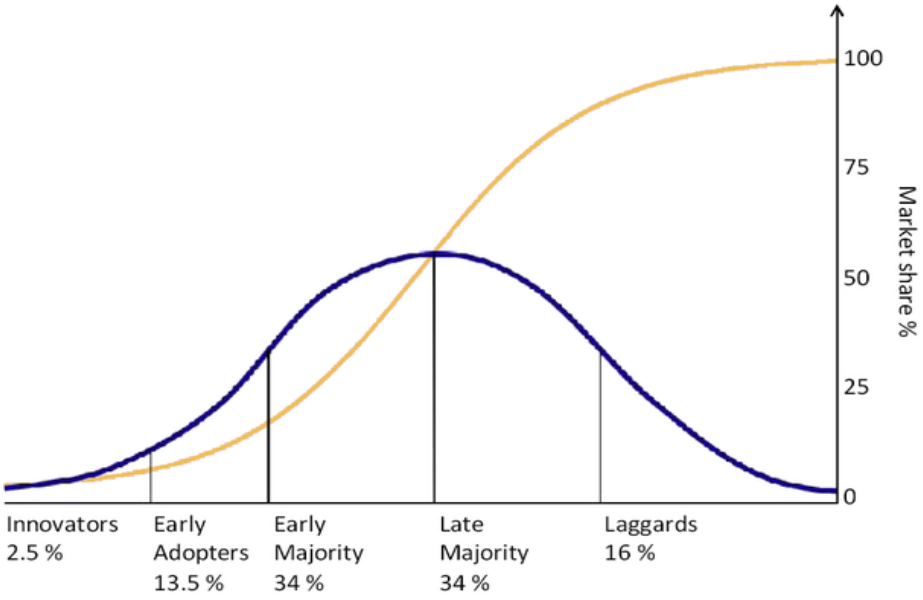

Figure 2.1 Diffusion Curve

This review discusses five (5) adoption and diffusion theories selected based on the prevalence of appearance in the literature,

i. Theory of Reasoned Action (TRA)

Although TRA model was firstly developed in 1975 by Fishbein and Azjen's for sociological and psychological researches (Fishbein & Ajzen, 1975), it has become foundational in investigation of individuals' technology usage behaviour (Kuo et al., 2015). It presupposes that any human behaviour is predicted and explained through three main cognitive components including attitudes (unfavourableness or favourableness of ones feeling

for a behaviour), social norms (social influence), and intentions (individual's decision to do or not to do a behaviour). This human behaviour should be volitional, systematic and rational. Furthermore, three boundaries factors, volitional control; intention stability over time; and measurement of intention in terms of target, time, context, action and specificity, are defined to test and evaluate the TRA. Likewise, some methods such as generality, target, action, context, and time horizon are established to improve the robustness between corresponding intention and attitude. On the other hand, the main disadvantages of TRA are the lack of addressing the role of habit, the cognitive deliberation, misunderstanding through a survey (attitudes, subjective norms, and intention of the respondents) and the moral factors. In addition, usage voluntariness is a crucial issue for validation of TRA.

ii. Theory of Planned Behaviour (TPB)

In this model, perceived behavioural control (PBC) as a new variable is added to extend TRA model. Basically, PBC is determined by the availability of resources, opportunities and skills, as well as the perceived significance of those resources, opportunities and skills to achieve outcomes (White et al., 2015). Although both TPB and TRA assumed person's behavioural intention (BI) is affecting individual's behaviour, TPB is using the PBC for individual's actions which are not under volitional control. By adding PBC, not only realistic limitations is composed but also, a self-efficacy type factor is achieved (Taherdoost, 2018b; Taherdoost & Masrom, 2009a). Moreover, PBC has the direct influence on actual behaviour as well as the indirect affect through the behavioural intentions. Therefore, in TPB model, three main factors are affecting BI including perceived behavioural control, subjective norm, and behavioural attitude. However, there are two main problems with TPB model (Taherdoost *et al.*, 2011). First, the one's attitudes towards new technologies will not be largely relevant if the technologies in question are not accessible. Second, the revised TPB may be viewed as the more suitable theoretical framework which is influenced the degree of individual's voluntariness that choose or not to choose the use of technology in their working environment.

iii. Theory of Interpersonal Behaviour (TIB)

This model is clarifying mainly the human's behaviour complexity which are effected by social and emotional factors. Therefore, this model not only contains all aspect of TRA and TPB but also, adding habits, facilitating conditions and affect in order to improve the prediction power. The concept of social factors which is similar to the subjective norms construct in TRA (Fishbein & Ajzen, 1975) contain roles, norms and self-concept. In brief, in

TIB, individual is neither fully deliberative nor fully automatic, further, neither fully autonomous nor entirely social. TRA differs from TIB, in the sense that TRA interests in accounting for the most variance with the fewest variables, whereas TIB interests in accounting for the most variance in total, because even a small amount of variance may be socially important, if the behaviour in question is critical. In this model, emotions, social factors (like subjective norms in TRA), and habits are identified as the main factors to form the intention. TIB has three levels to argue the behaviour. In the first level, personal beliefs, attitudes and social factors related to the behaviour is shaped by personal characteristics and previous experiences (Bornewasser & Bober, 1987).

The second level describes how affect, cognition and social determinants plus personal normative beliefs effect on intentions to a particular behaviour. In the third level, possibility of performing a specific behaviour is predicted by behavioural intentions, situational conditions and past experience. The main disadvantage of TIB is complexity and lack of frugality compared to TRA and TPB. Also, TIB does not provide simple procedure for the operational definition of the variables among model and it is left to the researcher (Taherdoost, 2018a).

iv. Technology Acceptance Model (TAM)

This model is derivate from TRA model. Due to uncertain theoretical and psychometric status in TRA model, TAM model is eliminated user's subject norms (Muk & Chung, 2015) and TAM explains the motivation of users by three factors; perceived usefulness, perceived ease of use, and attitude toward use. Therefore, not only BI would be contained in TAM but also, two chief beliefs like perceived usefulness and ease of use have considerable impact on attitude of the user. These can be determined as an unfavourableness and favourableness toward the system. TAM is one of the most widely cited model in the field of technology acceptance (Wu, 2009). During the past decades, it received substantial empirical support. Since TAM ignored the social influence on adoption of technology so it has limitations in being applied beyond the workplace. Besides, some variables as external variables need to be added to TAM to provide more consistent prediction of system use (Taherdoost et al., 2009). Since the intrinsic motivations are not addressed in TAM, the ability of TAM to apply in a household context where the acceptance and use of technologies is not only to achieve tasks but also to fulfil the emotional needs may be limited.

v. Diffusion of Innovations Theory (DOI)

DOI model examines a diversity of innovations by introducing four factors (which are time, channels' communication, innovation or social system) which influence the spread of a new idea. DOI not only has been used at both organizational and individual levels but also, offers a theoretical foundation to discuss adoption at a global level. DOI model integrates three major components: adopter characteristics, characteristics of an innovation, and innovation decision process (Taherdoost, 2018b). In innovation decision, five steps namely confirmation, knowledge implementation, decision, and persuasion have taken place through a series of communication channels among the members of a similar social system over a period of time. In characteristics of an innovation step, five main constructs; relative advantage, compatibility, complexity, trial ability, and observability have been proposed as effective factors on any innovation acceptance. In adopter characteristics step, five categories; early adopters, innovators, laggards, late majority, and early majority are defined (Sila, 2015). In conclusion, DOI focuses more on the system characteristics, organizational attributes and environmental aspects, it has less power in explanatory and less practical for prediction of outcomes compared to other adoption models.

2.4 Renewable Energy Adoption

The term "renewable" is generally applied to those energy resources and technologies whose common characteristic is that they are non-depletable or naturally replenishable (Armstrong & Hamrin, 2000). Renewable resources include solar energy, wind, falling water, the heat of the earth (geothermal), plant materials (biomass), waves, ocean currents, temperature differences in the oceans and the energy of the tides. While the general term covers a wide variety of sources, this study will focus on a smaller scale definition of the term to mean any naturally occurring theoretically inexhaustible energy that can be harnessed by households for their daily energy needs without a high cost of investment, such as but not limited to biomass briquettes, biogas and solar cells.

2.4.1 Benefits of Renewable Energy Technologies

RETs might provide the solution for alleviating energy poverty among the poor and impoverished in SSA. Especially in rural areas, where electrification rates are low, RETs can help improve livelihoods and reduce health impacts of households.

i. Reduction of indoor air pollution

In SSA, cooking is the main cause of indoor air pollution (IAP) (Fernandes & Mesquita, 2014). Traditional cooking setups, like cooking over a three-stone

open fire, are inefficient for burning biomass fuels and lead to incomplete combustion processes. Inhalation of the toxic smoke can lead to severe health impacts. Pollutants like harmful particulate matter (PM10), volatile organic compounds (VOCs), carbon monoxide (CO), sulphur dioxide (SO_2) and nitrous oxides amongst others are emitted (Menghwani et al., 2019). Bad ventilation contributes to the fact that pollutant levels in the indoor environment in developing countries frequently exceed health standards, in both living and sleeping areas (Daly & Zannetti, 2007). Estimations indicate that IAP, in total, was associated with over 1.6 million deaths in 2000, which adds up to almost 5% of total mortality worldwide (Zhang & Smith, 2003).

Women and children spend most time indoors and around the cook stove, they are therefore most affected. Inhalation of biomass smoke is associated with a range of illnesses, including chronic pulmonary disease, lung cancer, tuberculosis (TBC), eye diseases, acute lower respiratory infections (ALRI's) (e.g. pneumonia among very young children) and low birth weights. Globally ALRI's are the main cause of death for children under the age of five (Bailis et al., 2009).

Besides cooking, lighting and heating are activities that contribute to IAP. Kerosene-based lanterns, that are the most common devices used for indoor lighting, mainly use fuel for the production of waste heat instead of light. Since the light is of poor quality, one tends to move close to the lantern, which increases the threat of inhaling more of the kerosene fumes. These fumes contain harmful components, such as CO, oxides of Nitrogen and sulphur (NO_x, SO_x) and VOCs (Gall et al., 2013). There is evidence inhalation of these fumes can lead to respiratory diseases, throat and lung cancer, eye complications and infections and low birth weights (Duflo et al., 2008). Modern efficient fuels produce a large amount of useful energy and little pollutants. However, they are generally more expensive. The energy ladder theory describes the relationship between fuel choice and welfare: as income or status increases a shift in household fuel choice is likely to occur towards more sophisticated fuels (Torres-duque et al., 2008). RETs can benefit the welfare and health of households that cannot afford high-quality fuels.

RETs such as improved cook stoves (ICS) are technologically designed to burn biomass fuel efficiently and under the right conditions so as to minimize the production of harmful by-products in the combustion process. The new generation ICS bring down emissions up to 50% (World Bank, 2014). Photovoltaic Solar Lamps (PSL), another example of RETs, eliminates the need for kerosene fuels, since they rely on solar energy. This means PSL do not produce any damaging emissions.

ii. Hazards of traditional cooking and lighting

In developing countries, the traditional setups for lighting and cooking can pose a serious threat to the wellbeing of households. When indoor cooking and lighting are not done with the right equipment fire safety becomes a serious issue. An estimated amount of 98% of all lethal burn victims occur in developing nations (Peck et al., 2008). In Kenya, the poorest households live in simple homes that are made with basic materials such as mud walls with straw roofing. In urban areas, where houses are built closely to each other, the fire hazard is even greater. In the simple houses of rural Kenya, flames can rapidly get into contact with fabrics or other flammable (construction) materials. One study looked into the impacts of a simulated fire in a South African 'shack', triggered by a tipped over kerosene stove that has been burning for one hour. Within 4 minutes the inside temperature rose to 900°C (Peck et al., 2008). Since households in developing countries often include many members, dwellings are often crowded. This brings the risk that stoves can tip over or that people suffer from burns caused by direct contact with the stove. Especially, children injure themselves in this way (Victor, 2011). Peck et al. (2008) states that "burns caused by homemade bottle lamps or commercial wick lamps are a cause of major morbidity and mortality in developing nations"(p.5). Lanterns can easily be toppled over or cause burns when adding more fuel.

RET can provide a safer alternative to cooking and lighting. ICS are safer to use than traditional stoves, they are more robustly built and since they are well insulated to direct heat their surface gets less hot when used. In contrast to kerosene lanterns, PSL use electrical energy. This means the risk of fire hazard is reduced dramatically.

2.4.2 Adoption Studies on Renewable Energy Technologies

It has been posited that promoting renewable energy technology (RET) uptake could reduce the reliance on charcoal and firewood by rural household subsequently greenhouse gas (GHG) emissions, indoor air pollution and more damaging exploitation and degradation of forest resources (Renewable Energy Policy Network for the 21st Century, 2010). As seen in the previous paragraphs, rural households stand to benefit significantly when they adopt RETs.

The diffusion of renewable electricity technologies (RETs) has to speed up for countries to reach their, often ambitious, targets for renewable energy generation. This requires a large number of actors – including individuals, companies and other organizations – to adopt RETs.

A study by Bollinger and Gillingham (2012) found that peer-effect, personal attitudes/values and favourable subsidies have influence over the willingness to adopt a solar PV technology which they termed as spatial peer effect (Bollinger & Gillingham, 2012; Tate et al., 2012). The socioeconomic and demographic characteristics of those adopting technologies and those of surrounding them are the focus of many studies in diffused renewable energy technologies (DRETs). Two main reasons were cited as important in having someone in the surrounding area having the said technology: for emulating someone perceived as guidance; or for reducing the risk associated in being an innovator (Bollinger & Gillingham, 2012). A sense of security is created by having the physical presence of an RET, reducing the perceived risk for potential adopters and showing the change from the business-as-usual is possible. Snape and Rynikiewicz (2012) investigated a similar effect in the UK where results show stronger adoption in regions where agents first adopted photovoltaic systems and a concentric pattern, with lower adoption in the further areas.

According to Fischer and Sauter (2004), friends and neighbours seemed to be important references for investing in solar panels as they seemed to influence both acceptance and resistance to RET. Similarly, friends' and relatives' opinions were found to be important determinants of people's views on local renewable energy projects (Devine-Wright, 2005). Heaslip et al. (2016) also found that the extent of community involvement (social factor) in the development of sustainable energy community projects is a significant factor determining the acceptance of such energy projects in the community. Community involvement which composed of regular public meetings, with the people in the community and funding policy to encourage the citizens had a large influence on the adoption of RETs (Reinsberger & Posch, 2014).

According to a study by Ng'eno (2014), the level of knowledge and awareness of the technology, level of income of households, and availability of substitute power source influenced the adoption of domestic solar technology. Another study by Shen et al. (2015) also found that household characteristics (such as family size, age, gender, household income, location and structure), knowledge and public awareness about the technology (such as higher education, publicity and demonstration), policy and regulations, financial support from the government and renewable energy market development all were significant in influencing the adoption of clean fuels and cooking stoves in China.

2.5 Policy framework and RET

Policy is an important tool in enacting change in a country. When it comes to RET adoption, many studies pointed out that government policy is an important factor influencing people's willingness to adopt (Gillingham & Sweeney, 2012; Shen et al., 2015). The risk that renewable energy technologies (RETs) could face opposition and barriers due to public perception could be offset by policy design and policies which can either accelerate or slow down the diffusion of RETs (Gillingham & Sweeney, 2012; Painuly, 2001; Verbruggen et al., 2010). Verbruggen et al. (2010) argued that policies affect directly RETs costs, prices, and technology innovation. Mattes et al. (2014) found that access to renewable energy resources, size of firm, location of firm, financial resources, policy mix in terms of political and legal frameworks are major factors influencing the adoption of renewable energy technologies among firms in the manufacturing sector.

In Kenya the government introduced a raft of policies and bills beginning with the Energy Act of 2006 that aimed at ensuring a sustainable energy mix. This saw a growth of investment from virtually zero to more than US$1.3 billion (including funding for wind, geothermal and small hydro). Geothermal power generation was the highlight, with the local electricity- generating company, KenGen, securing debt finance for additional units at its Olkaria project (McCrone & Usher, 2011; United Nations Environmental Programme (UNEP), 2006). Most of these studies reflect a macroenomic outlook without necessarily looking at the full mix of RETs that fit into the household context and how policy impacts them.

2.6 Civil Society/ Non- Governmental Organisations

Bahmani (2016) defines civil society as a composite of people who make groups and associations based on their will and independent of the government, where the purpose of establishment of such groups is improving the desires and interests of the members. Civil society has developed and grown since the term first became popular in the 1980s and now signifies broad range of organised and organic groups including non-governmental organisations (NGOs), trade unions, social movements, grassroots organisations, online networks and communities, and faith groups (Vandyck, 2017; World Economic Forum (WEF), 2013). Such groups and networks vary by size, structure and platform ranging from international non-governmental organisations (e.g. International Commission of the Red Cross) and mass social movements (e.g. the Black Lives Matter) to small, local organisations (e.g. Clean Cooking Alliance of Kenya).

Civil societies have always played a critical role in society, since they exist outside government, their mandate has had great flexibility and mainly driven by member, sometimes donor interests.

One of the major strengths of civil societies is their ability to maintain institutional independence and political neutrality. Even though they need to collaborate with governments in numerous instances, failure to maintain neutrality and autonomy may severely compromise their legitimacy. Unfortunately, if a government insists upon political allegiance, the NGOs encounter the dilemma of either violating the neutrality position or failing to provide needed services to the population(Young & Dhanda, 2012).

In Kenya, civil societies have been an integral piece of the fabric that makes the nation, they champion rights of the underprivileged members of society or call the government to task over different issues. For example, The Green Belt Movement led by the late Nobel Laureate Prof. Wangari Maathai campaigned vehemently against the government lacklustre attitude towards the environment and impunity in grabbing gazetted forests and conservation areas (Hunt, 2014; Mathuki, 2014). The movement found itself at cross-purposes with the state at a time where civic space and free speech was highly limited. Despite state machineries working against them through arbitrary arrests and general bullying, their campaigns eventually forced the government to concede due to mounting international pressure.

2.6.1 Civil Society and RETs

Contemporary civil society actors have demonstrated their value as facilitators, conveners and innovators as well as service providers and advocates, while the private sector is playing an increasingly visible and effective role in tackling societal challenges (Vandyck, 2017). Civil society plays key roles in pushing for new laws, programmes, policies or strategies on climate change, in holding governments to account on their commitments; in identifying the lack of joined-up government responses to climate change; and in ensuring that national policy making does not forget the poor and vulnerable (Reid et al., 2012).

As the times have progressed, NGOs have become more relevant and visible in sustainable energy provision. According to a GlobeScan poll of experts, the leading role in achieving sustainability will be played by business (35%), followed by NGOs (30%), and governments (24%)(Young & Dhanda, 2012). NGOs have shown leadership in promoting sustainable community development. Due to their particular ideology and nature, NGOs are good at reaching out to the poor and remote communities and mobilizing these populations.

They can also empower these populations to regain control of their lives and can work with and strengthen local organizations. In addition, such NGOs can carry out projects more efficiently and at lower costs than government agencies and, most importantly, promote sustainable development (Nikkhah & Redzuan, 2010). NGO's promote empowerment, engineer change and eventually community sustainable development in communities through providing micro- finance, initiating capacity building and self-reliance (Nikkhah & Redzuan, 2010). Rappaport (1987) defines empowerment as the ability of individuals to gain control socially, politically, economically and psychologically through (1) access to information, knowledge and skills; (2) decision making; and (3) individual self-efficacy, community participation, and perceived control. Using this definition, it is clear to see how NGO's are able to be instruments of community empowerment, through micro-finance, they help members of community to access jobs, income-generation and improve economic situation. And then they would become empowered economically. On the other hand, NGOs develop the capacities of community such as skills, abilities, knowledge, assets and motivate the community to participate in projects to improve the quality of their lives. NGOs act as capacity builders that help the community to achieve the empowerment particularly individual empowerment.

An observed gap has been the lack of a definition of what constitutes capacity building, which can range from set up of formal training activities that have a certification at the end, to informal training that is looking more at imparting skills rather than an academic goal.

2.7 Universities and Research Institutions and RET promotion

Understanding of the social barriers to clean energy projects have improved, but the efforts necessary to tackle such issues have not received enough momentum (Cohen et al., 2014). A cost-effective measure to cultivate public acceptance and support of RETs is through the improvement of public energy knowledge and literacy, and a re-orientation of the education sector to adopt renewable energy education strategies in formal and informal settings (DeWaters & Powers, 2011; Kandpal & Broman, 2014; Mälkki et al., 2015; Ntona et al., 2015; Yazdanpanah et al., 2015). Universities and research institutions occupy a significant position in economic development and as incubation hubs for innovation, particularly when discussing RETs and their adoption, they cannot be left out. According to Özçiçek and Ağpak (2017),

When human capital is not rich enough to adapt new ideas and technologies in an economy, it is very likely to continue using conventional sources instead of renewable

energy. The less educated individuals are more likely to have lower income, and so is their renewable energy utilization reluctance. To sum up, these kind of demand decreasing factors are expected to be seen more in less educated economies. (p.50).

Education and training in the area of energy in general, and in new and renewable sources of energy in particular, is of great importance (Kandpal & Broman, 2014) as from a technical perspective large-scale development of renewable energy technologies requires an adequate number of well-trained and competent personnel (Kandpal & Broman, 2014; Negro et al., 2012; Thomas et al., 2008).

Universities and institutions of higher learning serve multiple purpose in innovation and renewable energy promotion. They are most valuable for the private and public sector in five main areas: (a) education and training (curriculum development); (b) combining existing knowledge; (c) contributing to fundamental research; (d) creating space for open exploration of ideas; (e) community involvement. What matters is not only technology development, but also contributions in terms of assimilation and absorption of these factors by various social groups, such that the result is a change in behaviour or practices (Brebbia et al., 2009). As the urgency of climate change problems continue to mount, a calling for action to not only better understand their origins, but also to take steps for promoting sustainable development models puts institutions of higher learning in focus as potential sources for solutions. To respond to these challenges, innovations are required not only in the technology realm for exploring alternative energy sources, but also in the organizational domain (how firms, governments, and other organizations operate) and in the social behaviour patterns (WorldWatch Institute, 2008). Universities contribute to community development and coherence, by promoting their core ethical values of equity, transparency, and equality (Brebbia et al., 2009). Through their interaction with the local government, universities can develop programs that involve the local community in a more effective way than the government or the private sector can, while also maintaining their core competence in education and research (A. Rappaport & Creighton, 2007).

In addition, the majority of socio-cultural and institutional barriers to renewable energy development, energy conservation, and environmental protection can be largely overcome if all stakeholders (end users, policymakers, politicians, private sector leaders, NGOs, public or charity associations, school pupils etc.) are made “energy conscious” and environmentally aware. This can be achieved by equipping the aforementioned stakeholders with updated and easy-to-understand relevant information, capacities, and skills in a dynamic, transparent,

interactive, and communicative learning environment (Dias et al., 2004; Jennings, 2008; Kandpal & Broman, 2014).

The interface between universities/research institutes with local communities has been scarcely mentioned with mostly being left to the institutions themselves to decide. This could be attributed to the fact that Universities are assumed to be well grounded in pedagogy, therefore how they interact with the world would also assume the same values to benefit from their core competencies especially in transmitting knowledge information and skill through this intrinsic characteristic (Vereijken & van der Rijst, 2020).

2.8 Summary of Research Gaps

2.8.1 Awareness measurement

The measurement of awareness has always posed a challenge to researchers, since it demands the imposition of an objective approach to phenomenon that is subjective. This has led to the development of varying methodologies to measure awareness which incorporate both subjective approaches e.g. asking somebody to describe their experiences/ how they feel, or objective methods i.e. asking people to choose between carefully constructed alternatives. Both methods present obvious advantages over each other while also possess fundamental weaknesses which contribute to the continuing debate. However, when it comes to renewable energy awareness measurement, in as much as both approaches have been employed by researchers in studies, there seems to be a forgotten factor/ paradigm. A human beings body of knowledge about a subject matter does not only include the positive, but negative bias a well, this has to be factored in since it does constitute awareness. Focusing on both positive and negative aspects of a technology will yield better understanding into the levels of awareness respondent might or might not be explicitly aware of.

2.8.2 Adoption

Adoption studies are important because they allow researchers understand the extent by which a given technology becomes accepted and incorporated into approved social practices. Various theories have been developed to explore reasons for adoption. These various models and frameworks have been developed to explain user adoption of new technologies and introduce factors that can affect user acceptance. Each of the six theories reviewed was found to have challenges in its applicability and none was found to be perfect fit in the study of renewable energy adoption.

The Theory of Reasoned Action (TRA) developed by Fishbein and Azjen, presupposed that any human behaviour is predicted and explained through three main cognitive components i.e. attitudes, social norms and intentions. Where methods such as generality,

target, action, context and time horizon are established to improve the robustness between intention and attitude, TRA fails to address the role of habit, cognitive deliberations, misunderstandings through survey and moral factors in its assessment.

The Theory of Planned Behaviour (TPB) extends the TRA model by appending perceived behavioural control as a new variable. Which therefore means three main factors affect behavioural intention i.e. perceived behavioural control, subjective norm and behavioural attitude. Two main problems with this approach have been identified, [a] one's attitude towards a new technology will largely not be relevant if the technology is not accessible, [b] TPB may be viewed as the more suitable theoretical framework which is influenced by the degree of an individual's voluntariness to choose or not to choose the use of technology in their working environment.

The Theory of Interpersonal Behaviour (TIB) clarifies human behaviour complexity which is affected by social and emotional factors. It contains all aspects of TRA and TPB and adds habits, facilitating conditions and affect in order to improve the prediction power. In TIB, individual is neither fully deliberative nor fully automatic, further, neither fully autonomous nor entirely social. TRA differs from TIB, in the sense that TRA interests in accounting for the most variance with the fewest variables, whereas TIB interests in accounting for the most variance in total, because even a small amount of variance may be socially important, if the behaviour in question is critical. The main disadvantage of TIB is complexity and lack of frugality compared to TRA and TPB. Also, TIB isn't providing simple procedures for the operational definition of the variables among model and it is left to the researcher.

Technology Acceptance Model (TAM) is a derivate from TRA. TAM eliminated user's subject norms and explains the motivation of users by three factors; perceived usefulness, perceived ease of use, and attitude toward use. TAM ignored the social influence on adoption of technology so it has limitations in being applied beyond the workplace. Since the intrinsic motivations are not addressed in TAM so the ability of TAM to apply in a household context where the acceptance and use of technologies is not only to achieve tasks but also to fulfil the emotional needs may be limited.

Diffusion of Innovations Theory (DOI) examines a diversity of innovations by introducing four factors (which are the time, channels' communication, innovation or social system) which influence the spread of a new idea. DOI not only has been used at both organizational and individual levels but also, offers a theoretical foundation to discuss adoption at a global level. DOI model integrates three major components: adopter characteristics, characteristics

of an innovation, and innovation decision process. The main weakness is because DOI puts more focus on the system characteristics, organizational attributes and environmental aspects, leading to less power in explanatory and less practical for prediction of outcomes compared to other adoption models.

2.8.3 RET Adoption and Policy

Many studies pointed out that government policy is an important factor influencing people's willingness to adopt. The risk that renewable energy technologies (RETs) could face opposition and barriers due to public perception could be offset by policy design and policies which can either accelerate or slow down the diffusion of RETs. Many of the studies that focus on policy also focus on macroeconomic adoption of RET without necessarily giving insights into the full mix of RET adoption particularly how it fits into the household context.

2.8.4 Civil Society and RET Adoption

Civil society has developed and grown since the term first became popular in the 1980s and now signifies broad range of organised and organic groups including non-governmental organisations (NGOs), trade unions, social movements, grassroots organisations, online networks and communities, and faith groups. As the times have progressed, civil society have become more relevant and visible in sustainable energy provision. According to a poll of experts, the leading role in achieving sustainability will be played by business (35%), followed by civil society (30%), and governments (24%). Civil societies have clearly shown leadership in promoting sustainable community development through reaching out to the poor and remote populations and mobilising them. Civil Society particularly NGOs can carry out projects more efficiently and at lower costs than government agencies and, most importantly, promote sustainable development. NGOs act as capacity builders that help the community to achieve the empowerment particularly individual empowerment. However, literature has not been clear on how this is done. An observed gap has been the lack of a definition of what constitutes capacity building, which can range from set up of formal training activities that have a certification at the end, to informal training that is looking more at imparting skills rather than an academic goal.

2.8.5 Universities, Research Institutions and RET promotion

Universities and research institutions occupy a significant position in economic development and as incubation hubs for innovation, particularly when discussing RETs and their adoption, they cannot be left out. As the urgency of climate change problems continues to mount, a calling for action to not only better understand their origins, but also to take steps

for promoting sustainable development models puts institutions of higher learning in focus as potential sources for solutions. To respond to these challenges, innovations are required not only in the technology realm for exploring alternative energy sources, but also in the organizational domain (how firms, governments, and other organizations operate) and in the social behaviour patterns. The majority of socio-cultural and institutional barriers to renewable energy development, energy conservation, and environmental protection can be largely overcome if all stakeholders (end users, policymakers, politicians, private sector leaders, NGOs, public or charity associations, school pupils etc.) are made "energy conscious" and environmentally aware. This can be achieved by equipping the aforementioned stakeholders with updated and easy-to-understand relevant information, capacities, and skills in a dynamic, transparent, interactive, and communicative learning environment. Unfortunately, literature has not expounded quite clearly the interface between Universities with local communities. This is left to the universities to decide and could be attributed to the fact that universities are assumed to be well grounded in pedagogy and information diffusion.

2.9 Theoretical Framework

The study is guided by The Theory of Reasoned Action as described by Brown et al. (2002). The theory states that both attitude and subjective norms are important determinants of people's intention to adopt and use technology in enterprises. Further the intention to adopt and to continue using technology is influenced by one's attitude. The theory explains that an individual behaviour is influenced by his or her behaviour's intention which is influenced by his or her attitude towards behaviour of subjective norm (Vanketesh & Davis, 2003).

Behavioural intention measures a person's relative strength of intention to perform a behaviour. Attitude consists of beliefs about the consequences of performing the behaviour multiplied by his or her evaluation of these consequences (Fishbein & Ajzen, 1975). Subjective norm is seen as a combination of perceived expectations from relevant individuals or groups along with intentions to comply with these expectations. In other words, "the person's perception that most people who are important to him or her think he should or should not perform the behaviour in question" (Fishbein & Ajzen, 1975). To put the definition into simple terms: a person's volitional (voluntary) behaviour is predicted by his attitude toward that behaviour and how he thinks other people would view them if they performed the behaviour. A person's attitude, combined with subjective norms, forms his behavioural intention.

Fishbein and Ajzen (1975) however, note that attitudes and norms are not weighted equally in predicting behaviour. "Indeed, depending on the individual and the situation, these factors might have very different effects on behavioural intention; thus a weight is associated with each of these factors in the predictive formula of the theory. For example, one might be the kind of person who cares little for what others think. If this is the case, the subjective norms would carry little weight in predicting your behaviour" (Miller, 2005:127).

What the theory of reasoned action approach attempts to do is to identify a relatively small set of variables that can account for a substantial proportion of the variance in any given behaviour, in our case the adoption of renewable energy technologies. A lot of government and civil society intervention on popularizing and sensitizing renewable energy technologies among rural households have been conducted in Kenya. From local capacity building trainings, to radio and television documentaries such as Media for Environment, Science, Health and Agriculture (MESHA) Kenya talk show. These can be said to be actions conducted with the purpose of exposing individuals to the various renewable energy technologies in order to modify their attitudes and beliefs toward usage of RETs. But is this enough? If trainings and capacity building workshops were all that was needed to do, then rural usage of RETs would be higher than the current rate of adoption. Does the theory of reasoned action find its limits when renewable energy technology among rural households is in question? What is missing? The theory also recognizes that there are situations (or factors) that limit the influence of attitude on behaviour. For example, if attitudes lead one to want to do something but have no money, the lack of money will prevent attitude from causing one to commit the intended action. Socio- economic status comes into play here, it would be expected that a family with a high income would preferably rely on cleaner energy sources, even though the prevailing community preferences would be on basic wood-based biomass sources. Therefore, Reasoned Action predicts behavioural intention, a compromise between stopping at attitude predictions and actually predicting behaviour. Because it separates behavioural intention from behaviour, Reasoned Action also discusses the factors that limit the influence of attitudes (or behavioural intention) on behaviour.

2.10 Conceptual Framework

According to Sekaran (2003) a good conceptual framework identifies and labels the important variables in the situation that are relevant to the problem defined. It logically describes the interconnections among these variables. The relationships among the independent variables, the dependent variable(s), and if applicable, the moderating and intervening variables are elaborated.

Independent Variable **Intervening Variables** **Dependent Variable**

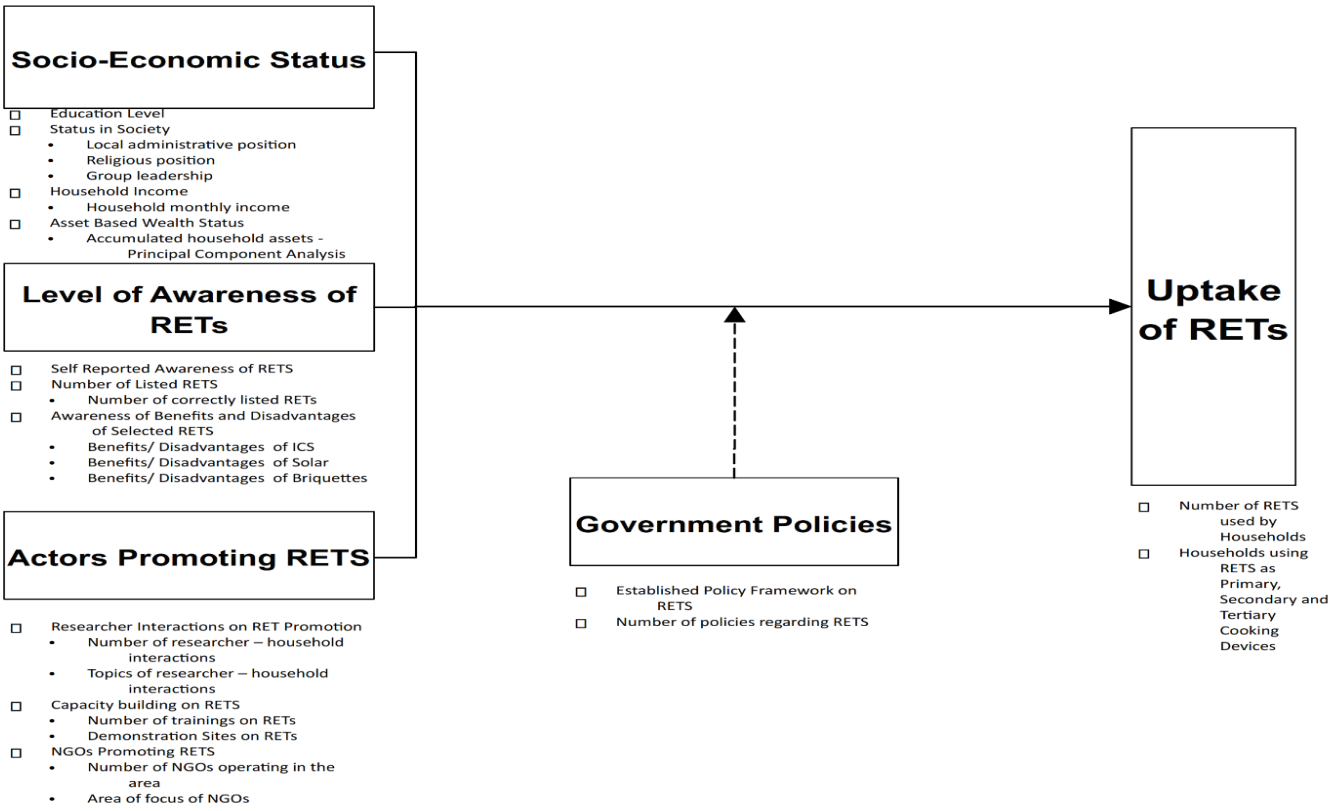

Figure 2.2 Conceptual Framework

Figure 2.2 above shows that the Dependent Variable is the Adoption of RETs for domestic use which is a composite of number of RETs used and Level of use of ICS as either primary, secondary or tertiary cooking device. This is influenced by the independent variables: (1) Socio-economic status – The researcher equated this to a multiple of various factors including education level, household head status in society, household monthly income and the asset-based wealth status. The researcher envisioned a positive correlation where a social economic status led to high level of RET adoption. The researcher also considered level of awareness which was composite measure from Self-Reported Awareness, explicit listings of technologies and knowledge of benefits and disadvantages. From the literature, awareness plays a critical role in adoption and the researcher envisioned a positive correlation between awareness and adoption.

Finally, Actors promoting RETS was the final independent variable which in itself had several key components i.e. (1) researcher respondent interactions to know the context that respondents were exposed to RETs by researchers, (2) Capacity building experiences of respondents on RETS, did they undergo training and which are the demonstration sites for

such activities should they chose to seek it, (3) Non-Governmental Organisation influence , are there NGO operating in the locale and what are their key focus areas in the community. National Policy Framework was considered an intervening variable which featured an analysis of established policy framework on RETs and number of policies that actually cover the RETs in this study.

CHAPTER THREE
METHODOLOGY

3.1 Study Area

Njoro Sub-County was selected as a viable place to determine the impact of the selected factors on the adoption of RETs. Njoro sub-County has a population of 184,859 people with 38,686 households (Kenya National Bureau of Statistics (KNBS), 2010). Njoro Sub-County borders the Mau Forest, one of the last remaining closed indigenous forests of Kenya. Majority of the residents source their firewood and charcoal from the forest, contributing to massive deforestation and degradation. Many forest conservation efforts are underway in the sub-county and understanding more on how to get the residents to adopt RETs would go a long way in enhancing conservation efforts. Frequently, the government through the Kenya Forestry Service (KFS) conduct operations to crack down on illegal logging and charcoal burning. Whenever this happens, fuel crisis occurs in the surrounding areas spreading all the way into Nakuru town. To link this up, Njoro Sub County has a large concentration of saw mills and other wood based industries which produce sawdust as a major by product. Sawdust is a main component in carbonised and non-carbonised briquettes which are viable alternatives to firewood and charcoal, studying the determinants to adoption of such RETs could help avert such energy shortage issues in future.

3.2.1 Location of Njoro Sub-County in Nakuru County

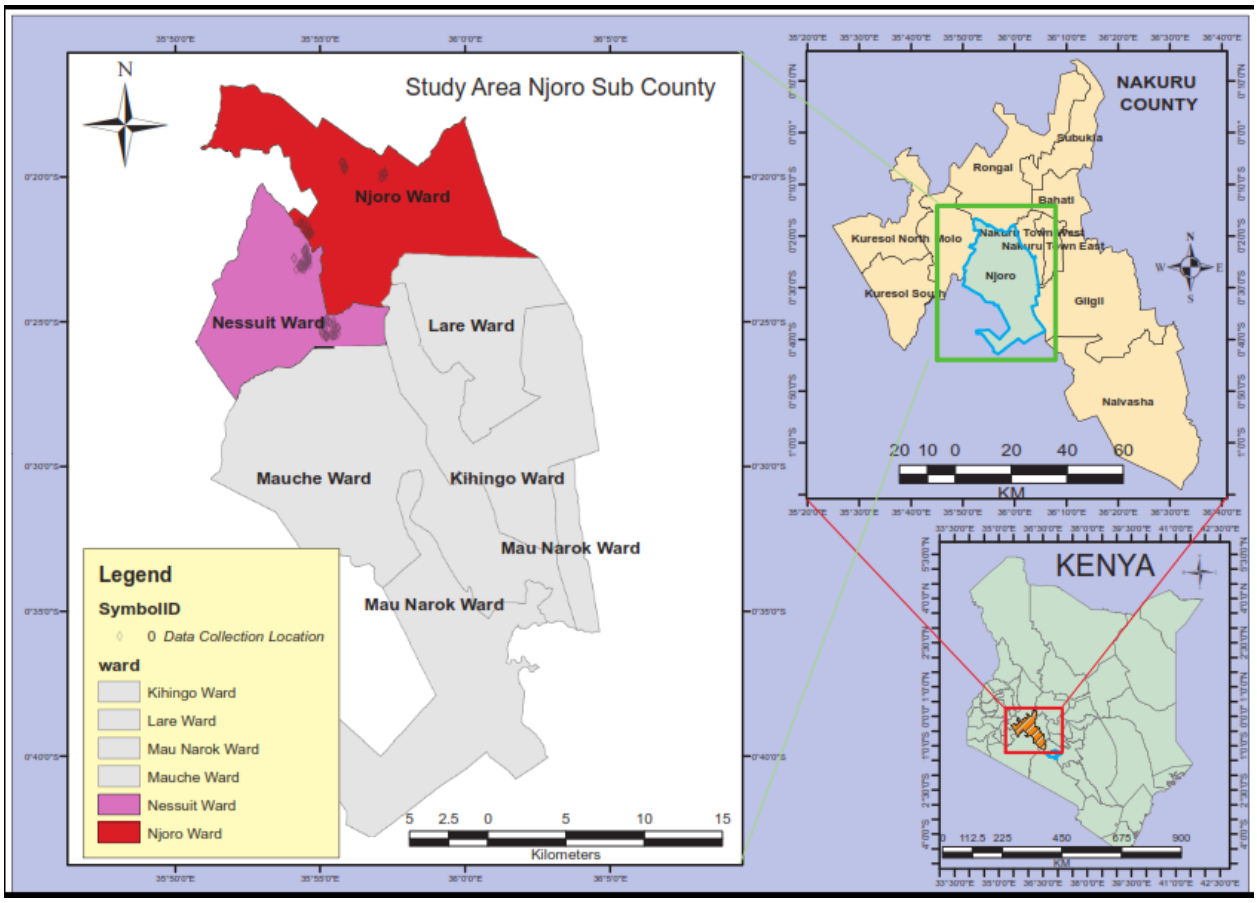

Figure 3.1 *Location of Njoro Sub-County in Nakuru County (Source GIS IEBC data, 2019)*

Conceptual Framework

3.3 Research Design

A Cross-Sectional Survey Design involving observation, questionnaires and oral interviews were used to collect data from individual households.

3.4 The Target Population

The population for the study comprised of households in Njoro Sub-County. The 2019 Kenya Population and Housing Census reported Njoro sub-County as having a population of 238,773 over 699.5 square Kilometres with a population density of 341 persons per square kilometre (KNBS, 2019) . The sub-County is comprised of Mau Narok, Mauche, Kihingo, Nesuit, Lare and Njoro Wards.

3.5 Sample Size determination and Sampling Procedure

Sample size determination plays a critical role in any research study, it is very important to understand that different study design need different method of sample size calculation and one formula cannot be used in all designs. Two formulae were considered specified the

precision of estimation desired which was then used to determine the sample size necessary to insure it; as defined by Kothari (2004) the first formula is as follows;

$$n = \frac{z^2.p.q.N}{e^2(N-1) + z^2.p.q}$$

(3.1)

Where

z=2.005 (as per table of area under normal curve for the given confidence level of 95.5%), where **p** is the proportion of the population that use RETs it was estimated to be 0.02 because the actual proportion is unknown (Daniel, 2009), and **q**=1-p. The population of households was N=38,686 and **e** precision expected e=0.02

n= 2.005^2 *0.05*(1-0.05)* 38,686/(0.02^2 (38,686-1)+ 2.005^2*0.05*(1-0.05)

(3.2)

n=195.988

n=196

As defined by Krejcie and Morgan (1970) the second formula used is as follows;

s=X^2 NP (1-P) ÷ d^2 (N-1) + X^2P (1-P)

(3.3)

s = required sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size (38,686 Households)

P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size).

d = the degree of accuracy expressed as a proportion (.07).

s=3.841 x 38,686 x (1-0.5) ÷ 0.07^2 (38686-1) + 3.841^2 x 0.5 (1-0.5)

(3.4)

s=199.9693

s=200

The sample size suggested by the two formulae was almost the same. Since the opportunity cost of reaching the additional respondents would not be significant, 200 was taken as the final sample size.

Two Stage Cluster Sampling technique was used to select rural households within the wards in Njoro Sub-County Nakuru County. The reason for the choice of cluster sampling

was because the target population is divided into divisions, locations, wards and villages. The decisions about sample size took into consideration the size of the target population being researched and the level of accuracy required from the research.

In order to come up with the samples, the researcher assigned arbitrary values to the wards in Njoro Sub-County and ran a series of random number generating functions in Microsoft excel as indicated in Step 1, Step 2 and Step 3. Once the ward was selected the same arbitrary values were assigned to the villages in the two selected wards and the same process was used in selecting villages.

Table 3.1 Clustered Wards of Njoro Sub-County

Njoro Sub-County	
Mau Narok (1-100)	Mauche (101-200)
Kihingo (201-300)	Nesuit (301-400)
Lare (401-500)	Njoro (501-600)

Step 1 - The researcher clustered the area to be sampled according to wards.

Step 2 - The researcher then assigned each cluster a range of values as indicated in Table 3.1 above. Step 3 - Simple random sampling was then used to select two clusters. The researcher did this by using the random function in excel (RANDBETWEEN (1,600)) twice which resulted in a figure of 302 and 553**,** which were used to shortlist the clusters with the corresponding figures within their ranges, Nesuit and Njoro Wards. The final areas selected were Njoro, Mukungugu, Sigotik and Miseipei.

3.5.1 Sampling Frame

The sampling frame is shown in table 3.2.

Table 3.2 Sampling Frame

No	Village	Households	Sample Size
	Njoro	10,149	44
	Mukungugu	2,899	33
	Sigotik	881	52
	Meseipei	394	52

To determine influence of policy on adoption, a content analysis was conducted with the following key parameters;

i. Documents had to be National bills and/or acts regulating the energy sector, energy governmental policies shaping the principal orientations followed by Kenyan authority, and governmental strategy envisioning and designing the future of the energy sector in Kenya.

Text from national policies, Acts, procedures and strategies regulating the energy sector were contextually analysed to reveal the elements of adoption of renewable energy technologies in biomass and clean cooking.

ii. The first level of the analysis was to check for the following specific key words; biomass, clean cooking, renewable energy, household energy, clean energy. The identification of the existence of the keywords was followed up by analysing the context under which they were mentioned within the text.

iii. The next level of assessment included checking for the mention of research and methodologies behind the conclusions and formulations of the specific policy intervention. Energy is a multifaceted crosscutting issue that has not only impact on the socio-economic welfare of the people, it also has direct impact on the health and wellbeing. Energy research is an ever-growing field of science, policy driven by the latest research would be a good indicator for policy progressiveness.

The research study used both quantitative and qualitative approaches. The data collected was used to study the factors affecting adoption of RETs by rural households in Njoro Sub-County, Nakuru County, Kenya. The data was analysed for differences, relationships and associations using the Statistical Package for the Social Sciences (SPSS) version 22 and data presented in charts and tables.

3.6 Data Collection Method

The overall methodology employed a qualitative and quantitative typology. While the quantitative methods and processes provided the figures in graphs etc., the qualitative ones

pieced the story behind these figures. All these answered the specific research questions that had been generated from the research objectives and aligned to the study's conceptual and theoretical framework.

The primary quantitative technique included the use of face-to-face questionnaire. The use of questionnaires enabled the respondents to remain anonymous and be honest in their responses (Cooper & Schindler, 2006). The choice of the questionnaire was based on the fact that it was easy to analyse the collected data statistically. Further, it is not biased and the responses were gathered in a standardized manner so they were more objective in their results. The questionnaire was divided into sections that examine the different variables that assisted in the discovery of what the real factors are that influences the adoption or lack of adoption of RETs by the people in Njoro Sub-County.

3.7 Instrument Validity

Validity is the degree to which an instrument measures what is supposed to measure (Kothari, 2004). 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 supervisors who are experts. Furthermore, the questionnaire was subjected to a pilot test on 30 respondents in the neighbouring Lare Ward to detect any deficiencies in it where the necessary improvements were made.

3.8 Instrument Reliability

Mugenda and Mugenda (2003) define reliability as a measure of a research instrument to yield consistent results or data after repeated trials. 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 responses between the two tests in a pilot study. The questionnaire also incorporated control questions to measure the reliability of the respondents.

3.9 Ethical Considerations

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 and guaranteed confidentiality in the entire research process. The researcher got a permit to conduct the research from the National Commission for Science Technology and Innovations (NACOSTI).

3.10 Data Analysis

Data analysis consisted of examining, categorizing, tabulating or otherwise recombining the evidence to address the initial prepositions of the study. All the quantitative data collected was reviewed for completeness and coded before analysing to ensure quality control. The

Statistical Package for the Social Sciences (SPSS) Version 22 Program was used to compute descriptive and inferential statistics as indicated in the data analysis table (Table 3.3). The collected data was presented using statistical techniques which included percentages and frequency distribution tables. Other forms of analysis included test statistics and correlation.

The analysed data is represented in the Results and Discussion section of the Thesis in various diagrammatic forms including tables and charts as well as narratives summarizing the key aspects / themes emerging from the research questions.

Table 3.3 Data Analysis Table

Research Questions	**Variables**	**Survey Questions**	**Analysis method**
1. What is the household level of awareness to the existence of RETs?	Knowledge of RETs; Use of mentioned renewable energy by the household	Q10, 27, 28.1, 28.2, 29, 30.1, 30.2, 31, 32.1, 32.2 Does level of awareness vary between (1) Gender (2) Age (3) Level of Education Q3 (4) Household Wealth (5) Leadership position	Descriptive statistics Chi Square Test for Independence
1. What is the influence of socio-economic factors of households on the adoption of RETs?	Use of RETs Household income level Household head status in society. Household educational level. Household assets. Gender and household energy decision making	**Socio-economic status** Q2,3,4,5,6,8,9.1,9.1.1,9.1.2, 16.1,16.2,16.3,16.4,17,18 **Adoption of RETs** Q10,12,20,20.1,20.2,23,23.1 **Decision Making** Q19	Descriptive statistics Pearson Correlation Analysis
1. What is the influence of	Policy promotion on the use of RETs. Policy deterrent on use		Content analysis (Secondary

policy framework on the adoption of RETs.	of non-renewables.		data sources) Descriptive statistics
1. What is the influence of external actors in promotion of RETs.	Actors (Government and Civil society) dealing in RETs. RETs training activities conducted in the past year. RETs promoting NGOs operating in Njoro sub-County. RETs demonstration sites in the sub-County. Distance of RETs demonstration sites from respondents.	Q33.1,34.1,34.2,34.3,35.1,35.2,36, 37.1	Descriptive statistics

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Background Information of the Respondents

The household heads were asked to indicate their gender, marital status, age and if the head of the family was in a position of leadership.

4.1.2 Socioeconomic characteristics of respondents in study area

I. Gender

The gender composition of respondents revealed an almost even proportion of male respondents (50.8%) to female respondents (49.2%) (Table 4.1).

Table 4.1 Gender of Respondents

	Household Demographic Details/Respondent Gender			
	Male		Female	
Ward	f	%	f	%
Misepei	20	38.5%	32	61.5%
Mukungugu	26	78.8%	7	21.2%
Njoro	27	61.4%	17	38.6%
Sigotik	19	36.5%	33	63.5%
Total	92	51%	89	49%

II. Age

Age distribution of the study respondents ranged between 17-83 years with the average age of 45 years. The study revealed that 64% of sampled respondents were over the age of 36 years (Figure 4.1). According to Okuthe and Akotsi (2014) , there is some controversy in using age in explaining technology adoption. Some adoption studies go by the assumption that older people have more experiences which help them adopt new technologies. On the flipside, others believe that because of their risk averting nature, older age people are more conservative than the youngest one to adopt new technology. The risk of adopting RETs arises from the high cost of production. Due to this fact age was thought to have a negative relationship with the adoption of RETs. According to the Kenya National Bureau of Statistics (KNBS) (2014) and the United Nations Development Programme (UNDP) (2012), Kenya has a predominantly ageing population in rural areas due to high rural-urban migration by young people in search of employment.

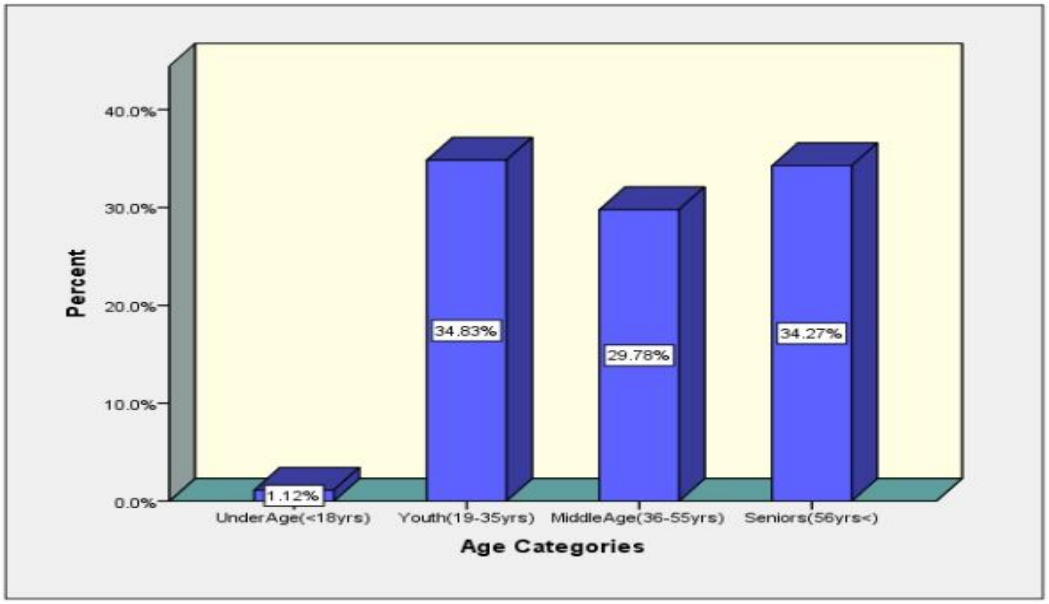

Figure 4.1 Age distribution of respondents

III. Education Level (El)

Half of the sampled respondents had achieved a certain level of formal education. Where 2.2 % had attained tertiary level education, 12.2 % had attained secondary level education, 35.6% had gone up to primary level and 50% had not attained any formal education (Table 4.2*)*. According to various studies (Foell et al., 2011; Pachauri & Spreng, 2011) higher education levels are determinants to access of varied and diverse information sources which increase the likelihood that they could include clean energy alternatives.

Table 4.2 Education Level of Respondents

Education level	n	%n
Pre-primary	90	50.0
Primary	64	35.6
Secondary	22	12.2
College	4	2.2
Total	**180**	**100.0**

IV. Monthly Income and Asset Based Wealth Index (ASBI)

With regards to total family income, 54.8% of the total respondents reported earning a joint family income of between KES 0 -5,000, 36.7% earned a monthly income of between KES 5,001-15,000, 7.3% earned monthly income between KES 15,001- 30,000, while only 1.1 % reported earning over 50,001(Figure 4.2). According to Ricciuto et al. (2006) and Verbeke and Vackier (2004) available disposable income increases the spending power of households.

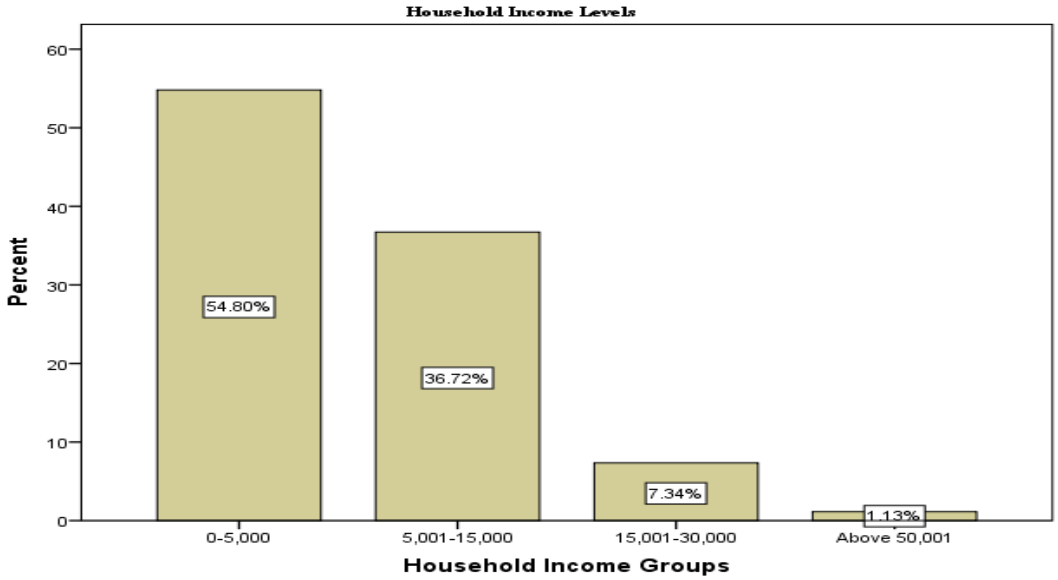

Figure 4.2 Monthly Household Income Group Distribution

Research has shown that income-based indices are less reliable in assessing social economic status than expenditure-based economic status indicators (Córdova, 2008; Deaton, 2018). That is why the researcher included indirect proxy measures such as ownership of household durable assets and housing characteristics as part of the Measure for Socioeconomic Status. These measures yield more reliable results in getting the relative wealth of the households (Karigi, 2014). Principal components analysis (PCA) was employed to generate household asset-based proxy indices. Households were grouped into quintiles, from wealthiest to the poorest.

In Kenya and most developing nations, regular monthly income may not paint a true picture of wealth or lack thereof, farmers, artisans and other informal sectors experience periods of increased income which might not coincide with the period of study. Most households use this added income to secure household assets, it is these assets that give clearer picture of wealth. An asset based wealth index allows for an extra dimension in measuring social economic determinants to RETs adoption particularly for rural areas where formal income cannot be relied upon solely as a measure of wealth or lack thereof.

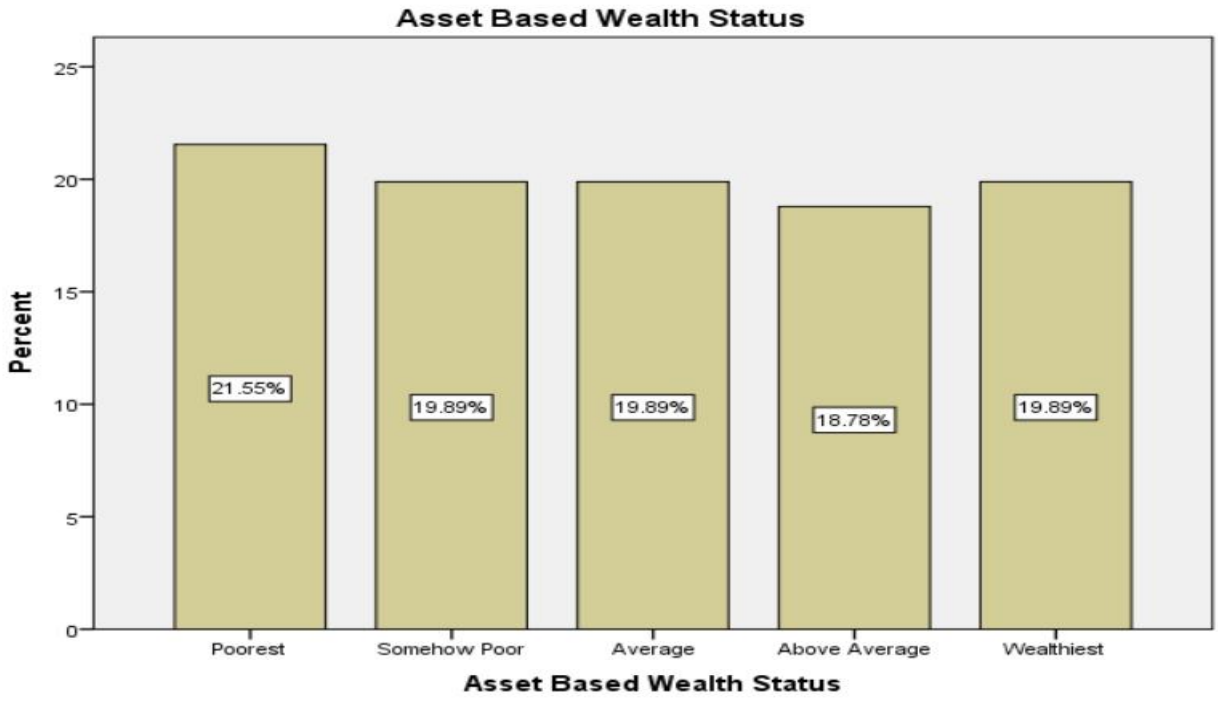

Figure 4.3 Asset Based Wealth Status Groups

Using the Asset based wealth measurement, it was clear that there was an almost even representation among the different asset-based wealth status groups. The poorest accounted for 21.55%, the Somehow Poor accounted for 19.89%, the Average stood at 19.89%, Above Average at 18.78% and the Wealthiest at 19.89% (Figure 4.3).

V. Status in Society (SS) / Leadership Position

According to Levy and Wyckoff (2014) holding position of leadership creates opportunities for acquisition of assets and information that might not be easily accessible to other households. As well Okuthe and Akotsi (2014) posits that, "households who have some position in any local organizations are more likely to be aware of new information and practices" (p202), where leadership is hypothesized as involvement of the respondents in any informal and formal organizations as a member and leader. Only 26.6% of households reported holding a position(s) of leadership in the society with the majority (74.4%) reporting not holding of any such position (Table 4.3).

Table 4.3 Positions of Leadership Held

Position of leadership in Community	*f*	Percent
None/ Ordinary Citizen	96	74.4

Other	9	7.0
Religious Leader	16	12.4
Village Elder	8	6.2
Total	129	100.0

Household heads held 67.6% of the leadership position followed by spouses at 23.5% with other household members covering the remaining 8.6%(Table 4.4).

Table 4.4 Family Member holding the leadership position

		f	Percent
Family Member	Head	23	67.6
	Son	2	5.9
	Spouse	8	23.5
	Uncle	1	2.9
	Total	34	100

VI. Socioeconomic Status

In order to come up with the Socioeconomic Status of the sampled households several steps were taken as outlined in operationalization of variables chapter (A3 Table 25). The average indexed socioeconomic status for the respondents was 1.825≠0.530 revealing that most of the respondents in Njoro sub-County have Low Socioeconomic Status (Table 4.5).

Table 4.5 Socioeconomic Status (SES) of Respondents

N	Mean	Std. Deviation
175	1.8257	0.53

From the results Miseipei ward had the highest average SES at 2≠0.49, followed by Njoro 1.83≠0.53 and Mukungugu 1.83≠0.49, with Sigotik trailing at 1.65≠0.56 (Table 4.6).

Table 4.6 Summary Average Socioeconomic Status per Ward

	Ward							
	Misepei		Mukungugu		Njoro		Sigotik	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation

SES	2	0.49	1.83	0.49	1.83	0.53	1.65	0.56

4.1.3 Occupation

Njoro sub-County is a predominantly agrarian community where majority of the sampled households practiced crop farming as their main occupation (53.63%), livestock farming accounted for 1.12%, dairy farming 0.56%, casual labour was the second most practiced income earning activity at 16.76%, salaried employment 8.94%, trading accounted for 3.35%, artisans accounted for 1.68%, while other income earning activities were 13.97% (Figure 4.4).

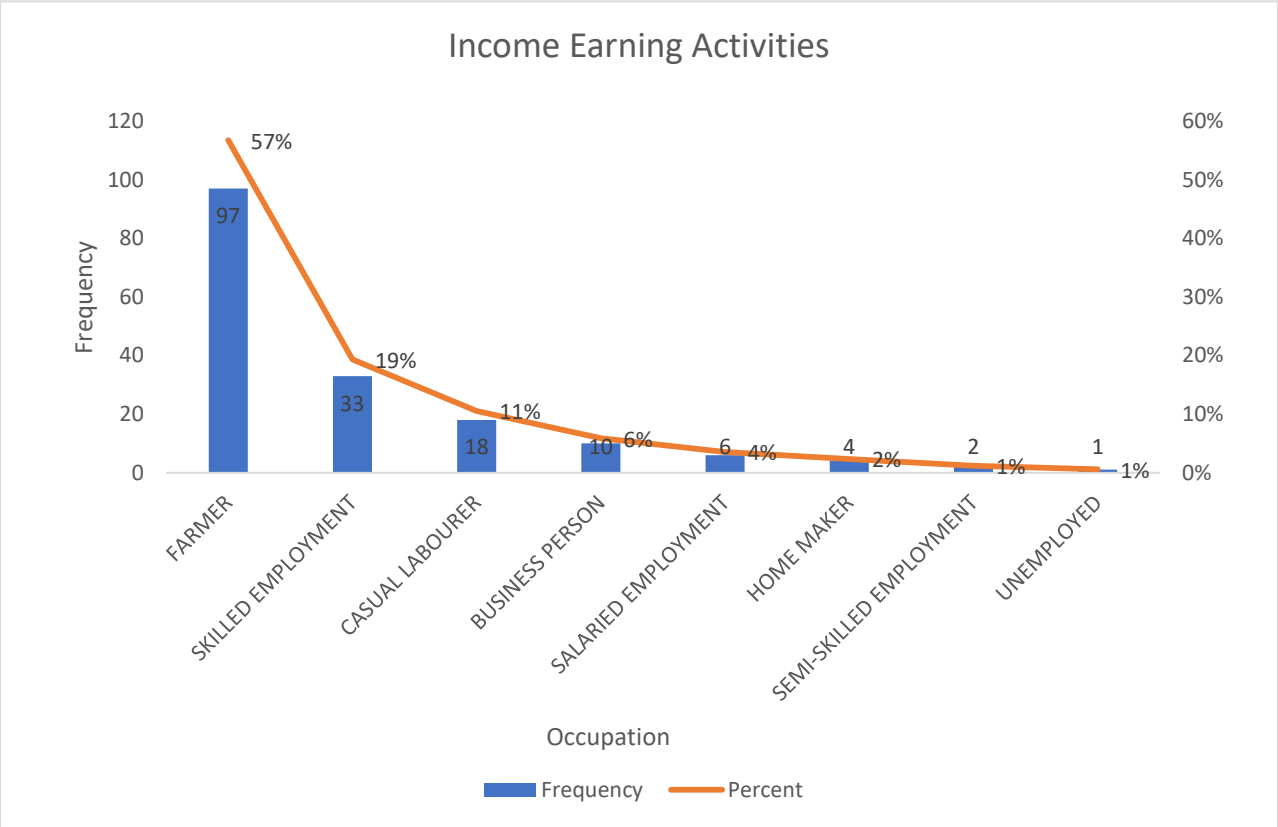

Figure 4.4 Income earning activities

4.1.4 Energy use patterns among households

Majority of the households surveyed utilised more than one source of energy to achieve the same purpose. According to Masera et al. (2000), this is known as fuel stacking whereby new cooking technologies are added but even the most traditional systems are rarely ever abandoned. The average number of energy sources used per household was four (4) with the most reported usage of energy sources being six (6) and the least at one (1). Firewood and

charcoal were used for cooking and heating interchangeably, but firewood was the most popular energy source with over 94% using it, 77% used agro-waste, 51% used charcoal, 1% sawdust, while kerosene use stood at 27% among the non-modern energy sources. Electricity was the most widely used modern source of energy with over 40% of households using it, solar home system use stood at 30% (Figure 4.5).

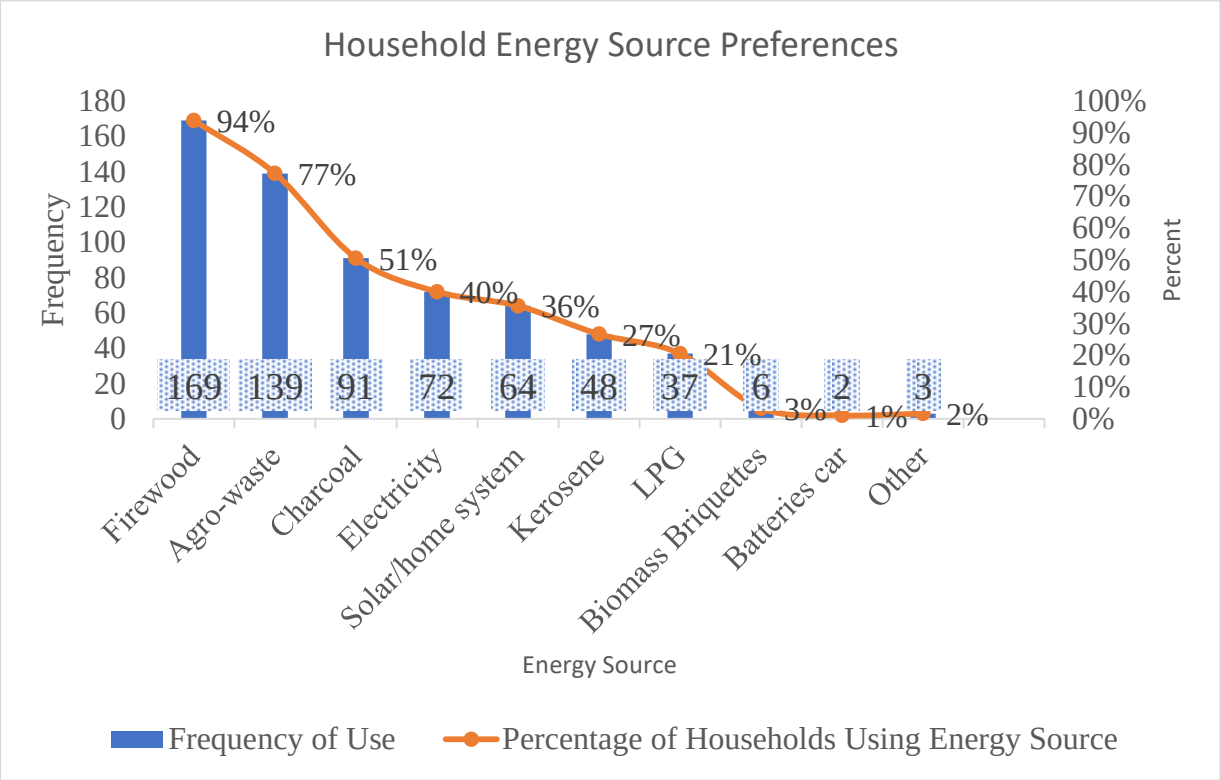

Figure 4.5 Household Energy Source Preferences

The main use for energy in the households sampled were Food Preparation, Heating, Lighting and powering radios. Going deeper into the secondary and tertiary energy usage for the different sources we see increased diversity such as powering radios and televisions (Electricity and Solar), charging phones (electricity and solar) as illustrated in Figure 4.6. From the results, use of RETs mostly favoured lighting and electrical equipment powering solutions other than cooking and heating (Figure 4.8), this is spread across primary and secondary energy use.

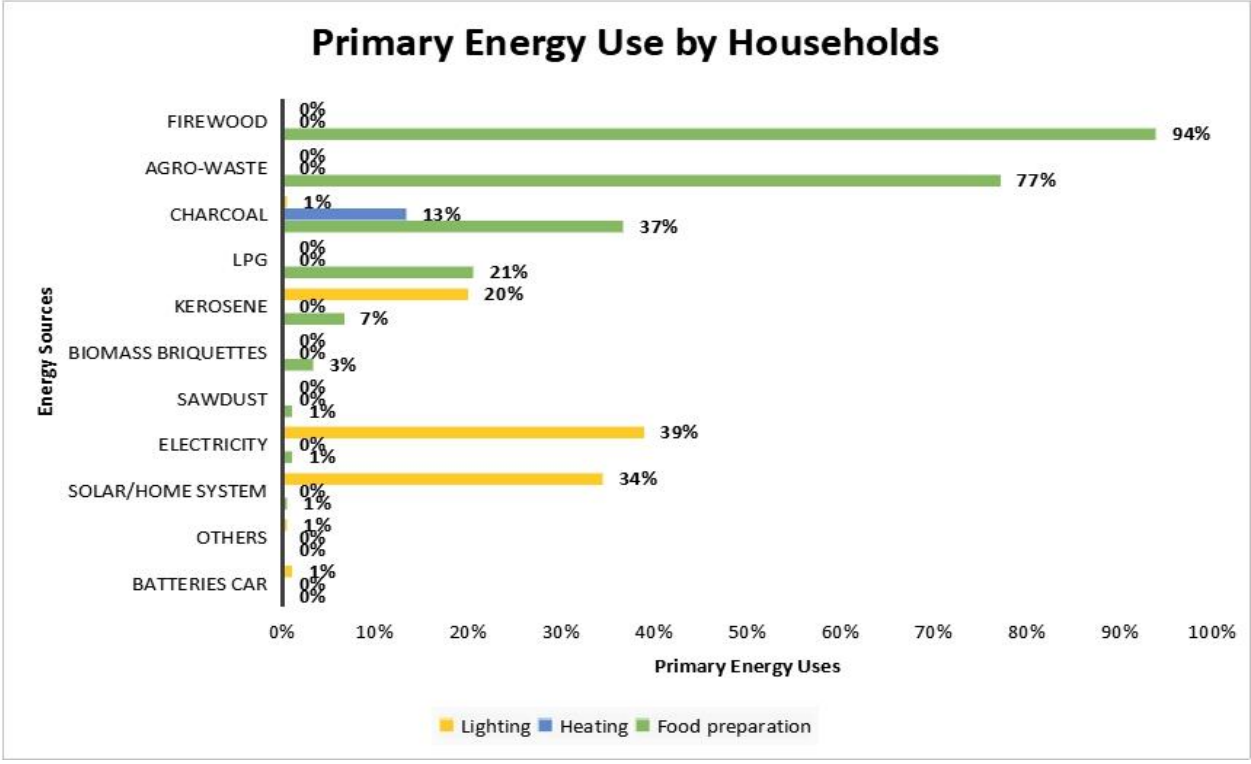

Figure 4.6 Primary Energy Use by Households

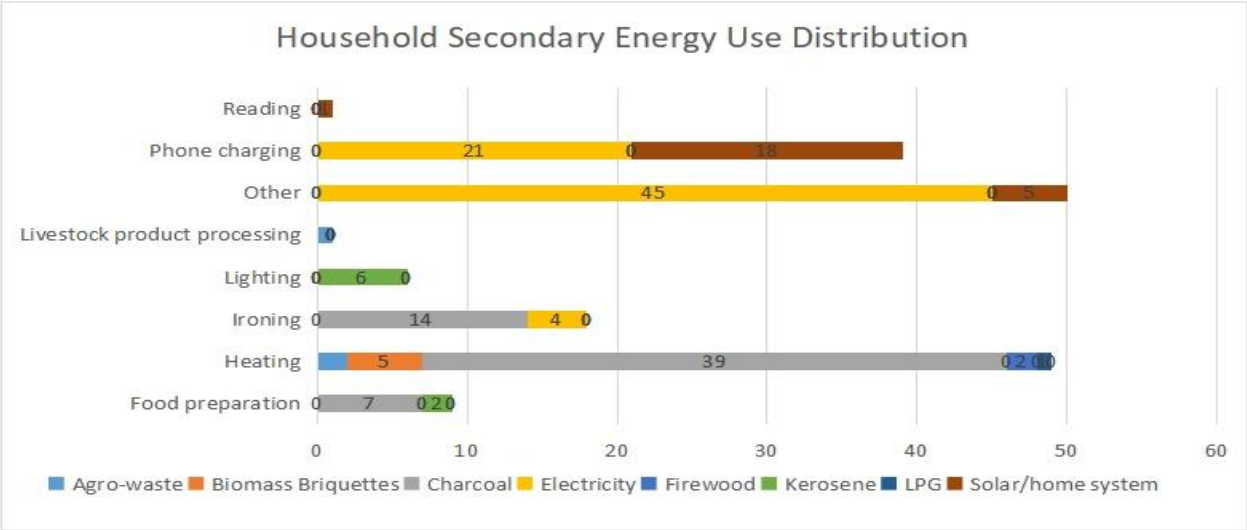

Figure 4.7 Secondary Energy Use by Households

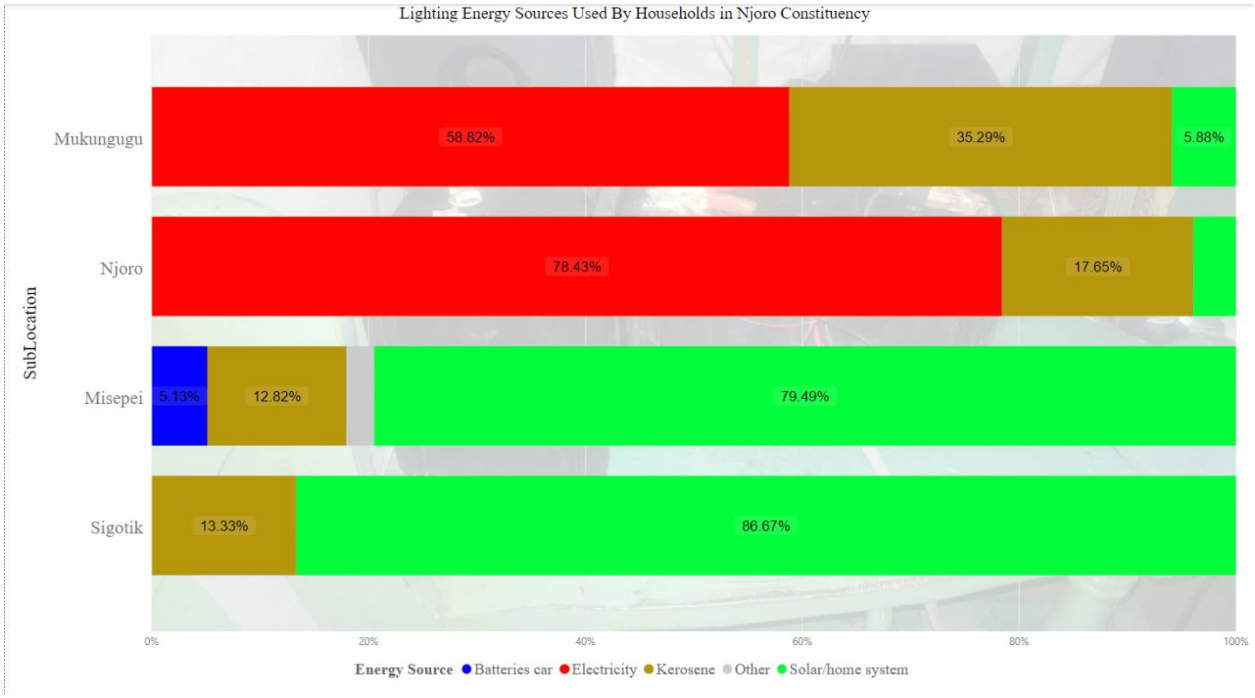

Figure 4.8 Lighting Energy Sources Used by Households

4.2 Level of Awareness of RETS

According to the Oxford Living English Dictionaries, Knowledge is "Facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject" while Awareness according to the same source is "the ability to directly know and perceive, to feel, or to be cognizant of events. More broadly, it is the state of being conscious of something". One of the objectives for the study is, 'to assess the level of awareness of households to the existence of alternative renewable energy technologies (RETs)'. Household awareness influencing adoption of RETs is defined in this study as the degree of knowledge and understanding (by the head of household) of the RETs and the benefits accruing from their use by the household. The researcher came up with 5 levels of awareness which as outlined in Table 4.7. Four distinct steps were taken to calculate the aggregate knowledge of RETs by the respondents. These steps are outlined in A3.2 Independent Variable: Household Awareness.

4.2.1 Aggregate Awareness Score

The aggregated score from Step 1 (***SRK***) + Step 2 (***RETlw***) + Step 3 (***RETwb***) +Step 4 (***RETwd***) was used to get the level of awareness according to the Household Awareness to RETs Index (Table 4.7).

Table 4.7 Household Awareness to RETS Index

DEGREE OF KNOWLEDGE AND UNDERSTANDING	WEIGHT

Very high Degree	5
High Degree	4
Moderate Degree	3
Low Degree	2
Trivial or no knowledge/understanding	1

Table 4.8 Household Awareness to RETS

Degree of Knowledge and Understanding	Frequency	Percent
Trivial or no knowledge/understanding	19	10.5
Low Degree	46	25.4
Moderate Degree	60	33.1
High Degree	49	27.1
Very High Degree	7	3.9
Total	181	100

The study revealed that a moderate to high degree of household awareness to RETS by the residents of Njoro Sub-County (Table 4.8), with the majority 33.1% possessing moderate degree of knowledge closely followed by 27.1% with high degree, 25.4 % having low degree, 10.5% having trivial or no knowledge and 3.9% with very high degree of knowledge (Figure 4.9).

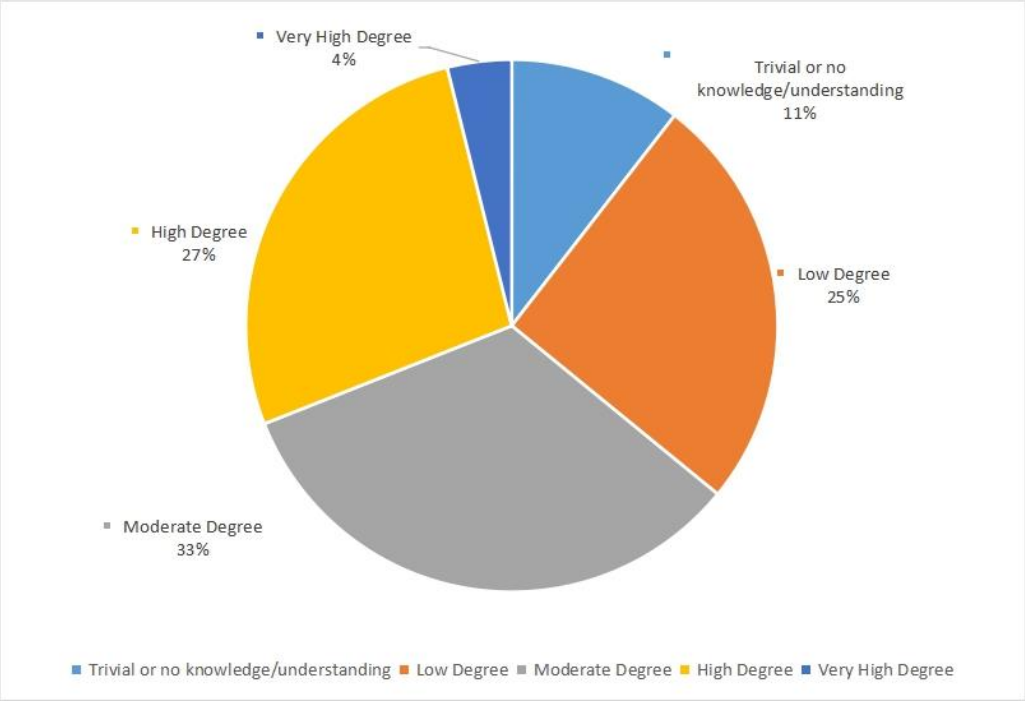

Figure 4.9 Household Awareness to RETs

From the results, Mukungugu residents had the highest awareness of RETS with a mean score of 3.596±1.184, followed by Misepei 2.974±0.764 and Sigotik 2.603±1.087 with Njoro trailing 2.598±1.305 (Table 4.9).

Table 4.9 Summary Household Awareness to RETS per Ward Mean±SD

	Ward							
	Misepei		Mukungugu		Njoro		Sigotik	
	Mean	Std Deviation	Mean	Std Deviation	Mean	Std Deviation	Mean	Std Deviation
Household awareness	2.9 74	0.764	3.5 96	1.184	2.5 98	1.305	2.6 03	1.087

4.2.2 Level of Awareness Discussion

The level of awareness of RETs was moderate to high although a significant portion was also shown to be of low to trivial understanding. The difference in awareness of RETs among the different wards in Njoro was not great. Knowledge of solar was the greatest while ICS and biomass briquettes were a distant second and third. Education level had a statistically significant effect on awareness of RETS. Although it accounted for a small percentage of the variance. Introducing RETs and climate change mitigation as part of the primary and secondary school curriculum could have a positive effect of knowledge of RETS. This is a big opportunity since the Kenyan government has greatly subsidized primary and secondary education through the universal free education program. Gender was shown to have a significant impact on RET awareness. Women were shown to have lower awareness compared to their male counterparts. Greater awareness creation for RETs should focus on women. Since it was shown that only gender had a significant impact on both RET awareness and adoption. Women seem to be the key to higher RET adoption rates in society and literature supports this conclusion.

4.3 Adoption of RETS

The field of renewable energy technologies has been broadening with new technologies being developed to increase efficiency and reduce costs, (both in acquisition and usage). With the ravages of climate change already evident, such technological advancements should no longer be viewed as optional but necessary.

Adoption of RETS in this study mainly centred on the use of ICS, Solar, Biomass Briquettes and other RETs. From the energy use background information of the respondents, it is clear to that a variety of energy sources are used by the households. This is clearly

reflected in the literature review where majority of households in rural areas in Kenya are reported to utilise firewood and charcoal as their main source of energy for cooking.

4.3.1 RET Adoption Scores

As outlined in the Appendix 3 Operationalisation of Variables, the researcher used the steps to calculate the RET adoption level of the households in Njoro Sub-County. From the results obtained, majority (35.4%) of the households in Njoro sub-County had Trivial or Not Adopted RET closely followed by Moderate Extent of Adoption (34.3%) and lastly Little Extent of Adoption (30.4%), no household reported High Extent or Very High Extent levels of adoption (Table 4.7).

Table 4.10 RET Adoption Level

		Frequency	Percent
Valid	Trivial or not adopted	64	35.4
	Little Extent	55	30.4
	Moderate Extent	62	34.3
	Total	181	100.0

Miseipei had the highest level of adoption among all the sampled locations with an average score of 2.63 with Sigotik and Mukungugu scoring 2.44 and 0.94 respectively, Njoro had the lowest score at 0.30 (Figure 4.10). Looking at the geographical positioning of the sublocation, such a distinct difference in adoption levels is not unexpected. From the earlier observation where the RETs use by households was mostly associated to use of solar for lighting and powering of electrical equipment and less to do with heating and cooking, then Njoro which was observed to have the greatest access to grid electricity (Figure 4.8) had the lowest rate of RET adoption, while Miseipei had the highest.

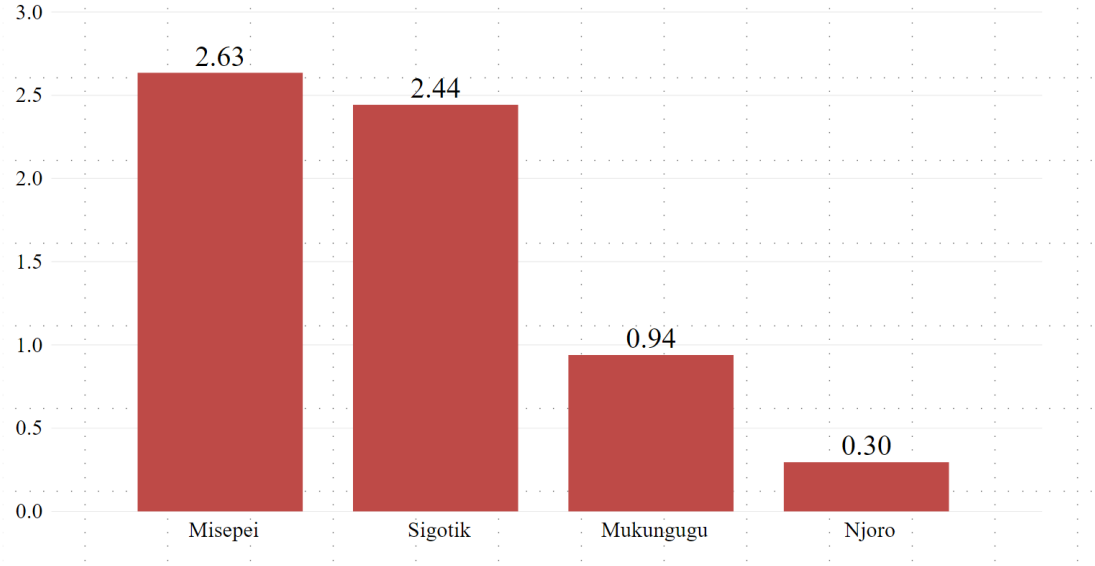

Figure 4.10 RET Adoption Score by Sub location

4.3.2 Socioeconomic Variables that Influence Adoption of RETS

The socioeconomic variables discussed in Chapter 4.1.2 were used to investigate adoption trends.

Table 4.11 RET Adoption Significant Correlations

		RET Adoption Level	Age	Status in Society	Gender
RET Adoption Level	Pearson Correlation	1	-.394**	.226**	.172*
	Sig. (2-tailed)		.000	.002	.021
	N	181			
Age	Pearson Correlation	-.394**			
	Sig. (2-tailed)	.000			
	N	178			
Status in Society	Pearson Correlation	.226**			
	Sig. (2-tailed)	.002			
	N	181			

Gender	Pearson Correlation	.172*
	Sig. (2-tailed)	.021
	N	181

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

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

From the results, Gender, Age and Status in society were shown to have significant effect on the adoption of RETS (Table 4.11).

I. Gender and RET Adoption

From the data, gender was shown to have a significant impact on RET adoption in Njoro Sub-County where women were shown to have higher RET adoption levels compared to men (Figure 4.11). According to Chukuezi (2009) and Okuthe and Akotsi (2014), women are typically burdened with household duties such as cooking, cleaning and caring for the young, therefore would also be most motivated to adopt RETs which have a direct impact on the day to day activities. Men on the other hand are much further removed from household duties and are mostly engaged in activities such as farming, casual jobs and construction and might not grasp the immediate need to adopt RETs.

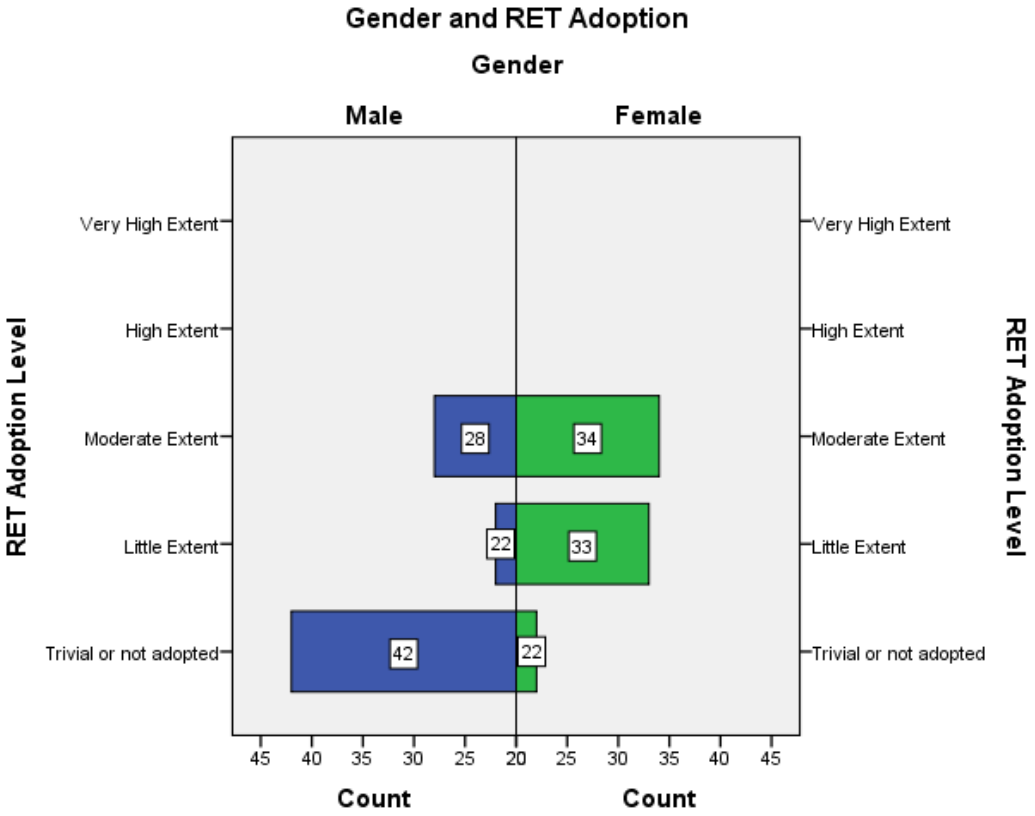

Figure 4.11 Gender and RET Adoption

II. Age and RET Adoption

Age had a significant impact on adoption where the older age groups were shown to have lower levels of adoption compared to younger ones (Figure 4.12). This is supported by Okuthe and Akotsi (2014) who had presented two arguments, the first one stated that older generations due to having more worldly experience would be more likely to adopt RETS compared to younger generations while the second argument posited that older generations are more risk averse and conservative in adopting new technologies as compared to younger generations. The findings in this study support the latter assertion. The findings are also supported by Willis et al. (2011) who found that older generations (>65) were less likely to replace existing technologies with more capital demanding renewable technologies such as solar. This is a point to contend with considering that rural areas in Kenya have a predominantly ageing population.

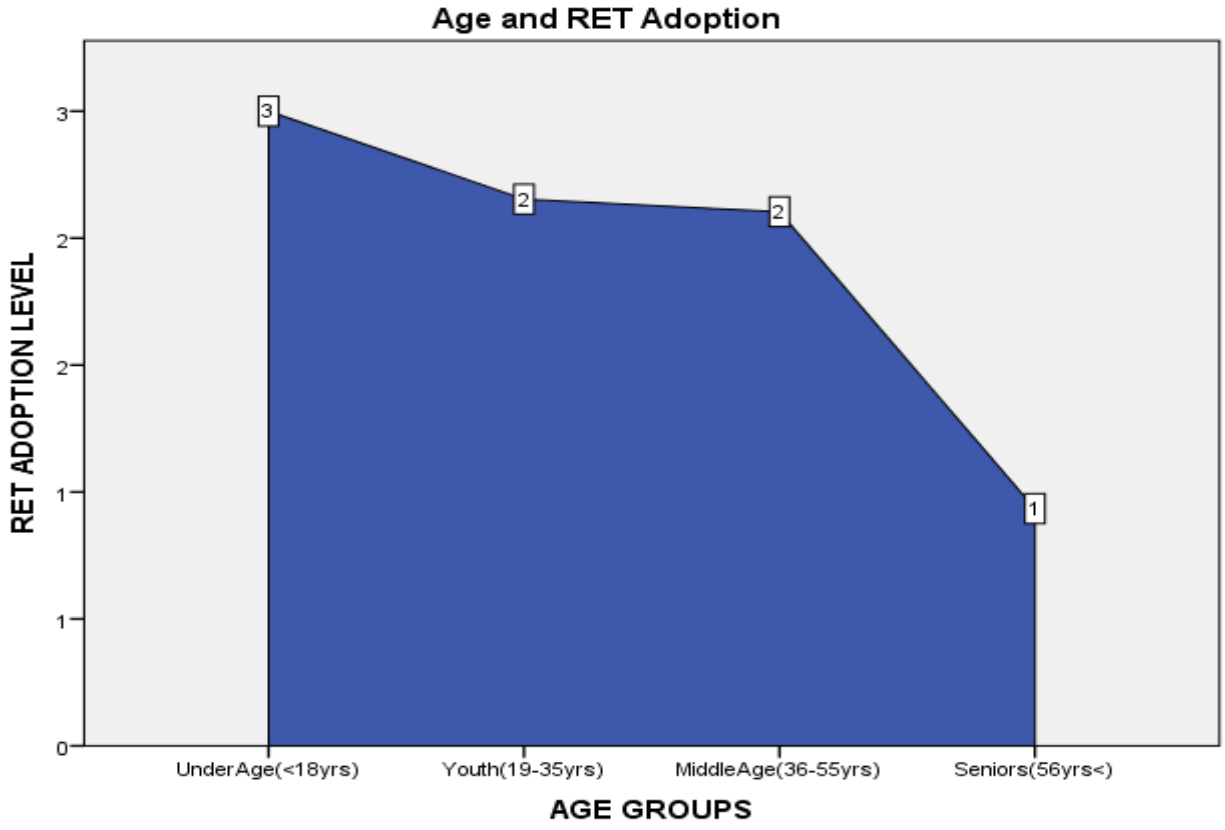

Figure 4.12 Age and RET Adoption

III. Status in Society and RET Adoption

The study findings indicate that status in society/ leadership position has an impact on RET adoption (Table 4.7). Those with higher leadership positions were shown to have higher rates of adoption (Figure 4.13). This is expected, due to their roles and responsibilities,

leaders are more likely to be the first people to come into contact with new technologies. Moreover, positions have the added advantage of granting them access to novel information. As well, the majority of people in leadership exhibit extraversion. Extraversion as a personality trait has been shown to be a significant precondition for being a leader in society (Paunonen, 2003), in a meta-analysis of the relationship between personality and leadership emergence and effectiveness, Judge et al. (2002) found that extraversion is "the most consistent correlate of leadership across study settings and leadership criteria"(p365). The extraversion personality trait has been has been shown to have a strong influence on adoption of new technologies among different cultures and societies (Sriyabhand & John, 2014).

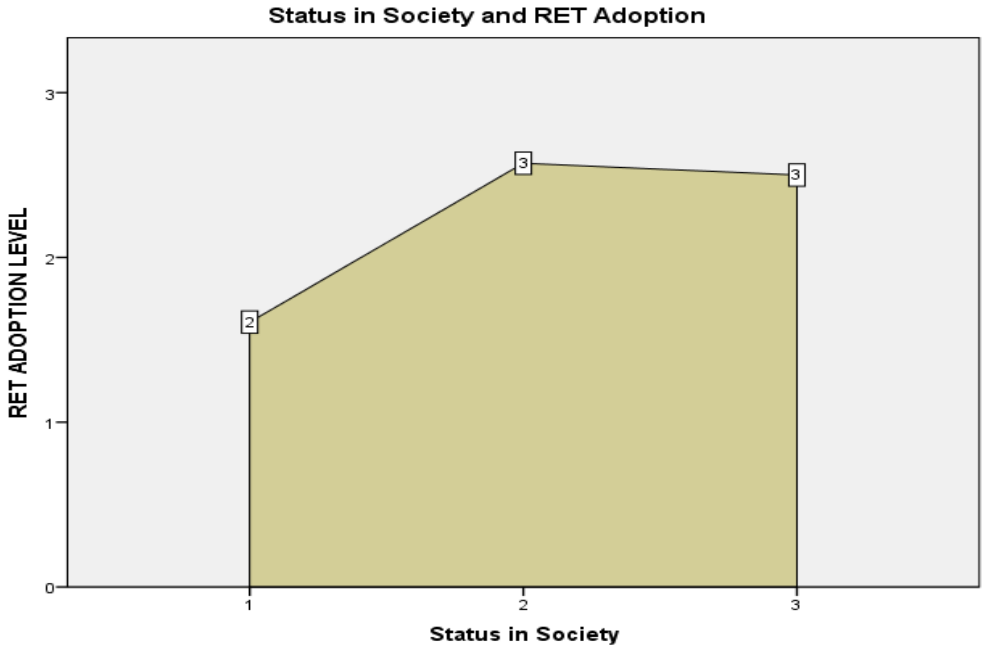

Figure 4.13 Status in Society/ Leadership position and RET Adoption

4.3.3 Level of Awareness and RET Adoption

From the results, there was no significant relationship between RET adoption and Awareness. The current literature however, paints a different picture, Acheampong et al. (2018) showed that awareness of a technology influenced its adoption and went ahead to conclude that awareness creation and education of the improved technologies will encourage adoption. Two arguments could be forwarded to explain the current situation, as it was observed the active awareness score by the residents of Njoro sub-County was quite low, too low to prompt significant change in behaviour that would see adoption of RETs. The second presupposition related to the influence of gender on RET adoption, women were observed to be more likely to adopt RETs, however, when it came to awareness, women were less likely to be knowledgeable about RETs compared to men (Table 4.13). The two situations

combined create an instance where the most knowledgeable group is also the least likely to adopt which could bring about the results observed. Gender has been selected since it is the only variable that has significant impact on both RET adoption and RET awareness (Table 4.12).

Table 4.12 Determinants of Household Awareness to RETS

		Household awareness to RETs	Age	Gender
Household awareness to RETs	Pearson Correlation	1	.029	-.151*
	Sig. (2-tailed)		.699	.042
	N	181	178	181
Age	Pearson Correlation	.029		
	Sig. (2-tailed)	.699		
	N	178		
Gender	Pearson Correlation	-.151*		
	Sig. (2-tailed)	.042		
	N	181		

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

Table 4.13 Gender and Household Awareness to RETS

Gender		N	Mean	Std. Deviation	Std. Error Mean
Household awareness to RETs	Male	92	3.058	1.338	0.140
	Female	89	2.715	0.857	0.091

4.3.4 RET Adoption Discussions

RET adoption was quite low in Njoro sub-County and it was found that, status in society, gender, and age were the main influencers. Those in leadership have access to more information and exposed to more technologies compared to ordinary member so of society. Women were more likely to adopt RETs compared to men. This is not surprising, it is women who take care of household affairs and even carry the burden of caring for the sick in the household (from the reviewed literature it has been shown that indoor air pollution causes acute lower respiratory illnesses). Therefore, women stand to benefit the most when it comes to adoption of RETs and this is reflected in the higher adoption rates. Empowering women in rural communities is a great way to improve RET adoption. More women should be availed opportunities in leadership, it stands to reason that combining the two would result in much higher adoption rates.

As well, the youthful population had higher RET adoption rates compared to older generations. This is expected as young people are open to change and are willing to take risks which extends to adoption of new technologies. However, most young people do not have access to resources. The youth need to be empowered to see higher RET adoption rates. Just like women, the youth need to involve in leadership in society, this would see higher rates of RET adoption.

4.4 Policy Framework and RET Adoption

Kenya's Renewable Energy Policy landscape has shown significant progress in the period which this review study covers i.e. 1999-2019, the country has enacted several policies, regulations and acts that are geared towards green energy development some examples being; The Environmental Management and Control Act 1999(Amended 2015), The Energy Act 2006, the Kenya Green Economy Strategy and Implementation Plan 2016 and others. The country seeks to be a leader in renewable energy generation and usage, with several large scale solar and wind plants commissioned in a bid to reduce greenhouse gas emissions by 30 percent by 2030 as well as reduce grid energy costs to make industry more competitive (Bounagui, 2015), which are spelled out in the Nationally Determined Contributions (NDC) (Ministry of Environment and Mineral Resources, 2015).

Kenya's energy sector relies on three main sources of energy, biomass, petroleum and electricity, at 68%, 21% and 9% of total energy consumption respectively (Kenya Institute for Public Policy Research and Analysis (KIPPRA), 2010). According to the latest official figures, Biomass constitutes the largest source of energy consumed in Kenya in the form of wood fuel and charcoal, with over 80 percent of Kenyans burning solid fuel for cooking and

heating (Ministry of Planning and National Development Kenya, 2005). Majority of biomass users are poor households in rural areas, apart from poor rural households, biomass is also used by small business, principally kiosks and restaurants within urban centres. This is no surprise considering that over the past two decades Kenya has seen a dramatic growth in the economy with disproportionately high levels of inequality with distribution of wealth largely skewed favouring urban dwellers where rural economies continue to lag. Rural households, being deprived of essential services such as access to education, clean water and sanitation, deepen poverty and reduces people's well-being. This deprivation also extends to energy and energy options available to such households. With demand for energy in Kenya increasing faster than available supply (Githiomi & Oduor, 2012) , primary sources of energy are becoming scarce leading to a depletion of natural resource capital perpetuating vicious cycles of poverty and environmental degradation (Karekezi, 2002).

The incomplete combustion of solid and biomass fuels generates smoke and other volatile gases which have hazardous effects on human health, with risk of getting both acute and chronic disease and increased risk of death. The WHO estimates that 4.3 million premature deaths were due to exposure to household air pollution in 2012 alone (WHO, 2016).

Despite such worrying statistics, Kenyan government's promotion of clean cooking and biomass technologies, as compared to other forms of energy, has been modest at best. Budgetary outlays from 2008 to 2016 having very little to do with promoting clean cooking and biomass, with the most expenditures concentrated on energy infrastructure. This has inadvertently led to low adoption of such renewable energy technologies, which are clean and help eliminate indoor air pollution, by rural households.

The purpose of the policy framework analysis was to undertake a situational examination of the Energy sector in Kenya with a specific view of probing the national energy policy, strategy and plans and their progression as they relate to adoption of renewable energy technologies in biomass and clean cooking. The end goal being to determine the influence of institutional framework on the adoption of Renewable Energy Technologies (RETs).

4.4.1 Acts, Policies and Regulations

I. The Environmental Management and Coordination Act of 1999 (EMCA)

The Environmental Management and Coordination Act of 1999 (Amended 2015) set the stage for environmental conscious thinking in policy and planning in Kenya. The general welfare and health of the environment and the people are given centre stage. This

inadvertently made control of pollution through energy and emissions to be under review by assigning definite rights and privileges in clean environment to citizens in environment. The National Environment Management Authority (NEMA) was hence forth established to regulate all matters that appertains to the environment, the EMCA formed a prelude to more concise and targeted policies that focused on clean environment and public welfare (*The Environmental Management and Co-ordination Act, No.8 of 1999*, 1999). Though the act does not explicitly mention biomass and clean cooking, it nonetheless formed a prelude to more detailed legislation such as Sessional Paper No. 4 which is covered in a later chapter within this text.

II. Economic Recovery Strategy (ERS) covering the 2003-2007 period

For the Economic Recovery Strategy (ERS) of 2003-2007 to be envisioned, Kenya's economy had stagnated for over two decades prior, leading to deterioration in the quality of life of Kenyans (Government of Kenya, 2003). ERS pays particular attention to promoting actions leading to the sustainable management of natural commons such as land, water, forests to which the very poor depend on. The ERS notes that energy is a critical driver of development and the then energy policy objectives emphasized the need for availability and accessibility at cost-effective prices, and in support of sustainable socio-economic development while protecting and conserving the environment. The document further stresses the role of the Government in formulating a comprehensive energy development policy and reform programme embracing all sources of energy, especially renewable ones aimed at fulfilling the energy policy objectives.

In relation to biomass and clean cooking,

i. Wood fuel and charcoal are identified as the main energy sources for cooking and lighting used by the poor people putting tremendous pressure on forest resources. The ERS recognizes that further measures need to be enacted to address environmental challenges that continue to face the country especially finding alternative and affordable energy sources for the rural and urban poor.

ii. Access to liquid petroleum gas (LPG) prior to the ERS was very low. The document forwards the recommendations of a prior study on an appropriate legal and regulatory framework to enforce standardization of LPG cylinders, gas regulators and valves to allow flexibility of usage, to be incorporated in the Petroleum bill.

III. Sessional Paper No. 4 of 2004

The Sessional Paper No. 4 of 2004 is the single policy document that cements the liberalization reforms in the energy sector in the mid-1990s. The objective of the

liberalization was to separate policy function with the regulatory and commercial functions. It unbundled the then vertically integrated utility Kenya Power and Lighting Company into the public sector generation company (KenGen) and the transmission and distribution company (KPLC). It also allowed entry of Independent Power Producers (IPPs) into commercial energy generation.

As part of the liberalization of the Energy Sector, Sessional Paper No.4's vision was to promote equitable access to quality energy services at least cost while protecting the environment. The paper therefore lay the policy framework upon which cost effective, affordable and adequate quality energy services will be made available to the domestic economy on a sustainable basis over the period 2004-2023 (Institute of Economic Affairs(IEA), 2015).

Sessional paper No. 4 of 2004 aimed at promoting energy efficiency. The policy outlines different energy options from petroleum to renewable energy. The broad objective of the policy as outlined is/was to ensure adequate, quality, cost effective and affordable supply of energy to meet development needs, while protecting and conserving the environment (Ministry of Energy, 2004). The policy affirms the role of IPPs in enhancing competition in energy generation and therefore drive energy generation costs down. There is a clear intention to have Kenya's energy landscape to be environmentally friendly.

Under renewable energy, its purpose is "to encourage the wider adoption and use of renewable energy technologies and thereby enhance their role in the country's energy supply matrix, Government will design incentive packages to promote private sector investments in renewable energy and other off-grid generation" (Ministry of Energy, 2004).

The policy clearly has a plan for biomass and cooking options. It recognizes the role of biomass and cooking on the energy landscape of urban and rural Kenya. The government commitment to ensure positive uptake and capacity building in sustainable charcoal production and improved cook stove production is considered and the identification of stakeholders in the sector is evident.

For the most part, the policy is well defied in its articulation of clean cooking and biomass, but some weakness observed include policy assumption would be the identification of kerosene as a clean energy source which is inconsistent with research finding which have proven that kerosene is not only a health but also a safety hazard (Lam et al., 2012).

IV. The Energy Act, 2006

The Energy Act of 2006, consolidates all laws relating to the energy sector in Kenya, its basis is the Sessional Paper no. 4 of 2004 which provided for further liberalization of the

energy sector (Institute of Economic Affairs(IEA), 2015).The Act recognizes renewable energy technology and gives the Ministry of Energy the mandate to promote their development. The Ministry of Energy is given the task of developing frameworks to govern the development, promotion and distribution of such technologies

Although the Act is not explicit in its mention of biomass and clean cooking, these technologies are covered under the broad definitions of renewable energy technologies where the Ministry of Energy is empowered to exercise functions with the goal of enhancing energy efficiency and conservation through, but not limited to;

(a) Making, in consultation with the Kenya Bureau of Standards, requirements for the particulars to be displayed on labels on equipment or on appliances;

The Kenya Bureau of Standards has published several standards that cover cooking and biomass technologies which are updated albeit infrequently *(*A4 Table 1*).*

(b) Taking all measures necessary to create awareness and for the dissemination of information for efficient use of energy and its conservation;

The Ministry has frequently partnered with many private companies to promote improved cookstoves (Ndegwa et al., 2010), a recent partnership was with Burn, the company behind *Jiko Okoa* ^{TM}. Other partnerships not necessarily under biomass and clean cooking but on renewable energy technologies include MKOPA Solar, a pay as you go solar home system that has become very popular in Kenya.

(c) Strengthening consultancy services in the field of energy conservation;

The Government of Kenya has partnered with the Kenya Association of Manufacturers (KAM) to form the Centre for Energy Efficiency and Conservation (CEEC) which champions energy efficiency and conservation efforts in Kenya. The CEEC was to continue where the United Nations Development Programme Global Environmental Facility-Kenya Association of Manufacturers (UNDP-GEF-KAM) project had ended; mainly to undertake on behalf of the Ministry – energy audits in mainstream industries, small and medium enterprises (SMEs) and public institutions, capacity building in energy efficiency and conservation, public education and awareness activities as well as administer the Energy Management Awards (EMA) annual events.

(d) Promoting research and development in the field of energy conservation;

The Kenya Forest Research Institute conducts research and development of technologies for utilization of wood and non-wood forest products. Some technologies include, briquetting machine, improved charcoal kilns and improved cookstoves.

(e) Formulating and facilitating implementation of pilot projects and demonstration projects for promotion of efficient use of energy and its conservation;

Through the Kenya Forestry Research Institute (KEFRI), demonstration sites for efficient use of biomass energy through showcasing technologies such as briquetting machines, improved charcoal kilns and improved cookstoves. Through the National Environment Trust Fund (NETFUND) the government has also promoted the renewable energy through investing in businesses and start-ups promoting the same.

(f) Giving financial assistance to institutions for promoting efficient use of energy and its conservation;

The Ministry of Energy and Petroleum and The Ministry of Environment have established the Climate Fund which has seen various projects under clean energy and clean cooking financed and accelerated.

(g) Supporting the preparation of educational curriculum on efficient use of energy and its conservation for educational institutions, and coordinate with them for inclusion of such curriculum in their syllabus;

Several curricula are already accepted by the Kenya Institute of Curriculum Development covering energy and energy conservation. While the National Industrial Training Authority (NITA) has authorized several short certification courses on renewable energy technology such as briquette production, solar lantern assembly, most of which are conducted by local and international NGOs.

(h) Implementing international co-operation programmes relating to efficient use of energy and its conservation; and

Various civil society organization and international NGOs have received government backing in promoting clean cooking technologies, some projects include Kenya Off grid Solar Access Project (KOSAP) financed by the World Bank whose main objective is to increase access to modern energy services in underserved counties of Kenya, the Energising Development (EnDev) Kenya project financed by various international development partners. EnDev Kenya focuses on stoves and solar power.

(i) Giving financial incentives for any investment made to replace or install additional capital investments to improve energy efficiency;

The Kenya Investment Authority (KenInvest) has a specific investment portfolio options for investors (both local and foreign) willing to venture into the Kenyan Energy sector. These packages are pegged on increasing power generation and energy efficiency. As well, the

Centre for Energy Efficiency and Conservation (CEEC) offers energy efficiency advisory services.

(j) Making it mandatory, in collaboration with Kenya Bureau of Standards, the importation of energy efficient but cost-effective technologies.

The Kenya National Bureau of Standards is currently developing a Biomass and Cookstoves Standards, it is working with the Clean Cooking Alliance Kenya (CCAK) to disseminate the DKS_1814_2019_Public Review and Adoption Proposal.

V. Kenya Vision 2030

Vision 2030 main objective is to help transform Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment. Energy forms one of the infrastructural enablers of the three "pillars" of Vision 2030. Although there is no explicit mention of biomass and clean cooking, the document nonetheless notes that at the national level, wood fuel and other biomass account for about 68% of the total primary energy consumption, followed by petroleum at 22%, electricity at 9% and others including coal at about less than 1% % (Government of Kenya, 2008). It appreciates the role of wood fuel in providing energy needs of the traditional sector including rural communities and the urban poor. Some notable consideration would be the objective of making LPG cheaper and more accessible to Kenyans.

VI. Kenya National Climate Change Response Strategy (2010) - Carbon Neutral Energy Development Plan

The Kenya National Climate Change Response Strategy (NCCRS) was developed in 2010 by the Minister for Environment and Mineral Resources (MEMR). The NCCRS was a culmination of various stakeholder engagements involving government, civil society, ordinary citizenry, academia, and other sector players in identifying drivers and developing strategies in climate change management. The strategy recognizes demand for energy as one of the main drivers of deforestation and land degradation in Kenya, where final delivered biomass energy accounts for 78% of all energy consumed (Ministry of Environment and Mineral Resources, 2010).

The most significant milestone in the NCCRS was the assignment of specific management/ mitigation measures to institutions and costing them (Figure 4.16). This gave definite purpose and responsibilities to identified sector players making the monitoring and evaluation of progress measurable (Ministry of Environment and Mineral Resources, 2010).

As with other policy documents covered in this discussion, the NCCRS also appreciates that Kenya predominantly depends on biomass energy, which is comprised mainly of

firewood, charcoal and agricultural waste. Under biomass and clean cooking, the NCCRS forwards various climate change adaptation and mitigation interventions;

(i) Encouraging agroforestry which will enable poor rural households to meet their subsistence and energy needs,

(ii) Promoting alternative energy sources, energy conservation initiatives, and efficient charcoal production and utilization technologies to reduce biomass consumption

(iii) Involving forest-dependent rural communities in forests management through a proper institutional framework that recognizes and defines their role. This will enable them benefit from REDD+ activities which require community involvement in forests management

(iv) Promoting the use of alternative renewable energy such as solar, biomass, wind, biofuels, and

(v) Promoting efficient firewood cook stoves, solar and LPG cookers, with the government addressing the issues of costs through giving subsidies or tax waivers to poor households.

(vi) Accelerate the development of green energy including wind, solar and renewable biomass through investment in renewable biomass energy including biofuels and sustainable charcoal, particularly in the ASALS.

The NCCRS also covers research and development (R&D) as important not only in understanding the causes, manifestations and impacts of climate change, but also in responding to it. It further posits that research focusing on technological development plays an important role in preparing a low carbon society of the future by improving existing climate-friendly technologies and developing new ones. Under Energy R&D in relation to biomass and clean cooking the following measures are mentioned;

(i) Promoting development, commercialization and widespread utilization of renewable energy technologies

(ii) Promoting research into efficient methods of conversion of wood and agricultural waste (coffee husks, used tea leaves, etc.) Into commercially useful forms of energy, and

(iii) Promoting research on improved kilns and ‘jikos’ for the production and use of charcoal respectively that will reduce biomass consumption while generating the same amount of energy

The NCCRS shows concrete intention by the government in promoting biomass and clean cooking technologies. The role of biomass and clean cooking technologies in mitigating and adapting to climate change is appreciated and not over shadowed by larger scale and more recognized renewable energy technologies such as off-grid solar, biofuels, and biogas. As

observed earlier the NCCRS has a framework for implementation and specific Ministry of Environment and Mineral Resource directories are tasked with specific responsibilities in partnership with other stakeholders (Figure 4.14).

Sector	Sub-Sector	Description of Specific Activities	Implementing Institutions	Implementation Timeframe	Resource requirement per year (Billion Ksh.)
Physical Infrastructure and service industry	**Energy**	Accelerated development of geothermal power by the government and its development partners	GDC, KENGEN, Min. of Energy, devt. partners	10 years	20.3
		Accelerated development of geothermal power by the private sector (GDC will take up if there are no suitable investors)	IPPs	10 years	12.1
		Accelerated development of green energy (solar, wind, renewable biomass, etc) by the govt. and its devt. partners	GDC, KENGEN, Min. of Energy, devt. partners	5 years	15
		Accelerated development of green energy (solar, wind, renewable biomass, etc) by the private sector	IPPs	5 years	22.5
		Provision of efficient (fluorescent) bulbs to domestic consumers	Min. of Energy, KPLC, development partners, private sector	10 years	0.36
		Water catchments protection programmes e.g. afforestation	KPLC, MOE, Private sector, development partners	10 years	0.375
		Provision of improved jikos	Min. of Energy, Private sector, devt. partners	10 years	0.075
		Promotion of low-end solar devices including solar drip irrigation, solar water heating, etc	Min. of Energy, Private sector, devt. partners	10 years	3
	Subtotal				***73.71***

Figure 4.14 Snapshot Action Plan and Costs (NCCRS 2010)

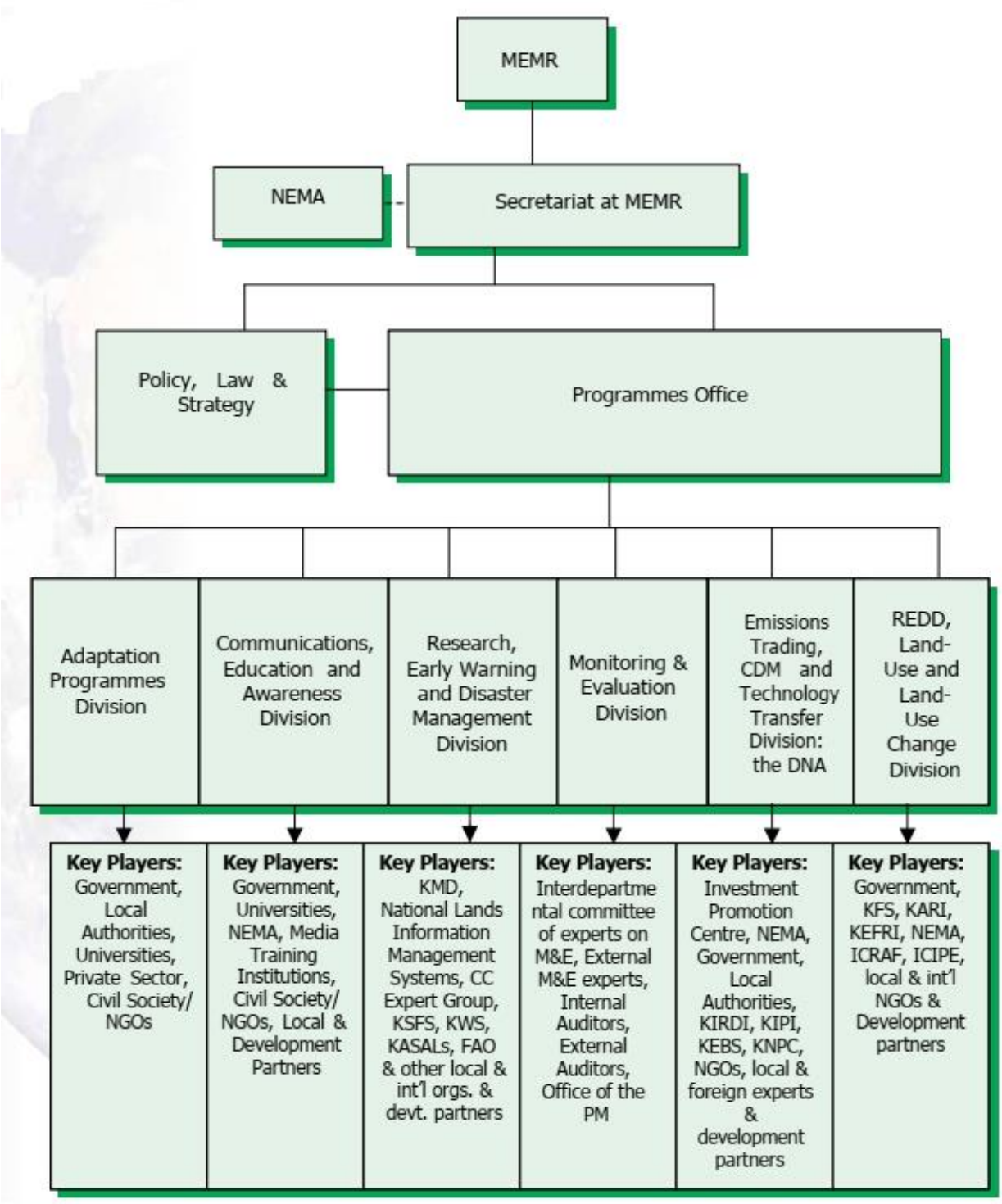

Figure 4.15 Proposed Climate Change Governance Structure (NCCRS 2010)

VII. Draft National Energy and Petroleum Policy (2015)

The Draft National Energy and Petroleum policy (2015) builds upon The Energy Act (2006) and borrows heavily from the NCCRS previously covered. The Policy's overall objective is to ensure sustainable, adequate, affordable, competitive, secure and reliable supply of energy to meet national and county needs at least cost, while protecting and

conserving the environment. Different from previous Legislation on Energy, the policy forwards a comprehensive and detailed deconstruction of various energy sources, their background, challenges, policies and strategies on how to promote them.

In addition, the Policy appreciates cross-cutting issues as they relate to energy availability and affordability. This critical analysis not only gives a clear picture of Kenya's energy scene but also shows definite future plans and implementation calendar.

The Policy identifies biomass as one of the key renewable energy sources and the largest source of primary energy in Kenya with wood-fuel (firewood and charcoal) accounting for about 69% of the total primary energy consumption. Where around 55% of it is derived from farmlands in the form of woody biomass as well as crop residue and animal waste and the remaining 45% is derived from forests. It goes further to expound on the challenges facing biomass use in Kenya, key being unsustainable use leading to negative environmental impacts. All the strategies mentioned are important and critical for the success of having sustainable biomass use in Kenya. The following are worth mentioning in the greater consideration of biomass and clean cooking;

i. Promote efficient conversion and cleaner utilization of biomass energy.

ii. Promote the use of biomass briquettes as alternatives to wood fuel.

iii. Provide incentives for private sector participation in conversion of waste to energy initiatives to reduce overreliance on Biomass energy

iv. Undertake public sensitization and awareness programmes to enhance participation in the management, protection and conservation of the environment as provided for in Article 69 (d) of the Constitution.

v. Promote alternative sources of energy and technologies such as LPG, biogas and solar as substitutes for biomass.

vi. Undertake and promote Research, Development and Dissemination (RD&D) of biomass energy technologies.

The policy recognizes environment, health and safety importance of cooking by proposing the "Support and promote conversion of cook stoves to uptake modern and clean fuels in households and institutions" (Government of Kenya, 2015) as part of the policies and strategies.

The Policy has dedicated a section on Household Energy Consumption Patterns. It identifies the two main models in clean cooking energy adoption i.e. The Energy Ladder Model and the Fuel Stacking Model, which attempt to explain why households' use different kinds of fuel for cooking. The fuel ladder model shows that as people become richer, they

may be expected to move from traditional biomass fuels to more advanced and less polluting fuels (e.g. from wood to charcoal, kerosene, and then to gas). The fuel ladder model postulates that fuel switching is mainly observed when there is significant increase in income. The fuel stacking model is where a household use multiple fuels. In this model, households continue to use more than one fuel as income increases. In Kenya however, different studies have shown that consumer engage in fuel stacking rather than fuel ladder. The policy identifies that there are different determinants of fuel choice price being the main one, others include; availability, accessibility fuel quality and convenience. It is quick to note that most modern energy services are subject to structured commercial supply/demand markets, include the cost of production plus profit margins and an array of taxes. Traditional energy resources such as wood fuel are often priced in an informal, less structured market, and often only reflects the cost of extraction (labour) and transportation. The cost of the raw material (e.g. tree replacement) is generally not considered and the wood is regarded as a free good.

VIII. Kenya Green Economy Strategy and Implementation Plan (2016)

The Kenya Green Economy Strategy and Implementation Plan (GESIP) is geared towards enabling Kenya to attain a higher economic growth rate consistent with the Vision 2030, which firmly embeds the principles of sustainable development in the overall growth strategy. The plan takes note that renewable energy offers part of the solution to cheaper energy and the investment in such technologies would yield a 2% reduction in energy consumption and an expanded supply of electricity.

The strategy is developed around five thematic areas, promoting sustainable infrastructure, building resilience, sustainable natural resource management, promoting resource efficiency, and social inclusion and sustainable livelihoods.

The GESIP, being a macro-economic plan does not mention biomass or clean cooking, it focuses on government institutions and promoting economic growth through sound environmental practices.

IX. Kenya Energy Bill 2017

The Kenya Energy Bill 2017 recognizes renewable energy and has proposed several measures to promote and regulate renewable energy production and distribution in Kenya. A key step is the establishment of the Rural Electrification and Renewable Energy Corporation (REREC), whose mandate is to;

(i) Undertake on-farm and on station demonstration of wood-fuel species, seedling production and management.

(ii) undertake feasibility studies and maintain data with a view to availing the same to developers of renewable energy resources;

(iii) develop and promote, in collaboration with other agencies, the use of renewable energy and technologies, including but not limited to biomass, biodiesel, bio-ethanol, charcoal, fuel-wood, solar, wind, tidal waves, small hydropower, biogas, cogeneration and municipal waste, but excluding geothermal;

(iv) formulate, in conjunction with the Institute, a national strategy for coordinating research in renewable energy;

(v) undertake, in conjunction with the Institute, research, development and dissemination of appropriate renewable energy technologies;

The Bill has also provided for the Establishment of an inter-ministerial Renewable Committee known as the Renewable Energy Resource Advisory Committee (RERAC) whose work would be to advise the Cabinet Secretary (Government of Kenya (Ministry of Energy and Petroleum), 2017) on

i) criteria for allocation of renewable energy resource;

ii) licensing of renewable energy resource areas;

iii) management of water towers and catchment areas;

iv) development of multi-purpose projects such as dams and reservoirs for power generation, portable water, flood control and irrigation with a view to ensuring proper coordination at policy, regulatory, conservation and operational levels on matters relating to the various uses of water resources; and

v) Management and development of renewable energy resources. The Renewable Energy Resource Advisory Committee may upon request advise the County Governments on matters relating to renewable energy resource

Although the Energy Bill 2017 has no explicit provision for promoting biomass and clean cooking technologies, it nonetheless advocates for the use of renewable energy technologies both on the macro and micro scale through providing regulation on the promotion of construction and running of renewable energy technologies.

On the negative side the Bill does not recognize households as key consumers of energy and the one most afflicted with Indoor Air Pollution. It would have been expected that with such a rich body of research, preceding Acts and Strategies which outline the importance of including household energy consumption, the Energy Bill of 2017 would be more elaborate in its consideration to households with regards to biomass and clean cooking.

X. Energy Act 2019

The Energy Act of 2019 was signed into law in March 2019. According to its preamble the Act consolidates the laws relating to energy, to provide for National and County Government functions in relation to energy, which were not otherwise specified in the repealed Energy Act (2006). Under the scope of this review, the new Energy Act has created new entities to replace previously existing ones such as the;

i) Energy and Petroleum Regulatory Authority (EPRA) to succeed the Energy Regulatory Commission (ERC)

ii) Energy and Petroleum Tribunal (EPT) which succeeds the Energy Tribunal

iii) Rural Electrification and Renewable Energy Corporation (REREC) which is adopted from proposals made in the Energy Bill of 2017. The role of REREC among many others includes

a. develop and update the renewable energy master plan taking into account county specific needs and the principle of equity in the development of renewable energy resources;

b. support the establishment of energy centres in the counties;

c. develop, promote and manage in collaboration with other agencies, the use of renewable energy and technologies, including but not limited to biomass (biodiesel, bio-ethanol, charcoal, fuel-wood, bio- gas) municipal waste, solar, wind, tidal waves, small hydropower and co-generation but excluding geothermal;

d. undertake feasibility studies and maintain data with a view to availing the same to developers of renewable energy resources;

e. formulate, in conjunction with the Nuclear Power and Energy Agency, a national strategy for coordinating research in renewable energy;

f. undertake, in conjunction with the Nuclear Power and Energy Agency, research, development and dissemination of appropriate renewable energy technologies;

g. provide an enabling framework for the efficient and sustainable production, conversion, distribution, marketing and utilization of biomass, solar, wind, small hydros, municipal waste;

h. promote, in conjunction with the agency responsible for forests, the use of fast maturing trees for energy production including bio-fuels and the establishment of commercial woodlots including peri-urban plantations;

i. promote, in collaboration with other agencies, the development of appropriate local capacity for the manufacture, installation, maintenance and operation of renewable

technologies such as bio- digesters, solar systems, turbines and other renewable energy technologies;

j. promote international co-operation programmes focusing on renewable energy sources;

k. harness opportunities offered under clean development mechanism and other mechanisms including, but not limited to, carbon credit trading to promote the development and exploitation of renewable energy sources;

Part IV of the Act covers Renewable Energy and has adopted the proposal in the Energy Bill (2017) to have all renewable and geothermal energy resources vested in the national government. This provision is primarily intended to clarify which level of government has the right to manage these resources and gives a framework for compensation of local communities and county for receiving a part of the royalties charged by the national government for the development of the resources.

The Energy Act 2019 borrows heavily/has adopted a significant proposals made in the Kenya Energy Bill of 2017. Therefore, similar observations and concerns as pointed out in the Kenya Energy Bill 2017 section are replicated. The Act does not explicitly mention biomass and clean cooking and its relation to Indoor Air pollution.

4.4.2 Policy Discussions

In as much as there is more articulation in renewable energy policy, with the latest Energy Act 2019 adopting proposals from a former bill, a lot is still left to be desired. The biomass and clean cooking agenda have been primarily championed by civil society, who source for funds and promote specific technologies. The government has given its support in this regard through goodwill and assignment of key staff to help spearhead and coordinate such endeavours as observed in the text. Public private partnerships have made technologies such as solar, cookstove and lpg gain considerable traction in adoption by households. Without targeted National policy covering biomass and clean cooking promotion progress in adoption will continue to be slow and mainly reserved for urban populations whereas rural households will continue to lag. As evidenced in the study, solar technologies have been widely adopted but the other RETs (ICS and biomass briquettes) have only had minimal adoption.

4.5 Influence of Actors on RET Adoption

External actors especially government and other external parties play a significant role in helping to nudge individuals in a community towards usage of new technologies (Rogers, 1983). These external nudges take the form of actions directly or indirectly intentioned towards adoption of a new technology such as trainings, workshops, demonstration sites and

general public service messages carried through media (radio and television). The researcher measured the number of interactions as well as activities that would lead to awareness and eventual adoption of RETs.

Table 4.14 Correlation Analysis of Actors and RET adoption

		RET Adoption Level	Participated in Meeting promoting RETs	Participated in Knowledge Exchange with researchers and Scientists	Knowledge of Demonstration Sites on RETS	Presence of NGOS in locality	Number of NGOs operating in Locality
RET Adoption Level	Pearson Correlation	1	-.089	-.200**	-.088	-.062	.001
	Sig. (2-tailed)		.232	.007	.238	.407	.989
	N	181	181	181	181	181	181
Participated in Meeting promoting RETs	Pearson Correlation	-.089					
	Sig. (2-tailed)	.232					
	N	181					
Participated in Knowledge Exchange with researchers and Scientists	Pearson Correlation	-.200**					
	Sig. (2-tailed)	.007					
	N	181					

Knowledge of Demonstration Sites on RETS	Pearson Correlation	-.088
	Sig. (2-tailed)	.238
	N	181
Presence of NGOS in locality	Pearson Correlation	-.062
	Sig. (2-tailed)	.407
	N	181
Number of NGOs operating in Locality	Pearson Correlation	.001
	Sig. (2-tailed)	.989
	N	181

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

From the results, among the many avenues for external support, only knowledge exchange with researcher was shown to have significant impact on RET adoption (Table 4.14).

4.5.1 Researcher / Scientists Interactions

Njoro Sub-County houses one of largest and oldest public universities in Kenya, Egerton University, the Kenya Agricultural and Livestock Research Organization (KALRO) as well as Rift Valley Institute for Science and Technology (RVIST). As institutions of higher learning and research housed within the sub-county, it would be expected that the effects of the knowledge concentration therein would find a trickle-down effect to the surrounding communities. Although this was the main assumption, when questioned the majority of the respondents (90.61%) reported no knowledge sharing between themselves and researchers or scientists (Figure 4.16).

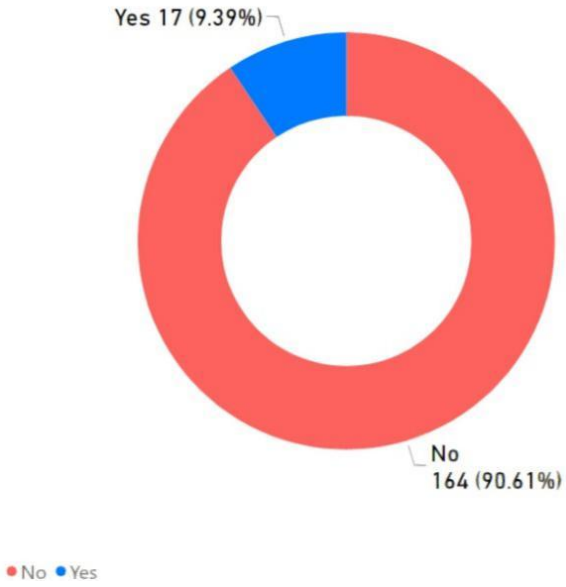

Figure 4.16 Knowledge sharing with University Scientists or Researchers

Mukungugu cluster reported appreciably high interactions on knowledge sharing (11), followed by Njoro (5) and Sigotik (1) with Misepei reporting zero interactions (Table 4.15). Mukungugu and Njoro lie in closest proximity to Egerton University and KALRO which could explain the high number of reported interactions.

Table 4.15 Sublocation Disaggregated Knowledge Sharing

Interaction with any University researchers or scientists in knowledge exchange and sharing		
Sublocation	No	Yes
Misepei	52	0
Mukungugu	22	11
Njoro	39	5
Sigotik	51	1
Total	164	17

Of importance to the researcher was also the date and location of interaction between the respondent and the researchers/scientists. The most reported occurrences were in 2017 and specifically at home (Table 4.16).

Table 4.16 Year and Place of Interaction with University Scientist or Researchers

	Location							
Year	Along the road	ASK show Nakuru	Home	Jowatho	KALRO Njoro	Njoro Post Office	Town Roadside	Total

2003					1			1
2013			2					2
2016	1		1					2
2017			6	1		1	1	9
2018		1	1					2
N.D.				1				1
Overall	1	1	10	2	1	1	1	17

All of these interactions had an impact on the level of adoption of RETs albeit minimal.

4.5.2 Capacity Building

Capacity building among the measured variables did not have a significant impact on RET adoption. Nonetheless, literature espouses that the role of capacity building cannot be understated when it comes to the adoption of a new technology. Community intervention especially in the fields of agriculture, health and sanitation have relied upon the transfer of skills to members of the community in order to come up with positive change and eventual positive impact (Muyanga & Jayne, 2006). From the study it was notable that the communities had participated in appreciably very low capacity building initiatives on RETs, Miseipei reported No capacity building activity at all while Njoro reported the highest at 6, with Mukungugu and Sigotik both reporting 5 (Table 4.17). This was somewhat in contradiction to the findings that had identified Misepei as having the highest RET adoption Rate, it would be expected that higher levels of capacity building would result in higher levels of RET adoption by the recipients. The researcher tried to explain this by comparing the existing energy use whereby Njoro and Mukungugu households had greater access to grid electricity compared to Misepei and Sigotik (Figure 4.5).This would lead to lesser motivation to use RETs as lighting solution, this finding is congruent with the energy use patterns among the sampled household which showed lighting solutions as most likely to be RET based (Figure 4.5).

Table 4.17 RET Capacity Building

Participation in Meetings and Capacity Building Around RET		
Sublocation	No	Yes
Misepei	52	0
Mukungugu	28	5
Njoro	38	6
Sigotik	47	5
Total	165	16

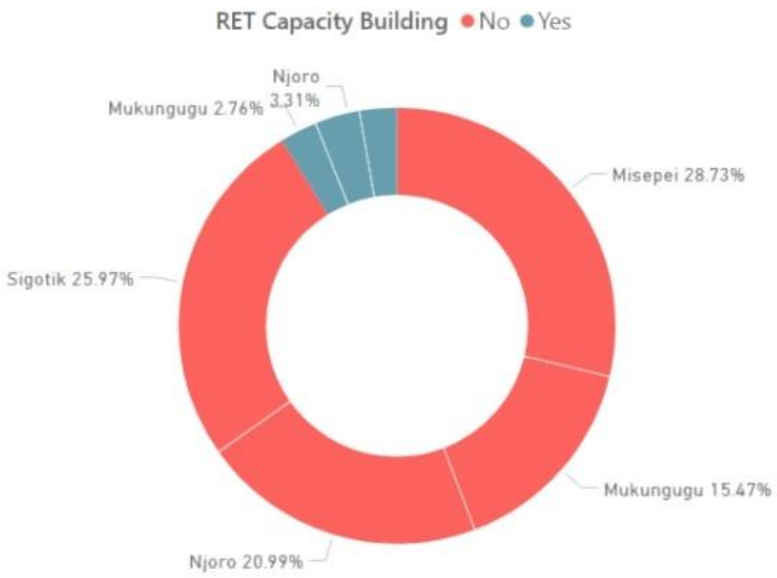

Figure 4.17 RET Capacity Building

4.5.3 Demonstration Site on RETs

As well, demonstration sites were shown to have no significant impact on RET adoption. Despite this, Singh et al. (2018) posits that "demonstrations have been used to increase knowledge, awareness, and adoption of best practices and technologies primarily by university extension programs and other conservation professionals in Agriculture" (p. 276). In the study area, knowledge of demonstration sites that incorporate RETs was appreciably low, with only 2.21% (4) claiming knowledge of such sites (Figure 4.18).

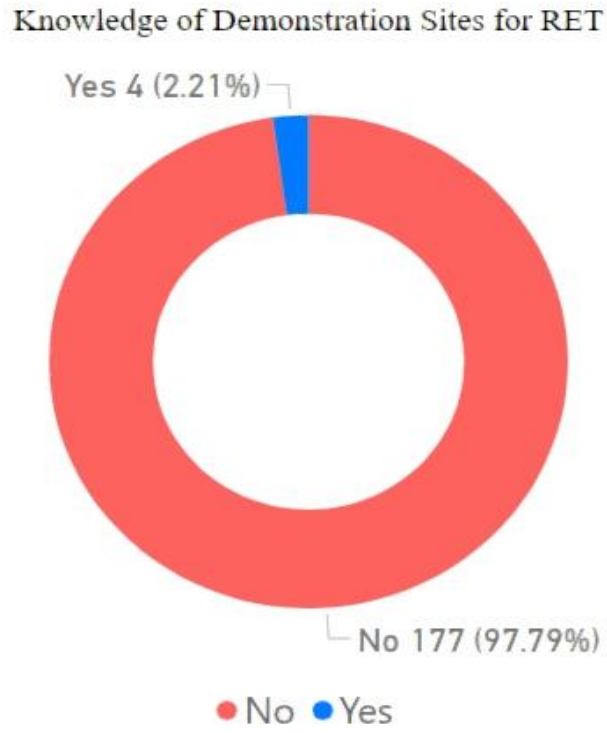

Figure 4.18 Knowledge of Demonstration Sites for RETs

From the positive responses, three demonstration sites were mentioned, Egerton University, Juhudi kilimo, and Naswet (Table 4.18).

Table 4.18 RET Demonstration Sites Details

Name of RET Demonstration Site	Location of Demonstration Site	Managing Organization
Egerton University	Njoro	Egerton university
Juhudi kilimo	Nakuru	Juhudi Kilimo
Naswet	Njoro ward	Unknown

The lack of significant impact on RET adoption for Demonstrations site could be explained by their low presence and knowledge of such by the residents on Njoro. With the current results being inconclusive, investigation of the impacts of demonstration sites on RET adoption should be studied further.

4.5.4 Non-Governmental Organizations (NGOs)

NGOs are typically value-based organizations which depend, in whole or in part, on charitable donations and voluntary service. NGOs range in their size and scope form large charities to regional, national and community-based self-help groups. They include research centres, religious institutions and professional associations. NGOs have contributed significantly in the development of marginalized sections and backward areas through their service (Meena et al., 2013). NGOs have more competitive advantages and flexibility of

operations in fields like awareness generation, community level preparedness and capacity building of communities.

From the data, NGOs did not have any significant impact on RET adoption and it was quite apparent that Njoro Sub-County had very little NGO interaction (*Table 4.19*) and in the few cases reported their interaction was limited to Orphan and Vulnerable Children (OVC) care and School bursary programmes (Table 4.20).

Table 4.19 NGOs Operating in the Area

Sublocation	No	Yes
Misepei	52	0
Mukungugu	33	0
Njoro	42	2
Sigotik	52	0
Total	179	2

Table 4.20 NGO Respondent Interaction

	NGO Interaction with Respondents		
	Name of NGO	Nature of relationship	Latest Interaction
1	USAID	OVC care givers	2004
2	School programme	School bursary	Never

4.5.5 External Actors Discussions

Rural households in Njoro Sub-County had very minimal interactions with external actors (scientists and NGOs) and very few of the reported interactions were related to RET promotion. Despite the sub-County housing Egerton University, Rift Valley Technical Institute and Kenya Agriculture and Livestock Research Organisation, the community recorded only minimal capacity building interactions related to RET. Such institutions of learning have a very high potential for impact with the community and should focus on publicize awareness on the RETs through fora that the public can take part in. Open days, fairs and exhibitions are some of the most common means of public engagement platforms which the community can be able to engage with academia to learn and exchange ideas.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

When it comes to policy, it is essential that biomass and clean cooking is considered a crosscutting issue with influence on health, welfare and socioeconomic bearing of households. Very little of the policy in Kenya touches on biomass and clean cooking, regardless many rural and urban households still suffer from the effects of indoor air pollution due to use of biomass energy for cooking and heating needs. Policy on biomass and clean cooking renewable energy technologies are essential to tame such numbers and reduce the burden on health and improve socioeconomic welfare of households. The government has shown great capacity in working with development partners, civil society and private sector actors to enact transformative change in different sectors. Such partnerships should be encouraged but with the people and households being the main driver for change. This will ensure that problems being solved are actual problems and not perceived problems. Policy to mainstream biomass and clean cooking technologies should be given priority given the grim health statistics, at the same time creating awareness on the dangers of indoor air pollution is essential. Leveraging on technological advancements especially with mobile telephony and smartphone/ internet penetration, sensitization can cover wider areas cost effectively and need not rely solely on traditional communication means.

An additional and significant finding was that residents in Sigotik and Miseipei had developed interesting cookstove innovations. Instead of the three stone firewood cooker that is most common in rural areas, these cookstoves were modified with a U-shape with cemented sidewalls either using clay or cement (Plate 1). The users reported greater fuel efficiency and some had even installed chimneys to vent the smoke outside. If indeed true, such a technology would be accessible as well as require very low technical expertise to install / build. Further research needs to be conducted to test the efficiency of such cookstoves and their emissions and ways of improving them.

Plate 1 Cook Stove Innovations by Residents of Njoro

5.2 Recommendations

i) Women and youth should be empowered in rural areas in household decision making as well as in leadership opportunities to enhance RET adoption rates.

ii) RET awareness creation should focus on women and youth in society, this would ideally lead to greater RET adoption.

iii) RETs should be considered a crosscutting issue and policy on biomass and clean cooking should be defined to a greater level of details than where it is currently at.

iv) Institutions of research and higher learning need to focus on RET promotion and improve public outreach and interactions with neighbouring communities to ensure that knowledge new and old finds its way to the people who would best benefit from it.

v) Further studies on the cookstove innovations exhibited by the residents of Njoro sub-County need to be conducted. They were very popular and easy to construct and would be a good candidate for High Impact Low Cost Scalable (HILC) interventions.

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APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

Introduction

I am doing research for my Masters Degree in Environmental Science which seeks to assess the influence of selected factors on renewable energy technology adoption among rural households in Njoro Sub-County Nakuru, Kenya. Your participation is important and very much appreciated. The conclusions derived from this research may help advice on policies and laws regarding renewable energy technologies to improve their access to rural households. All responses are completely anonymous and will only be used for the purpose of this study. Please answer as truthful as possible. If you are ready, let us begin.

Survey Date (dd /mm /yy) **SURDATE _____/_____/2018**

SURVST_____ SURVED

Interview duration (hh/min) _____

NS_____ HH1_____._____

(North=1, South=2) **dd**

GPS Coordinates East **HH2_____ ._____dd**

Altitude MT. a.s.l **MASL (_____)**

Household head name _____

Age _____ Tel: _____

Gender Male [ ] Female [ ]

Identifying Variables:

Enumerator:_____

Province:_____

Ward: _____

Sub-Location: _____

Village: _____

Marital status (hh)? Single [ ] Married [ ] Divorced [ ] Widowed [ ]

Can you read or write? Yes [ ] No [ ]

Highest level of education attained by household head? (*Tick one*)

Pre-primary [ ] Primary [ ] Secondary [ ] College [ ] University Degree and above [ ]

Do you engage in informal /business activity? Yes [ ] No [ ]

What is your current occupation/ job?_____

Does your household receive any remittances from members not currently living here?

Yes [ ] No [ ]

How long has your family lived in this sub-County? _____ Years.

How many people currently reside in your household? _____

9.0 Has any member of this household held any of the following positions of leadership in the society (Either past or present)?

Ordinary Citizen [0] Religious Leader [1] Village Elder [2] Member of County Assembly [3] Member of Parliament [4] Other[5]

9.1 If Other please specify

9.1.1 Who held the position? [ ] Hh/ Father [ ] Wife/ Mother [ ] Son [ ] Daughter [ ] Aunt [ ] Uncle [ ] Grandfather [ ] Grandmother [ ]Sister [ ] Brother

9.1.2 When was the position held? _____

10. ENERGY TYPES /SOURCES THAT YOU USE:

List all the energy types and sources for each used by the household.

Energy type/source		Knowledge of the energy source? [1] Yes [2] No	Main activity for which energy source is used for	What is the total quantity acquired by your household in the last 30 days?	What is the total cost your household paid in the last 30 days?	Person mainly responsible for payment? State ID	Who decides on how much & when to purchase? State ID	Where is energy obtained from?	Who is responsible for bringing this energy source to the household?	Distance covered in km from your homestead	Number of trips per month	Total time spent obtaining this energy per trip(hrs)	How has the Household changed its use of this energy source /type in the last 3 years	What effect has this change brought to the household? (Combinations can be selected which are not counter intuitive)

Source			**enact1**	**enact2**	**enact3**	**tQty**	**tcost**	**name**	**decid**	**esource**	**memresp**	**edist**	**etrips**	**etime**	**echange**	**eimpact**
Firewood	**1**															
Charcoal	**2**															
Agro-waste	**3**															
Biogas	**4**															
LPG	**5**															
Kerosene	**6**															
Petrol	**7**															
Diesel	**8**															
Electricity	**9**															
Solar/ home system	**10**															

Batteries-dry cell	**11**															
Batteries car	**12**															
Wind	**13**															
Water	**14**															
Biomass Briquettes	**15**															
Sawdust	**16**															
Solar Drier	**17**															
Municipal Solid	**18**															

Waste																
Bio-ethanol	**19**															
Bio-diesel	**20**															

	enact1; enact2; enact3			**name**		**Esource**					**Echange**	**Eimpact**
1=Food preparation	9=phone charging			1 =Hh/ Father		1=Bush					1=Increased	1=Saved time or 2= Increased time
2=Lighting	10=Crop processing			2= Wife/ Mother		2=Own farm					2=Constant	
3=Heating	11=Livestock product processing			3=Son		3=Public forest					3=Decreased	3= Lowered costs or 4= Increased costs
4=Storing	12=Feed			4=Daughter		4=Private farm						

food		preparation											
5=Ironing		13=Milking			5=Aunt		5=Market/kiosk						5= More convenient or 6= Less Convenient
6=Reading		14=poultry brooding			6=Uncle		6=Filling station						
7=Irrigation		15=storing livestock produce			7=Grandfather		7=National grid						7= no effect
8=Transport of crops		16=other specify_____			8=Grandmother		8=Sun						
					9=Sister		**9=Other specify_____**						
					10=Brother								

Q11.1 Do you know of renewable energy technologies? a. [ ] Yes b. [ ] No

Q11.2 If yes which ones are you aware of (List according to what is mentioned)?

1 _____

2 _____

3 _____

4 _____

5 _____

Q12 How easy is it for you to acquire the following energy sources?

(A)Very Hard (B) Hard (C) Moderately Easy (D) Easy (E) Very Easy

1	Solar Panels	[A]	[B]	[C]	[D]	[E]
2	Charcoal	[A]	[B]	[C]	[D]	[E]
3	Briquettes	[A]	[B]	[C]	[D]	[E]
4	Paraffin	[A]	[B]	[C]	[D]	[E]
5	Firewood	[A]	[B]	[C]	[D]	[E]

Q13. OTHER HOUSEHOLD ASSETS

Household Assets (PROMPT for each item AS LISTED BELOW): AT PRESENT, how much/many of the following does this household own that are usable/repairable? (**Instructions**: For value per unit, ask for the resale price for the asset or the current market value of the asset as it is.)

Household Asset ownership /possession		Quantity	Value per Unit (Ksh)	If Value/Unit not known Ask for Total Value	**Asset** Household Asset ownership /possession		Quantity	Value per Unit (Ksh)	If Value/Unit not known Ask for Total Value
ASSET		**QTY**	**VALUE**	**TOTVAL**		**ASSET**	**QTY**	**VALUE**	**TOTVAL**
1	Animal plough				**30**	planter			
2	Axe				**31**	Ploughs for			

						tractor			
3	battery				**32**	Posho mill			
4	bicycle				**33**	Poultry houses			
5	Bio-gas unit				**34**	Power saw			
6	Borehole				**35**	Radio			
7	Cane crusher				**36**	Refrigerator			
8	Car				**37**	Rigder/weeder			
9	Cart				**38**	Sewing machine			
10	Cattle dip				**39**	Sheller**			
11	Chaff cutter				**40**	Solar panel			
12	Commercial houses**				**41**	Spray pump			
13	Dam				**42**	Stores			
14	Fish ponds				**43**	Trailer			
15	Fixed telephone				**44**	Tractor			
16	Furniture				**45**	Truck			
17	Gas cooker				**46**	TV			
18	Generator				**47**	Water pump			
19	Grinder				**48**	water tanks			

20	Hand hoe				**49**	Water trough			
21	Harrow/tiller**				**50**	Weighing machine			
22	Irrigation equipment				**51**	well			
23	Jiko				**52**	wheel barrow			
24	Milking shed				**53**	wind mill			
25	mobile phone				**54**	Woodlots			
26	motorcycle				**55**	Zero grazing unit			
27	pestle and mortar				**56**	Cook stove			
28	Piggery houses				**57**	Other specify			
29	Panga								

Q14. Livestock Ownership (*If No ,**go to Q15**)*

a. Over the past one year, did anyone in your household **own** any livestock? 1=Yes 0= No **LIVSTOCK**_____

b. Please complete the following table on the household's livestock over the past 12 months***(September 2017*-October 2018*)***

Livestock

1

1

Livestock code		Number owned in September 2017	Current average value per unit	Who is primarily responsible for these animals?	Who decides whether or not to sell these animals?	Who decides on the use of income from the sale?	Number **purchased** and average purchase **price per** unit		Number died ***September 2017-October 2018***	Number consumed ***September 2017-October 2018***	Number Sold ***September 2017-October 2018***	Average Unit Price When Sold (Ksh)
				1=Head 2=Spouse 3=Head and Spouse 4=other female hh member **-44=Non household member (**For those kept by others)	5= other male hh member							
livecode		**numown**	**Curval**	**whoresp**	**decida**	**incomeid**	**npurch**		**price**	**died**	**consume**	**sold**	**avprice**
Improved cow	1												

Improved bull	2													
Improved calves	3													
Local cow	4													
Local bull/oxen	5													
Local calves	6													
Sheep	7													
Goat(dairy)	9													
Camels	10													
Chicken-indigenous	11													
Chicken-improved	12													
Ducks/Geese	13													
Turkeys	14													
Pigs	15													
Rabbits	16													
Fish (if ponds)	1													

	7													
Bee hives	18													
Donkey	19													
Other specify_____	20													

15.1 Do **you** or **any member** of this household belong to **any group or organization?** 1=Yes 0=No [***skip to Q16***] **GROUP_____**

Q15.2 List all the names and ID of members of the households who belong to any group and answer subsequent questions

Name & ID of household members who Belong to a group.	What type of group is this ?	Which activity / enterprise(s) does this group deal with? i.e.	Position held in this **group**		Do you consider the **group** receptive to your views?	Are you **satisfied** with the services received from the group?
(May have multiple lines with the same ID number, if that person belongs to multiple groups.	1=agricultural 2=savings & credit	Group type **1=Cash crop**	1=chair 2=Vice chair		1=Yes	
	3=education	**2=Food crop**	3= Secretary	Year Joined	0=No	

			4=community	3=dairy cattle	4=Treasurer			
			5=religious	4=beef cattle	5=supervisory committee			1=Satisfied
			6=other (specify)	5=dairy goats	6=Ordinary member			2=Dissatisfied
				6=bee keeping	7=Membership not active			3=Indifferent (Neutral)
				7=poultry	8=Other Specify			
				8=fish farming 9=irrigation				
				10=water management				
				11=saving and credit				
				12=other Specify)____				
NAME			**GRUP**	**GRPENT**	**POSITN**	**YRJOIN**	**RECEPTV**	**SATISFAC**

Q16. MAIN HOUSING

(The enumerator to establish the following)

Q16.1 What is the roofing material of the main house?

1=grass 2=iron sheet 3=tiles 5=Other (Specify)_____

Q16.2 What is the **wall** material of the **main house**?

1=mud 2=Bricks/Stones 3=Iron sheet 4=Wood 5=Plastered

6=Other (Specify)_____

Q16.3. What is the floor material of the main house?

1= Earth/ Sand 2= Dung 3= Wood/ Planks 4= palm/ Bamboo 5= Parquet or Polished wood 6= Vinyl or Asphalt Strips 7= Ceramic Tiles 8= Cement 9= Carpet 10= Other (Specify) _____

Q16.4 How many rooms are used for sleeping? _____

Q17 Occupation

Q17.1 What is your main occupation?

[ ] (0) Farming

[ ] (1) Livestock

[ ] (2) Dairy

[ ] (3) Trading

[ ] (4) Artisan

[ ] (5) Salaried employment

[ ] (6) Casual labour

[ ] (7) Other, namely ……

Q18 What is the approx. monthly income for this household? _____

Q19 Who in your household makes the decision on: (select from options – if applicable)?

(1) Husband (2) Wife (3) Joint decision (husband/wife)

(4)Both (Individual Decision making) (5) Other, namely

Activity	**Person Responsible**
a) Buying food	
b) Buying cooking fuels	
c) Buying fuels for lighting	
d) Buying household products	

e) Buying mobile phone credit	
f) Buying cook stove	
g) Saving up money for later use	
h) Small investments (< 1000 Ksh)	
i) Large investments (> 1000 Ksh)	

COOKSTOVE USE AND PURCHASE

Q20 What type of cook stove is your **primary cooking device**?

(0)Three stones / open fire [ ]

(1) U shape, surrounded fire [ ]

(2) Metal charcoal stove [ ]

(3) Kenya Ceramic Jiko [ ]

(4) Upesi / Maendeleo (firewood) [ ]

(5) Kuni Bili (firewood / charcoal) [ ]

(6) Rocket Stove [ ]

(7) LPG [ ]

(8) Electric cooker/burner [ ]

(9) Jiko poa/ Jiko Okoa [ ]

(10) Biogas Cooker

(11) Other, namely _____

Q20.1 Which is your secondary cooking device(Select from above list (Q21)) _____

Q20.2 Which is your tertiary cooking device(Select from above list (Q21)) _____

Q21) How often do you buy a new stove?

Every …… years

Q22) Where do you buy cook stove

22.1) What kind of shop? [ ] General Shop/ Kiosk [ ] Hardware shop [ ] Market/Jua Kali vendors [ ] Door to Door vendors [ ]Others

22.1.1) If Others, please specify …….

22.2) Which town? …….

22.2.1) How far is this shop from home? (km)……

22.3) How much did you pay? Ksh ……

22.4) What is the biggest determinant for choice of cook stove?

(1) Price (2) Energy efficiency (3) Ease of use (4) Size (5) Other

22.4.1) If other please specify _____

LIGHTING EQUIPMENT USE AND PURCHASE

Q23) What is the most used lighting equipment in your home?

[ ]Solar lighting system [ ]Electric bulb [ ]Paraffin Lamp (with glass cover) [ ]Paraffin Lamp (without glass cover/koroboi) [ ]Battery powered lamp (rechargeable) [ ] Battery powered lamp (non-rechargeable) [ ]Others

23.1) If other please specify _____

Q24) How often do you buy the above lighting equipment in your home? Every …… years

Q25) Where lighting equipment are purchased

25.1) What kind of shop?

[ ] General Shop/ Kiosk [ ] Hardware shop [ ] Market/Jua Kali vendors [ ] Door to Door vendors [ ]Others

25.2) Which town? …….

25.2.1) How far is this shop from home? (km)

25.3) How much did you pay? Ksh ……

25.4) What is the biggest determinant for choice of lighting product?

(1) Price (2) Energy efficiency (3) Ease of use (4) Brightness (5) Popularity (6)Other

25.4.1) If other please specify _____

RET USE

Q26) Do you know anyone (else) that owns an improved cook stoves?

a. [ ] Yes b. [ ] No

Q27) Are you aware of the benefits of improved cook stoves (ICS)?

(0) Not (1) Hardly (2) Moderately (3) Very

I am …….. aware

Q28.1) List the ones that you know?

_____

_____

_____

Q28.2) What are the disadvantages of improved cook stoves (ICS)?

_____

_____

Q29) Are you aware of the benefits of Solar Lanterns?

(0) Not (1) Hardly (2) Moderately (3) Very

I am …….. aware

Q30.1) List the ones that you know?

_____

_____

_____

_____

Q30.2) What are the disadvantages of solar lanterns?

_____

_____

Q31) Are you aware of the benefits of using biomass briquettes?

(0) Not (1) Hardly (2) Neutral (3) Moderately (4) Very

I am …….. aware

Q32.1) List the ones that you know?

_____

_____

_____

_____

Q32.2) What are the disadvantages of biomass briquettes

_____

_____

Q33.1) Have you participated in any meetings around the promotion of renewable energy technologies?

a. [ ] Yes b. [ ] No

Q33.2) If yes,

What type of meeting was it

For each of the selected options please specify:	Information Workshop [ ]	Training Workshop [ ]	Exhibition [ ]	Policy Workshop[ ]
How many meetings have you attended?				
When was the latest meeting attended?				
Who organized the meeting?				
What was it about?				

Q34.1) Have you interacted with any University researchers or scientists in knowledge exchange and sharing?

a. [ ] Yes b. [ ] No

Q34.2) If yes when _____ and

Q34.3) Where_____

Q35) Do you know of any demonstration sites where you can be trained on renewable energy technologies?

a. [ ] Yes b. [ ] No

Q35) If yes

(**Q35.1**) Where is it found _____

(**Q35.2**) Which organization runs it _____

Q36.) List the NGOs you know who operate in your locality:

_____

_____

_____

_____

Q37) Of the above mentioned NGOs which ones have you interacted with and what was the nature of the interaction.

	NGO	**Nature of Interaction**	**Year of latest Interaction**

Q38) Give challenges that you have faced in adopting renewable energy technologies?

Q39) Give suggestions on how to up-scale successful renewable energy technologies in your rural community?

_____

_____

Q40) What do you think the Government's role is in improving adoption of renewable energy technologies?

_____

_____

_____

_____

THE END

Thank you for your cooperation

APPENDIX 2: DATA ANALYSIS RESULTS

A2.1 Household Assets

A2 Table 1 Household Asset Ownership

Items	Frequency	Percent
Animal plough	9	.6
Axe	132	9.1
Battery	17	1.2
Battery lamp	1	.1
bicycle	39	2.7
Cane crusher	1	.1
Car	4	.3
Cart	1	.1
Chaff cutter	2	.1
Chicken House	1	.1
Commercial houses**	3	.2
Cook stove	16	1.1
Fixed telephone	2	.1
Furniture	164	11.3
Gas cooker	39	2.7
Generator	2	.1
Hand hoe	127	8.7
Iron box	2	.1
Irrigation equipment	1	.1
Jiko	109	7.5
Milking shed	3	.2
mobile phone	132	9.1
motorcycle	22	1.5
panga	141	9.7
Paraffin Lamp	2	.1

pestle and mortar	2	.1
Piggery houses	1	.1
Posho mill	3	.2
Poultry houses	26	1.8
Radio	99	6.8
Sewing machine	6	.4
Solar panel	40	2.8
Spade	1	.1
Spray pump	16	1.1
Stores	45	3.1
TV	77	5.3
Water pump	6	.4
water tanks	126	8.7
Water trough	2	.1
Weighing machine	5	.3
wheel barrow	20	1.4
Zero grazing unit	5	.3
Total	1452	100.0

A2.2 Benefits and Disadvantages of RETS

A2 Table 2 All Listed Benefits of ICS

		Frequency	Percent
Valid	Can be easily made using soil; Multiple cooking points; Fuel efficient	1	.6
	Can make it myself; Cooks faster; Fuel efficient; Can heat up the whole room	1	.6
	Clean; Cook faster	1	.6
	Convenient	1	.6
	Cook Faster; Uses less fuel; Interchangeable with firewood and	1	.6

Sawdust		
Cooking; cooks faster	1	.6
Cooks faster	2	1.1
Cooks faster; lights faster	1	.6
Cooks faster; saves energy; no smoke; nice shape	1	.6
Cooks faster; Fuel efficient; Less fuel	1	.6
Cooks faster; Fuel efficient; Multipurpose; Can be used on any surface	1	.6
Cooks faster;Saves energy	1	.6
Easy to use	2	1.1
Easy to use; no smoke	1	.6
Energy effeciency	1	.6
Energy efficient;Clean	1	.6
Fuel	1	.6
Fuel economy	1	.6
Fuel economy;Cook faster;Heat saver;Multiple cooking at once	1	.6
Fuel efficient	14	7.7
Fuel Efficient	1	.6
Fuel Efficient Clean	1	.6
Fuel efficient Durable Cheap to make	1	.6
Fuel efficient Easy to control heat Lasts longer	1	.6
Fuel efficient Good heat	1	.6
Fuel efficient Holds sufurias more stability	1	.6
Fuel Efficient Insulated Smokeless	1	.6
Fuel efficient Lasts longer	1	.6
Fuel Efficient Lasts longer	1	.6
Fuel efficient Long lasting	1	.6
Fuel efficient Low energy use	1	.6
Fuel efficient Multi fuel use Cooks faster Safe use	1	.6
Fuel efficient Saves fuel	1	.6
Fuel efficient Smokeless	1	.6

Fuel efficient Uses many types of fuels	1	.6
Fuel efficient Well Insulated Saves fuel	1	.6
Fuel efficient; Burns longer	1	.6
Fuel efficient;Conserves energy	1	.6
Fuel efficient;Cook faster;Durable	1	.6
Fuel efficient;Cooks faster	2	1.1
Fuel efficient;Cooks faster;Saves money	1	.6
Fuel efficient;Cooks faster;Well Insulated;Can heat up the room	1	.6
Heats up a roomt	1	.6
Less costly	1	.6
Less fuel	1	.6
Less. Fuel Saves energy Smokeless Charge phone	1	.6
Lights faster Cooks faster Fuel efficient Can control heat easily	1	.6
Low fuel consumption	1	.6
Low fuel use	1	.6
More heat	1	.6
More stable than 3stone Insulating Fuel efficient High heat output	1	.6
Multiple cooking points Looks good Fuel.efficient	1	.6
Na	1	.6
No information	1	.6
No smoke, not dangerous	1	.6
No smoke, saves time, cooks faster	1	.6
Not aware	1	.6
Save energy	2	1.1
Save energy Cooks faster	1	.6
Save energy Fuel efficient Regulate heat	1	.6
Save energy, easy to cook	1	.6
Save energy, faster, less time	1	.6
Save energy, save time, occopy less space, mobile	1	.6

Save firewood Cooks faster	1	.6
Save fuel Cooks faster Can be made at home	1	.6
Save fuel Less smoke Cook faster Less. Prone to. Accidents	1	.6
Save makaa	1	.6
Save s fuel Safe to use indoors Cooks faster	1	.6
Save time	3	1.7
Saves charcoal,	1	.6
Saves energy	4	2.2
Saves energy Fuel efficient Uses less fuel	1	.6
Saves energy Saves heat Cook faster	1	.6
Saves energy,	3	1.7
Saves energy, cooks faster	1	.6
Saves energy, cooks faster, no smoke	1	.6
Saves energy, cooks faster, saves time	1	.6
Saves energy, cooks faster, convinient, no smoke	1	.6
Saves energy, does not loose heat	1	.6
Saves energy, durable	1	.6
Saves energy, easy to use	1	.6
Saves energy, fast	1	.6
Saves energy, no smoke, cooks faster, dont get cold easily	1	.6
Saves energy, no smoke. Cooks faster	1	.6
Saves energy, saves time, no smoke	1	.6
Saves energy, convinient	1	.6
Saves energy, uses less time	1	.6
Saves fuel	4	2.2
Saves fuel Conserves energy Cooks faster	1	.6
Saves fuel Cooks faster	2	1.1
Saves fuel Cooks faster Smokeless Insulated	1	.6
Saves fuel Directed heat No smoke Cooks faster	1	.6
Saves fuel Energy efficient	1	.6
Saves fuel High heat Cooks faster	1	.6

	Saves fuel Multiple cooking points Durable Cleaner to use	1	.6
	Saves time	1	.6
	Saves time, cooks faster, convinient, durable	1	.6
	Ssves energy, conserve environment, no smoke	1	.6
	Stable Doesn't smoke as much High heat output Can use bigger pans/sufurias	1	.6
	Use less fuel Lasts longer	1	.6
	Uses less charcoal	1	.6
	Uses less fuel	2	1.1
	Uses less fuel Cook faster Saves money	1	.6
	Uses less fuel Cooks faster	2	1.1
	Uses less Fuel Cooks More food	1	.6
	Uses less fuel More stable Cheaper to construct	1	.6
	We don't have stones therefore the cookstove is easily made from the soil around	1	.6
	Total	137	75.7
Missing	-999	44	24.3
Total		181	100.0

A2 Table 3 All Listed disadvantages of improved cook stoves (ICS)

		Frequency	Percent
Valid			
	Can crack easily	1	.6
	Can crack if poorly used Has to be properly constructed to last	1	.6
	Can't be used when you want to cook slowly	1	.6
	Can't compete with 3stone when there is fuel	1	.6
	Cannot be used in water logged soils	1	.6
	Cant cook using large sufuria	1	.6
	Cheaper	1	.6
	Clogs up with ash	1	.6
	Can crack easily	1	.6

Cooks slow compared to three stone	1	.6
Cracks almost everyday Needs constant maintenance	1	.6
Cracks when it's not maintained	1	.6
Cultural barriers	1	.6
Difficult to make	1	.6
Expensive	41	22.7
Expensive Not available	1	.6
Expensive Not easily available	1	.6
Expensive Not easily available Does not heat up room	1	.6
Expensive Not locally available	1	.6
Expensive Not really appealing when you have good energy sources	1	.6
Expensive to buy	1	.6
Expensive,	1	.6
Expensive, accessible	1	.6
Expensive, cannot be used for heating	1	.6
Expensive, depends on what is available	1	.6
Expensive, may be stolen easily	1	.6
Expensive, not accessible	1	.6
Expensive, not accessible, no knowledge on how to use it	1	.6
Expensive, not convinient	2	1.1
Expensive, not good for heating	1	.6
Expensive, requires skills to use	1	.6
Expensive, no skills	1	.6
Expensove, requires skills, not convinient in rural areas	1	.6
Expensuve	1	.6
Financial	1	.6
Gets cold easily, expensive	1	.6
Hard to get, expensive	1	.6
Hard to use, expensive	2	1.1

Have to be knowledgeable to make	1	.6
Have to size it appropriately to get optimum fuel efficiency	1	.6
High price Not locally available	1	.6
Lack of clay soil to repair	1	.6
Lack of knowledge, illiteracy	1	.6
Lack of skills	1	.6
Lacks knowledge	1	.6
Lacks knowledge, expensive	1	.6
Lacks knowledge, where to get it	1	.6
Low awareness about the cookstove	1	.6
May take time to cook fast for more food	1	.6
Must use charcoal, risky, expensive	1	.6
Na	1	.6
Need to be constantly patched or it will collapse Needs an expert to make	1	.6
Needs to be maintained	1	.6
Not accessible	1	.6
Not accessible, expensive	2	1.1
Not accessible, hard to light	1	.6
Not convinient	2	1.1
Not convinient, expensive	1	.6
Not durable	1	.6
Not durable Expensive	1	.6
Not durable If it overheats it breaks down Some of the recommended fuels are hard to get	1	.6
Not easily accessible Not visible Expensive	1	.6
Not easy to use	1	.6
Not easy to use. With some. Food	1	.6
Not. Easily available	1	.6
Price	2	1.1
Requires skills to use,	1	.6

	Slow in cooking	1	.6
	Smoky	2	1.1
	Smoky and affects eyes	1	.6
	Takes. Time to light	1	.6
	Too much work Expensive	1	.6
	Uses firewood	1	.6
	Without clay to patch it up it will crack	1	.6
	You cannot use it to heat	1	.6
	Total	121	100.0

A2 Table 4 All Listed Benefits of Solar Lanterns

Listed Benefits of Solar		Frequency	Percent
Valid	Cheap, convenient, natural source of energy	1	.6
	Accessible, cheap	1	.6
	Accessible, helps in charging battery	1	.6
	Bright	1	.6
	Bright Can power radio and tv Is cheaper	1	.6
	Bright Charges phone Power radio	1	.6
	Bright Charges phone Powers radio	1	.6
	Bright Clean energy No health effects	1	.6
	Bright light Cheap to maintain Pay as you go	1	.6
	Bright light Power Radio Power tv	1	.6
	Bright Pay as you go Waranteed	1	.6
	Bright Uses sun No added costs	1	.6
	Brightness	2	1.1
	Brightness Good for reading at night Pay as you go Cheaper than paraffin	1	.6
	Brightness,	1	.6
	Brightness, charges phone and tv, entertainment	1	.6
	Brightness, charges phone, entertainment, security	1	.6
	Brightness, charging	1	.6

Brightness, cheap	1	.6
Brightness, cheap, security purposes	1	.6
Brightness, convenient, no smoke	1	.6
Brightness, entertainment, cheap, convenient	1	.6
Brightness, free once bought	2	1.1
Brightness, free once bought, conserve environment	1	.6
Brightness, free once bought, durable	1	.6
Brightness, has multiple uses, used for entertainment	1	.6
Brightness, popularity	1	.6
Brightness, portable	1	.6
Brightness, reading	1	.6
Brightness, security	1	.6
Brightness, security, charges phone	1	.6
Brightness, security, portable	1	.6
Brightness, used for reading, saves time and cost	1	.6
Brightness, charges battery,	1	.6
Brightness, no smoke	1	.6
Brovhr Can. Power tv and radio Will. Charge phone No. Cost	1	.6
Can be used to power all electronics Charging phones No added costs	1	.6
Can be used to power electronics devices	1	.6
Can be used to power hh electronics Can be used without electricity Can be usd to charge phone	1	.6
Can be used without electricity Can be used with hh electronics Uses sunlight to power	1	.6
Can be used without electricity Can power electronics Cheaper	1	.6
Can be used without electricity Power radio, TV and charges phone	1	.6
Can Charge phone Can power electronics	1	.6
Can charge phone Lights up at night	1	.6

Can power electronics	1	.6
Can power electronics Uses sunlight Good. Brightness	1	.6
Can power lights and electricronics	1	.6
Can power lights Light at no cost	1	.6
Can store charge Can power electronics Uses sunlight	1	.6
Can. Be used in place of electricity Yu can storr power Charges phone	1	.6
Can.used where there is no electricity Charges using the sun Can be used with radio and even tv	1	.6
Charge phone, brightness	1	.6
Charges by sun, less costly, you buy once	1	.6
Charges in the sun Don't buy batteries	1	.6
Charges on its own,	1	.6
Charges phone Powers radio Lights up at night children can read easily	1	.6
Charges phone Good lighting Powers TV and radio	1	.6
Charges phone,	1	.6
Charges phone, brightness, used for reading	1	.6
Charges phone, free once bought, durable,	1	.6
Charges using Sun Charges phone Bright light Power Radio	1	.6
Charges using sunlight	2	1.1
Charges, convinient	1	.6
Charging, brightness	1	.6
Charging, cheap, entertainment	1	.6
Charging, used for reading	1	.6
Cheap	2	1.1
Cheap to maintain Uses sunlight	1	.6
Cheap, brightness	1	.6
Cheap, brightness, convenient,	1	.6
Cheap, brightness, you buy once	1	.6
Cheap, charges phone	1	.6

Cheap, convinient	1	.6
Cheap, convinient, durable, brighntness	1	.6
Cheap, durable, convinient	1	.6
Cheap, uses sun, bright	1	.6
Cheap, portable	1	.6
Cheaper Charges using the sun	1	.6
Convinient, free once bought, cheap	1	.6
Convinient, free once bought, used in charging, used in repaires, uses invertor	1	.6
Durable, brightness	1	.6
Durable, charges phone, entertainment	1	.6
Durable, cheap	2	1.1
Durable, portable, cheap, accessible	1	.6
Durable, renewable, accessible	1	.6
Easy to use, durable	1	.6
Easy to use, durable, brightness	1	.6
Economical, charging, brightness, used in kinyozi	1	.6
Free energy, cheap	1	.6
Free once bought, brightness	1	.6
Free once bought, brightness, looks good, nice shape	1	.6
Free once bought, cannot end, brightness	1	.6
Free once bpught, convinient, conserve environment	1	.6
Good replacement for electricity	1	.6
Heat water Can be use in place of the electricity Has different uses	1	.6
Less costly, charges phone,	1	.6
Less maintenance cost, you buy once	1	.6
Light at night Power radio	1	.6
Lights up at night Charges phone	1	.6
Lights up well Charges phone Powers radio	1	.6
Nature, cheap, convinient, security	1	.6

No added costs beyond purchase	1	.6
No additional costs after purchase and installation Is Multipurpose Durable	1	.6
No bills	2	1.1
No bills Charges phone	1	.6
No bills Solar panels do not wear out No unexpected disconnection	1	.6
No bills Sun Charged	1	.6
No bills Uses sunlight	1	.6
No Bills Uses sunlight to power Comes in different sizes	1	.6
No cost	1	.6
No cost uses sun	1	.6
No cost Multipurpose	1	.6
No cost since it uses sun Does not burn bulbs Stores energy Can charge phones	1	.6
No information	1	.6
No payments	3	1.7
No payments Can. Charge phone Can be used to brood chicken	1	.6
No payments Sunlight powered	1	.6
No payments Uses sunlight	1	.6
No. Recurrent costs	1	.6
Not recurrent payments No health risks Uses sunlight	1	.6
Not reliant on electricity Multipurpose You can move with the solar	1	.6
Portable, brightness	1	.6
Power houses Multipurpose	1	.6
Powered by the sun	1	.6
Powers hh electronics	1	.6
Reliable Uses sun	1	.6
Save energy Bright	1	.6
Save energy Is used without electricity	1	.6

Save time	1	.6
Saves cost, brightness	1	.6
Saves energy Powers TV and radio Convenience in multiple uses	1	.6
Saves energy Works with low power	1	.6
Saves energy, convenient, brightness, durable	1	.6
Saves time, charges phone	1	.6
Self charging Can.be used I places without electricity	1	.6
Stores energy Charges with sunlight	1	.6
Use for lighting and powering radio	1	.6
Use in place of electricity Can charge phones	1	.6
Use sunlight	1	.6
Used as electricity	1	.6
Used in place of electricity	1	.6
Used instead of electricity Sunlight powered	1	.6
Used like electricity Very bright	1	.6
Uses sun light	1	.6
Uses sun No bills Multiple light options	1	.6
Uses sun no other costs	1	.6
Uses sun, charges on its own	1	.6
Uses sunlight	3	1.7
Uses sunlight as energy source No payments beyond initial cost	1	.6
Uses sunlight Can charge phone, radio, television	1	.6
Uses sunlight Lasts for long Multiple purposes, lighting phone charging Payment mode is gradual Added security through tracking	1	.6
Uses sunlight No added cost	1	.6
Uses sunlight No cost	1	.6
Uses sunlight Portable	1	.6
Uses sunlight. Can be used to power hh electronics	1	.6
Uses the sun Has no cost	1	.6

	Uses the sun Is good when the sun is shining Cost is lower	1	.6
	You never buy fuel again Multiple options for powering One panel can power multiple bulbs	1	.6
	Total	168	92.8
Missing	-999	13	7.2
Total		181	100.0

A2 Table 5 All Listed disadvantages of solar lanterns

		Frequency	Percent
Valid	Affected by rain	1	.6
	Affected by rains n clouds, not accessible	1	.6
	Affected by sun,	1	.6
	Affected by sun, theft	1	.6
	Affected by weather change, theft, dlight not durable	1	.6
	Affected by weather,	1	.6
	Affected by weather, expensive	1	.6
	Battery can short out Poor lighting when wiring is bad	1	.6
	Can be damaged by children throwing stones	1	.6
	Can be damaged by water Will not charge without sunlight	1	.6
	Can be easily damaged No sunlight no charging Not as bright as electric	1	.6
	Can over charge battery	1	.6
	Can power radio and tv	1	.6
	Can Run out of power	1	.6
	Can.be damaged by water	1	.6
	Can't charge properly with poor sunlight Won't store energy if battery is broken	1	.6
	Can't charge without good sunlight	1	.6
	Can't charge without sunlight Portable solar have to be taken outside everytime	1	.6

Can't compete with electricity	4	2.2
Can't compete with electricity More uses with electricity	1	.6
Can't compete with electricity Expensive to buy	1	.6
Can't compete with electricity More expensive than electricity	2	1.1
Cannot be used without battery Expensive	1	.6
Cannot compete with electricity Price can be high	1	.6
Cannot power tvs Takes long to charge Expensive	1	.6
Cant charge during low light Has to be use with battery	1	.6
Cant compete with electricity Low sunlight will not charge	1	.6
Daily payments	2	1.1
Depend on sun	1	.6
Depend on sun, installment in payment	1	.6
Depends on battery	1	.6
Depends on sun	1	.6
Depends on sun,	1	.6
Depends on sun, a bit expensive	1	.6
Depends on sun, affected by rain, theft	1	.6
Depends on sun, affected by rains	1	.6
Depends on sun, gets spoilt	1	.6
Depends on sun, may get spoilt	2	1.1
Depends on sun, theft	2	1.1
Depends on sun, theft,	1	.6
Depends on sun, theft, breakages	1	.6
Depends on weather	1	.6
Dlight gets spoilt easily	1	.6
Does not charge in low insolation	1	.6
Does not charge with limited sunlight	1	.6
Does not work in rainy season,	1	.6
Doesn charge without sunlight	1	.6
Doesn't charge I low sunlight	1	.6

Doesn't charge when there's no sunlight	1	.6
Doesn't charge with rain	1	.6
Doesn't have good brightness like electricity Needs to be charged Can be easily stolen	1	.6
Expensive	15	8.3
Expensive Can short circuit when children play with it	1	.6
Expensive to buy Can't. Charge without sunlight	1	.6
Expensive to maintain	1	.6
Expensive,	2	1.1
Expensive, depends on sun	1	.6
Expensive, may get spoilt by children	1	.6
Expensive, spoilt by children	1	.6
Expensive, theft, some are fragile	1	.6
Expensive, depend on sun	1	.6
Get spoilt, theft	1	.6
Gets spoit	1	.6
Has no spare parts, depends on sun	1	.6
It may fall, theft	1	.6
Lack of awareness on solar	1	.6
Limited application	1	.6
Low brightness	1	.6
Low charge without sunlight	1	.6
Low power when overcast	1	.6
Low Power when overcast	1	.6
Low powered, limited application	1	.6
Maintenance of battery	1	.6
May get spoilt	1	.6
May get spoilt n not easily repaired	1	.6
May spoil, depends on sun, theft	1	.6
Needs to be cleaned to absorb more sunlight Can be easily damaged Fire safety risk I overcharging	1	.6

No charge without sunlight	1	.6
No charge without sunlight Theft	1	.6
None	1	.6
Not as Bright	1	.6
Not as bright as electric Some electronics cannot be used	1	.6
Not bright at night	1	.6
Not bright enough	1	.6
Not convenient	1	.6
Not durable compared to electricity, may break, theft,	1	.6
Not durable for dlight	1	.6
Not Durable Wiring can be easily damaged	1	.6
Not durable, depends on sun	1	.6
Not durable, retains heat if not disconnect, requores control	1	.6
Not durable, theft	1	.6
Not easily available	1	.6
Not efficient without sun Spoils and doesn't light	1	.6
Not reliable especially when no sunlight	1	.6
Overcharging can burn things, theft,	1	.6
Price is expensive	1	.6
Price is too high	1	.6
Price is too High Not competitive with electricity	1	.6
Requires care	1	.6
Theft	6	3.3
Theft Breakdown	1	.6
Theft,	4	2.2
Theft, affected by rain	1	.6
Theft, affected by rains,	1	.6
Theft, breaking,	1	.6
Theft, can be spoilt by children	1	.6
Theft, can get spoilt, fragile	1	.6
Theft, charges one by one in a battery	1	.6

	Theft, depends on sun	1	.6
	Theft, depends on sun, spoils if rained on	1	.6
	Theft, gets spoilt	1	.6
	Theft, may be easily damaged	1	.6
	Theft, may be spoilt by children	1	.6
	Too. Expensive	1	.6
	Without sun can't function	1	.6
	Without sunlight battery doesn't charge	1	.6
	Without sunlight you don't get power	1	.6
	Won't charge well without sun	1	.6
	Total	148	81.8
Missing	-999	33	18.2
Total		181	100.0

A2 Table 6 All Listed benefits of biomass Briquettes

		Frequency	Percent
Valid	-999	126	69.6
	Burn Longer	1	.6
	Burns long	1	.6
	Can be homemade Cheap make	1	.6
	Can be homemade Cheaper than charcoal	1	.6
	Can cook and heat up room	1	.6
	Can heat up the house Can replace makaa	1	.6
	Cheap to make Cooks faster Appropriate heat	1	.6
	Clean Energy efficient	1	.6
	Conserve environment, cooks faster,	1	.6
	Cooks faster	3	1.7
	Cooks faster, saves time	1	.6
	Cooks faster, retains energy, conserve environment	1	.6
	Easy to light	1	.6
	Energy saving Lasts long	1	.6

Fuel economy Easy to get and make Saves time	1	.6
Fuel efficient Lasts for a long time	1	.6
Fuel efficient Longlasting	1	.6
Fuel. Efficient Long lasting	1	.6
Home made Lasts long	1	.6
Homemade Lasts longer	1	.6
Is good Cooks faster	1	.6
Last long	3	1.7
Lasts for Long	1	.6
Lasts long	2	1.1
Lasts long High heat	2	1.1
Lasts longer	4	2.2
Lasts longer Cooks faster	1	.6
Lasts longer Fuel efficient Saves money	1	.6
Lasts longer Fuel efficient No costs if making for yourself Smokeless	1	.6
Lasts longer Fuel. Efficient	1	.6
Lasts longer Recycle. Waste	1	.6
Lights faster	1	.6
Lights up well Cooks for longer	1	.6
Long lasting High heat	1	.6
Minimise cost	1	.6
No cost Lasts longer	1	.6
No waste Smokeless Lasts longer Easy to find	1	.6
Recyclable	1	.6
Recycled, available when there is no charcoal	1	.6
Saves energy, cheap	1	.6
Saves energy, preserve	1	.6
Saves fuel	1	.6
Smokeless Cook faster Save energy	1	.6
Smokeless Lasts long High heat Fuel efficient	1	.6

	Take long to stop lighting,	1	.6
	Use less fuel	1	.6
	Total	181	100.0

A2 Table 7 All Listed disadvantages of biomass briquettes

		Frequency	Percent
Valid	Affected by rain	1	.6
	Affected by water, may be smoky, not accessible	1	.6
	Buying raw materials Time consuming to make briquettes	1	.6
	Can't compete with firewood	1	.6
	Can't compete with other cheaper biomass sources	1	.6
	Cooks slow	1	.6
	Doesn't last long Hard to get raw materials	1	.6
	Easily damaged Not easily available Expensive to buy	1	.6
	Expensive	2	1.1
	Expensive and low awareness on their use	1	.6
	Expensive to common people, not conviniet	1	.6
	Expensive to. Buy	1	.6
	Expensive,	1	.6
	Expensive, hard to get	1	.6
	Expensive, not available in rural areas	1	.6
	Full of smoke	1	.6
	Hard to find, may not be available of no trees	1	.6
	Hard to get raw materials	2	1.1
	Hard to lighr	1	.6
	Has odour Poor quality Lack of knowhow in manufacturing	1	.6
	Have to be completely dry to bs useful	1	.6
	Lack of knowledge on how to make	1	.6
	Lack of raw materials	2	1.1
	Makes people cough	1	.6

	Making is hard work Can't be bought anywhere	1	.6
	More smoke,	1	.6
	Negative perception,linked with poverty	1	.6
	Not accessible	1	.6
	Not accessible	5	2.8
	Not accessible, is not known to people	1	.6
	Not as usable as charcoal Takes long to light up	1	.6
	Not available	13	7.2
	Not available Expensive	1	.6
	Not available	1	.6
	Not avaliable readily	1	.6
	Not convenient	1	.6
	Quality is dependent on how it was manufactured	1	.6
	Raw materials are not available	2	1.1
	Smoky	2	1.1
	Take time to light Must have charcoal dust to make Tiresome to make	1	.6
	Takes time to light	1	.6
	Takes time to make	1	.6
	Too hot can't leave children alone with it Prone to breakage	1	.6
	Too much Time for making briquette	1	.6
	Very smoky	1	.6
	Total	66	36.5
Missing	-999	115	63.5
Total		181	100.0

A2 Table 8 Indexed listed benefits of ICS

		Frequency	Percent
Valid	0	47	26.0
	1-2≥	93	51.4
	3≤	41	22.7
	Total	181	100.0

A2 Table 9 Indexed listed disadvantages of ICS

		Frequency	Percent
Valid	0	61	33.7
	1-2≥	115	63.5
	3≤	5	2.8
	Total	181	100.0

A2 Table 10 Indexed Listed Benefits Solar

		Frequency	Percent
Valid	0	14	7.7
	1-2≥	103	56.9
	3≤	64	35.4
	Total	181	100.0

A2 Table 11 Indexed Listed Disadvantages of Solar

		Frequency	Percent
Valid	0	34	18.8
	1-2≥	135	74.6
	3≤	12	6.6
	Total	181	100.0

A2 Table 12 Index listed Benefits Biomass Briquettes

		Frequency	Percent

Valid	0	126	69.6
	1-2≥	46	25.4
	3≤	9	5.0
	Total	181	100.0

A2 Table 13 Indexed listed disadvantages of Biomass Briquettes

		Frequency	Percent
Valid	0	115	63.5
	1-2≥	62	34.3
	3≤	4	2.2
	Total	181	100.0

A2 Table 14 RET Weights Descriptive Statistics

		ICSwb(Weighted benefits of ICS)	ICSwd (Weighted Disadvantages ICS)	Swb(Weighted Solar Benefits)	Swd(Weighted Disadvantages Solar)	BBwb(Weighted benefits Briquettes)	BBwd(Weighted Disadvantages of Briquettes)
N	Valid	181	181	181	181	180	181
	Missing	0	0	0	0	1	0
Mean		.68	.20	1.09	.43	.22	.12
Mode		0	0	1	0	0	0
Std. Deviation		.821	.468	.784	.616	.513	.384

A2 Table 15 Household Awareness of RETs Ward Score

		Ward			
		Mis	Muku	Nj	Sig

		epei		ngugu		or o		oti k	
		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
	Trivial or no knowledge/understanding	0	0.00%	2	10.5%	9	47.4%	8	42.1%
DEGREE OF KNOWLEDGE AND UNDERSTANDING OF RET	Low Degree	19	41.3%	3	6.50%	11	23.9%	13	28.3%
	Moderate Degree	21	35.0%	6	10.0%	12	20.0%	21	35.0%
	High Degree	11	22.4%	19	38.8%	11	22.4%	8	16.3%
	Very High Degree	1	14.3%	3	42.9%	1	14.3%	2	28.6%

A2.3 Decision Making

A2 Table 16 Household Decision Making on Buying food

	f	Percent
Wife	25	13.9
Other	1	0.6
Joint decision (husband/wife)	35	19.4
Head	119	66.1
Total	180	100

A2 Table 17 Household Decision Making on Buying fuel for lighting

	f	Percent
Wife	26	14.4
Other	1	0.6
Joint decision (husband/wife)	34	18.9

Head	119	66.1
Total	180	100

A2 Table 18 Household Decision Making on Buying cooking fuel

	f	Percent
Wife	47	26.1
Other	1	0.6
Joint decision (husband/wife)	33	18.3
Husband	6	3.3
Head	93	51.7
Total	180	100

A2 Table 19 Household Decision Making on Buying household products

	f	Percent
Wife	47	26.4
Other	1	0.6
Joint decision (husband/wife)	30	16.9
Head	99	55.6
Both/ Individually	1	0.6
Total	178	100
	180	

A2 Table 20 Household Decision Making on Buying mobile phone credit

	f	Percent
Wife	36	20
Joint decision (husband/wife)	8	4.4
Head	89	49.4
Both/ Individually	47	26.1
Total	180	100

A2 Table 21 Household Decision Making on Buying cook stove

	f	Percent
Other	1	0.6
Wife	51	28.3
Joint decision (husband/wife)	26	14.4
Head	102	56.7
Total	180	100

A2 Table 22 Household Decision Making on Saving up money for later use

	f	Percent
Wife	28	15.6
Other	1	0.6
Joint decision (husband/wife)	42	23.3
Head	108	60
Both/ Individually	1	0.6
Total	180	100

A2 Table 23 Household Decision Making on Small investments (< 1000 Ksh)

	f	Percent
Wife	29	16.1
Other	1	0.6
Joint decision (husband/wife)	42	23.3
Head	105	58.3
Both/ Individually	3	1.7
Total	180	100

A2 Table 24 Household Decision Making on Large investments (> 1000 Ksh)

	f	Percent
Wife	15	8.4
Other	1	0.6
Joint decision (husband/wife)	43	24

Head	120	67
Total	179	100

APPENDIX 3 OPERATIONALIZATION OF VARIABLES

The following variables reflected in the study's specific objectives and research questions were defined and operationalized as follows:

The household head in this study was defined as the individual in the household who makes decisions regarding use and purchase of energy used by the household.

A3.1 Dependent variable: Adoption of renewable energy technologies (RETs)

was defined in this study as the extent in which the RETs are adopted by the sampled respondents representing the Njoro sub-County community.

The variable was operationalized in Likert scale categories of:

A3 Table 1 Operationalization of Variable Adoption of renewable energy technologies

EXTENT OF ADOPTION	WEIGHTED
Very high Extent	5
High Extent	4
Moderate Extent	3
Little Extent	2
Trivial or not adopted	1

Adoption of RETs was measured as per the number of RET used by the household, which were a combination of the following weighted points;

A3.1.1 Step 1 Number of Renewable Energy Technologies used by the households (*retus*)

The RET Use Index (A3 Table 2), considered a variety of technologies as RETs, including but not limited to; biogas, solar/ home system, wind, water, biomass briquettes. These were extracted from the list of household items, cooking and lighting technologies all covered in the survey protocol (A2 Table 1).

A3 Table 2 Household RET Use Index

Number of Renewable Energy Sources	Weighted
0	0
1-2	1
3	2

4-5	3

From the results it was evident that majority of the households (61.3%) did not utilize any Renewable Energy Sources while only 38.7% used 1-2 sources (A3 Table 3).

A3 Table 3 RET Sources Weight

Renewable Energy Sources Weight			
		Frequency	Percent
Valid	0	111	61.3
	1	70	38.7
	Total	181	100.0

A3.1.2 Step 2 Use of Improved Cook Stove

Due to existing energy systems especially in rural communities, the supply of some RETs such as biomass briquettes and other processed forms of biomass might be scarce. However, access to firewood and charcoal as main sources of cooking energy is comparatively easier, therefore use of improved cook stoves has been accepted as a means of reducing energy consumption while utilising locally accessible biomass (Okuthe & Akotsi, 2014). The study put this into consideration by measuring the level of usage of improved cook stoves. Upesi Maendeleo, Kuni bili, Rocket stove, Jiko Okoa/ Poa, Biogas cooker are popular cook stoves types in Kenya and depending on the usage as follows;

i) Primary cooking device(ICS p) = 2 (Weight)

ii) Secondary cooking device(ICS s) =1 (Weight)

iii) Tertiary cooking device(ICS t) = 0.5 (Weight)

From the results, majority of the households (64%) used Improved cook stoves as their primary cooking devices, this figure appreciably diminished in the Secondary and Tertiary Levels whose usage stood at 2.8% and 1.1% respectively (A3 Table 4).

A3 Table 4 Improved Cook Stove Usage Levels

		Nesuit				Njoro					
		Misepei		Sigotik		Mukungugu		Njoro			
		Count	N		N		N		N	Total	% Total
Primary cooking	NP	0	0.00%	3	1.66%	21	11.60%	41	22.65%	65	35.91%

device Level	P	52	28.73%	49	27.07%	12	6.63%	3	1.66%	116	64.09%
Secondary cooking	NP	51	28.18%	50	27.62%	31	17.13%	44	24.31%	176	97.24%
device Level	P	1	0.55%	2	1.10%	2	1.10%	0	0.00%	5	2.76%
Tertiary cooking	NP	52	28.73%	50	27.62%	33	18.23%	44	24.31%	179	98.90%
device Level	P	0	0.00%	2	1.10%	0	0.00%	0	0.00%	2	1.10%
Overall		156	86.19%	156	86.19%	99	54.70%	132	72.93%	543	

Key – NP (Not Present) | P (Present)

A3.1.3 Step 3 Adoption Level

By combining results from Step 1 and Step 2 above (RETus+ ICS p+ICS s+ICS t), the researcher was able to quantify the RET adoption level of the households in Njoro Sub-County.

A3 Table 5 RET Adoption Level

		Frequency	Percent
Valid	Trivial or not adopted	64	35.4
	Little Extent	55	30.4
	Moderate Extent	62	34.3
	Total	181	100.0

A3.2 Independent variable: Household awareness

Was defined as the degree of knowledge and understanding (by the head of household) of the RETs and the benefits accruing from their use by the household.

The variable was operationalized in Likert scale categories of:

A3 Table 6 Operationalization of Variable Household Awareness

DEGREE OF KNOWLEDGE AND UNDERSTANDING	WEIGHTED
Very high Degree	5
High Degree	4
Moderate Degree	3
Low Degree	2
Trivial or no knowledge/understanding	1

In order to quantify the household level of awareness to RETs the researcher created an index which captured the knowledge the respondent had with regard to RETS. The computation of the household RETs awareness index involved the following steps.

A3.2.1 Step 1 Self-Reported Knowledge of RETs

The research first inquired whether the respondents knew of Renewable Energy Technologies, this was recorded as Self-Reported Knowledge (SRK) and was weighed as 1 (SRK= 1). Self-reported Knowledge of renewable energy technologies was high with 89% of responding in the affirmative, that they had some knowledge of RETs (A3 Table 7).

A3 Table 7 Self-Reported Knowledge of RETS

		Frequency	Percent
Valid	No	20	11.0
	Yes	161	89.0
	Total	181	100.0

A3.2.2 Step 2 Listed Renewable Energy Technologies

In order to validate SRK the researcher inquired further by asking the respondent to list the RETs they knew of, it is from the correctly listed RET that their knowledge was inferred and weighed *(RET lw).* This indicated in A3 Table 8.

A3 Table 8 Listed RETs and their Weight (RET lw)

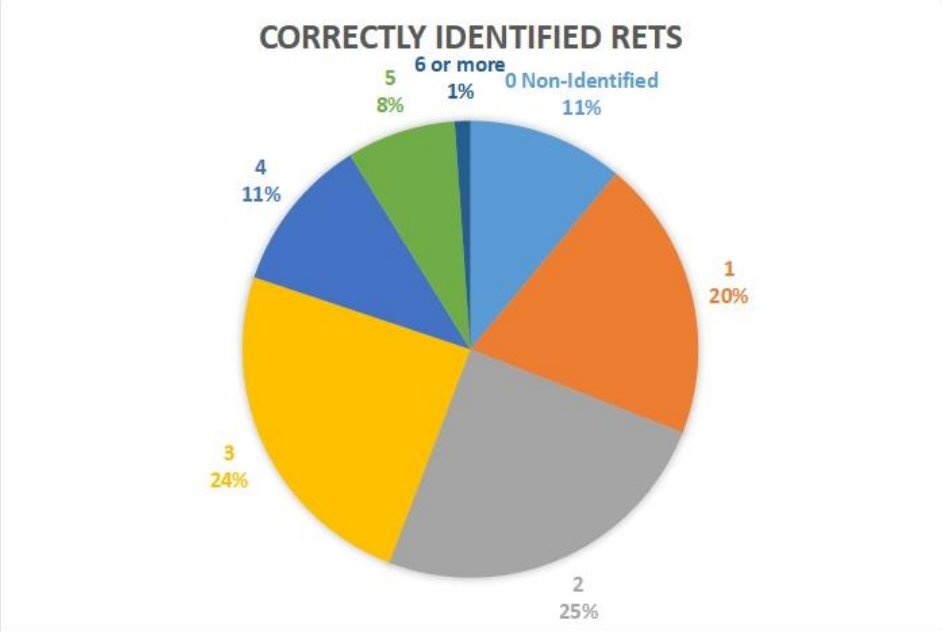
Listed Renewable Energy Technologies by respondent	Weighed
0	0
1-3	1
4≤	2

A majority (69.1%) of the respondents listed more than two RETs (A3 Figure 1). Although the respondents could list a number of RETs, very few correctly listed 6 or more RETs (1%) (A3 Figure 1). Moreover, the respondents did not deviate much from the following list of RETs;

i) Solar
ii) Improved Cook Stove
iii) Biogas
iv) Geothermal Electricity
v) Hydroelectricity
vi) Wind

When the researcher inquired further about the source of such information, it emerged that there has been a lot of discussion around Large Scale renewable energy projects on media stations, radio and TV inclusive, especially about geothermal energy extraction which is in Nakuru County, where the study was undertaken.

Solar and Improved cook stoves were the most widely identified RETs with geothermal, hydroelectric and wind power being the least mentioned.



A3 Figure 1 Per Cent (%) Correctly Identified RETs by Respondents

A3.2.3 Step 3 Benefits of Selected RETs

The respondents were asked a series of questions targeting knowledge of the benefits of the following selected RETs; Improved cook stoves, Solar Lanterns and Biomass briquettes. Correctly listed benefits (*RETw*b) were weighed and averaged as follows:

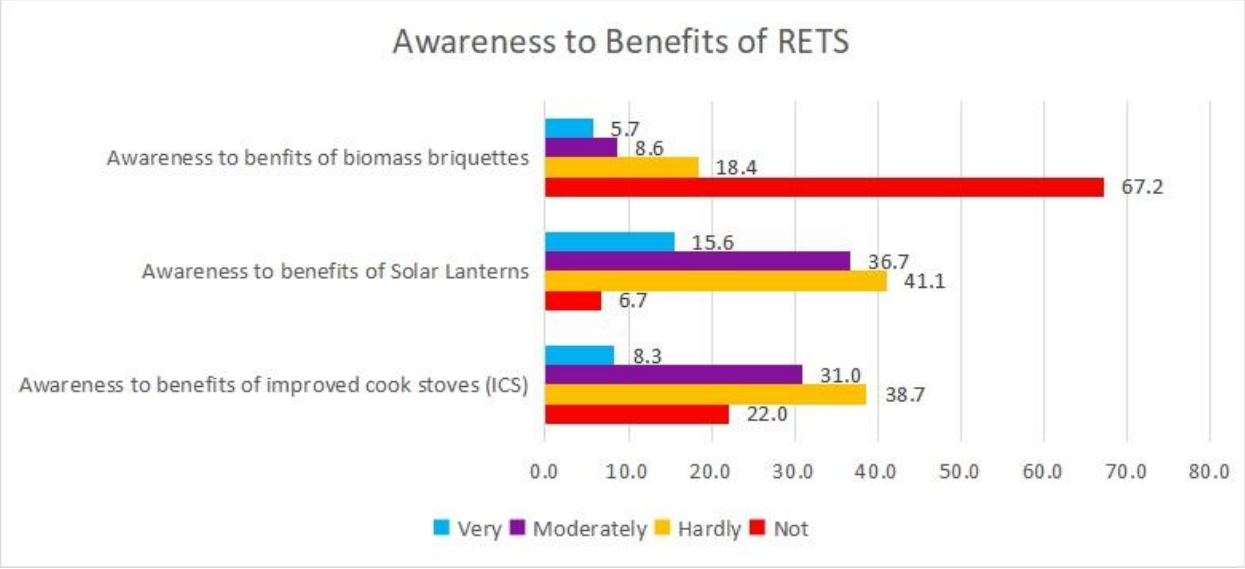
I. Benefits of Improved Cook stoves (ICSwb)

A3 Table 9 Benefits of ICS Index

Listed benefits of ICS	Weighed
0	0
1-2≥	1
3≤	2

When asked about how informed the respondents were about knowledge about the benefits of ICS, 8.3% stated they were Very aware, with 31.0 % stating they were Moderately aware, 38.7% stating Hardly any awareness while 22.0% stated they were Not aware (A3 Figure 2).

When asked about the benefits of improved cook stoves, the respondents were more or less uniform, with responses centering around; (i) Energy efficiency/ saves energy (2) Less smoke (3) Fuel Efficiency (A2 Table 2). The researcher interrogated further about the subject and came to discover that most of the knowledge about specific benefits of ICS were obtained from neighbours and media advertisements.



A3 Figure 2 Awareness to benefits of RETS (Likert Scale)

Fifty One percent (51%) of the respondents correctly listed 2 or less benefits of ICS, with 26% not listing any correct ones while only 23% could list 3 or more benefits of ICS(A3 Figure 3).

A3 Figure 3 Correctly listed benefits of ICS

In summary majority of the respondents (54.7%) scored 0 on the ICSwb index, with those who scored 1 and 2 matching at 22.7% (A3 Table 10). The average score on ICSwb index was 0.68 (A2 Table 8), which indicated a low to moderate level of knowledge with regards to knowledge of ICS benefits.

A3 Table 10 Weighed benefits of ICS (ICSwb)

Weight/Score	Frequency	Percent
0	99	54.7
1	41	22.7
2	41	22.7
Total	181	100.0

II. Benefits of Solar (Swb)

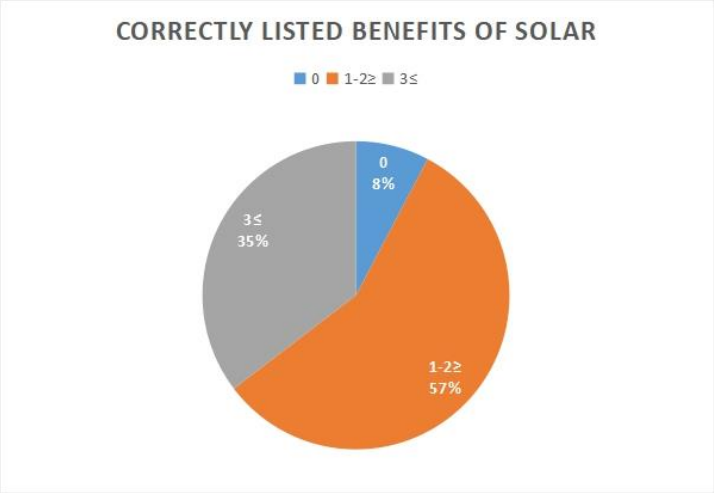
A3 Table 11 Solar Weighed Benefits Index

Listed benefits of Solar	Weighed
0	0
1-2≥	1
3≤	2

Knowledge to benefits of solar was the highest recorded among the three RETS, with 15.6 % stating they were Very aware, 36.7% stating Moderate awareness, 41.1% stating Hardly any awareness and only 6.7 % stating No awareness(A3 Figure 2).

The most mentioned benefits for solar centred around; (1) being bright (2) Cheap to maintain/ no additional costs (3) charges phone (4) Powered by the sun (A2 Table 4). This evidence is supported by the fact that over 40 households were recorded to have a form of solar powered lighting solution (A2 Table 1).

Over 56.9% managed to answer 1-2 correctly, while 35.4 % were able to answer 3 or more correctly, only 7.7% did not get any correct answer (A3 Figure 4).



A3 Figure 4 Correctly listed benefits of Solar

According to the *Swb* index, 38.1% scored 1 closely followed by 35.4% who scored 2 and lastly 26.5% who scored 0 (A3 Table 12). The average score for the *Swb* index was 1.09 (A2 Table 8), which reveals a moderate to high level of knowledge among the respondents on the benefits of solar.

A3 Table 12 Weighted Solar Benefits (Swb)

Weight/score	Frequency	Percent
0	48	26.5
1	69	38.1
2	64	35.4
Total	181	100.0

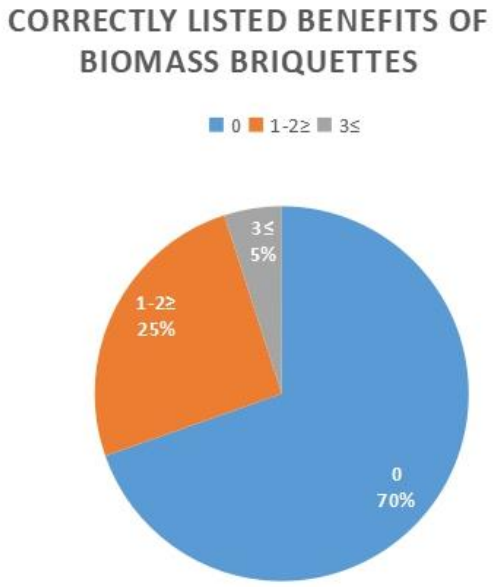
III. Benefits of Biomass Briquettes (BBwb)

A3 Table 13 Briquettes weighed benefits Index

Listed benefits of Biomass Briquettes	Weighed
0	0
2≥	1
3≤	2

Biomass briquettes proved to be the least understood RET among the three, 67.2% claimed they did not have any information on them, 18.4% stating hardly any knowledge 8.6% and 5.7% stating moderate and High knowledge respectively (A3 Figure 2). The following were the three most listed common benefits of biomass briquettes; (1) Lasts longer (2) Fuel efficient/ saves energy (3) Cooks faster.

Over 70% of the respondents did not any correct answer, with 25% getting 1-2 answers correctly, while only 5% managed to answer 3 or more correctly (A3 Figure 5).



A3 Figure 5 Correctly listed benefits of Biomass Briquettes

According to the *BBwb* index 82.2% scored 0, followed by 13.3% and 4.4% for those who score 1 and 2 respectively (A3 Table 14). The Average *BBwb* index score for the respondents was 0.22, which shows low knowledge of benefits of biomass briquettes.

A3 Table 14 Weighed benefits briquettes (BBwb)

Weight/Score	Frequency	Percent
0	148	82.2
1	24	13.3
2	8	4.4
Total	180	100.0

In order to extract net benefits of RET knowledge the following equation was used;

$$RET\,wb = (ICSwb + Swb + BBwb)/3$$

Where

$ICSwb$ = Improved cook stove weighed benefits

Swb= Solar weighed benefits

$BBwb =$ Biomass briquettes weighed benefits

From the results obtained the overall average score was 0.663±0.035 (A3 Table 15) indicating a low to moderate level of awareness to the benefits of the selected RETS. Among the four wards sampled, Mukungu had the highest average score of 0.788±0.095 followed by Njoro, Sigotik and Misepei with, 0.689±0.080, 0.622±0.058, 0.603±0.059 respectively (A3 Table 16).

A3 Table 15 Descriptive Statistics for RETwb

	N	Mean	Std. Error	Std. Deviation	Skewness	Std. Error
RETwb (ICSwb + Swb + BBwb)/3	181	.663	.035	.474	.395	.181

A3 Table 16 Summary of RETwb data for the wards in Njoro Sub-County. Mean±SE

	Ward			
	Misepei	Mukungugu	Njoro	Sigotik
RETwb	.603±0.059	.788±0.095	.689±0.080	.622±0.058

A3.2.4 Step 4 Disadvantages of Selected RETS

Having knowledge of something does not mean knowing only the positive attributes of the topic of discussion, having negative information also constitutes part of the body of knowledge. When a new technology or experience is concerned several studies show that people are more likely to remember negative cues/ attributes than they are of positive ones. According to Vaish, Grossmann, & Woodward (2008),"there is ample empirical evidence for an asymmetry in the way that adults use positive versus negative information to make sense of their world; specifically, across an array of psychological situations and tasks, adults display a negativity bias, or the propensity to attend to, learn from, and use negative information far more than positive information". From this premise the researcher asked respondents to list negative traits of the three selected RETs. Correctly identified disadvantages were averaged to come up with the overall RET negative index (*RETwd*) as follows;

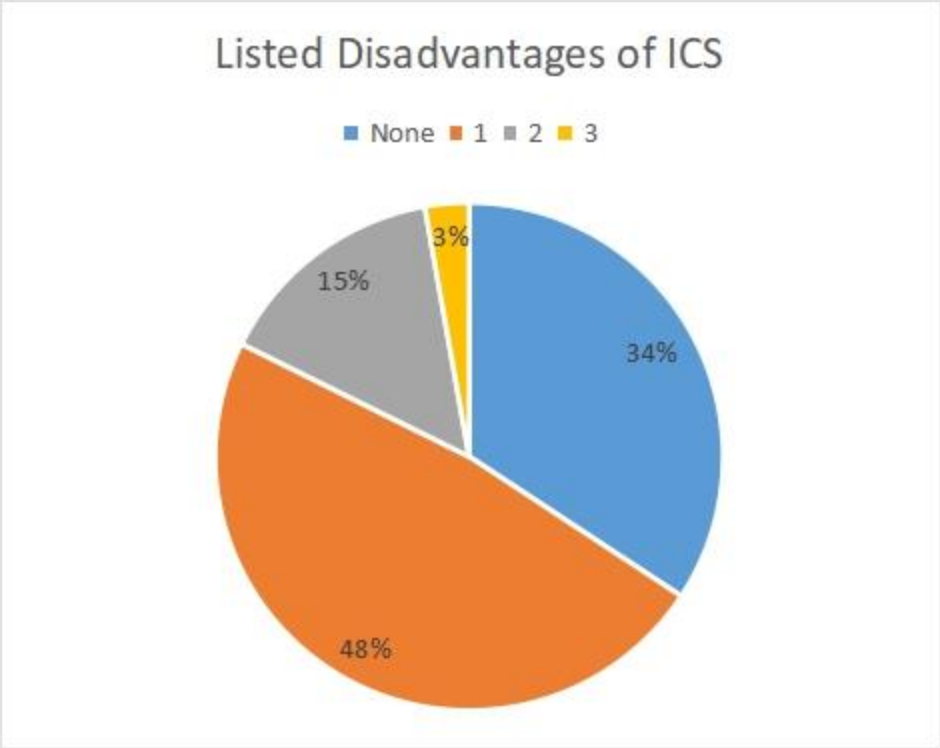
I. Disadvantages of Improved cook stove (ICSwd)

Measuring the level of knowledge or the negative aspects of ICS followed a similar index scheme as measuring the benefits(A3 Table 17).

A3 Table 17 Disadvantages of ICS Index

Listed Disadvantages of ICS	Weighted
0	0
2≥	1
3≤	2

Majority (48%) of the respondents could only list one correct disadvantage of ICS, while a 34% could not list any correct answer followed by 15% and 3% who could list two (2) and 1(one) answer respectively (A3 Figure 6).



A3 Figure 6 Listed Disadvantages of ICS

The respondents listed (i) Expensive to obtain, (ii) Not durable as the two most common disadvantages of ICS (A2 Table 5).

A3 Table 18 Weighted Disadvantages ICS (ICSwd)

Weight/ Score	Frequency	Percent
0	149	82.3
1	27	14.9
2	5	2.8
Total	181	100

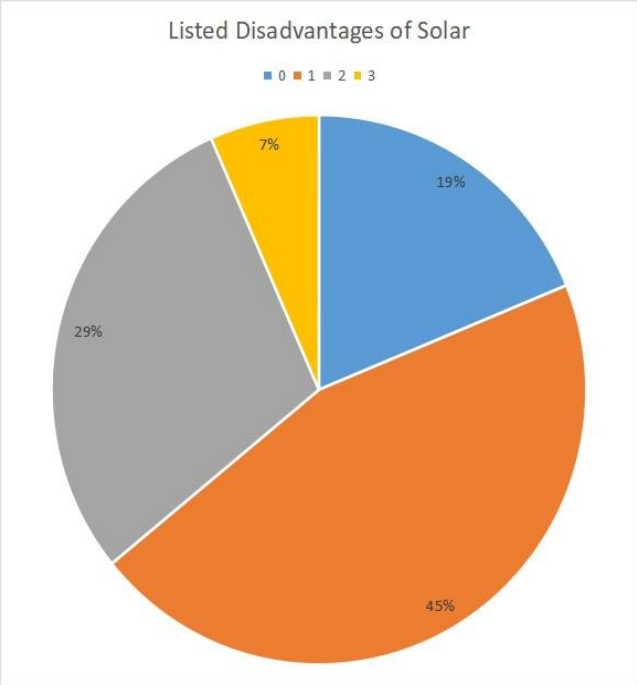
The Average *ICSwd* index score for the respondents was 0.20 (A2 Table 14**)**, which shows **low** knowledge of disadvantages of Improved Cookstoves.

II. Disadvantages of Solar (Swd)

A3 Table 19 Solar Weighted Disadvantages Index

Listed disadvantages of Solar	Weighted
0	0
2≥	1
3≤	2

Solar proved to be the most understood of the three RETS, 45% of the respondents correctly listed one (1) disadvantage with 19% having zero (0) correct answer, 29% and 7% listed 2 and 3 correct disadvantages respectively (A3 Figure 7). Majority of the correctly listed responses centred around (i) Affected by the weather/depends on sunlight (ii) Theft (iii) Not accessible (A2 Table 5).



A3 Figure 7 Listed Disadvantages of Solar

A3 Table 20 Weighted Disadvantages of Solar (Swd)

Weighted Score	Frequency	Percent
0	116	64.1
1	53	29.3
2	12	6.6
Total	181	100

The Average S*wd* index score for the respondents was **0.43** (A2 Table 9**)**, which shows **moderate level** knowledge of disadvantages of solar.

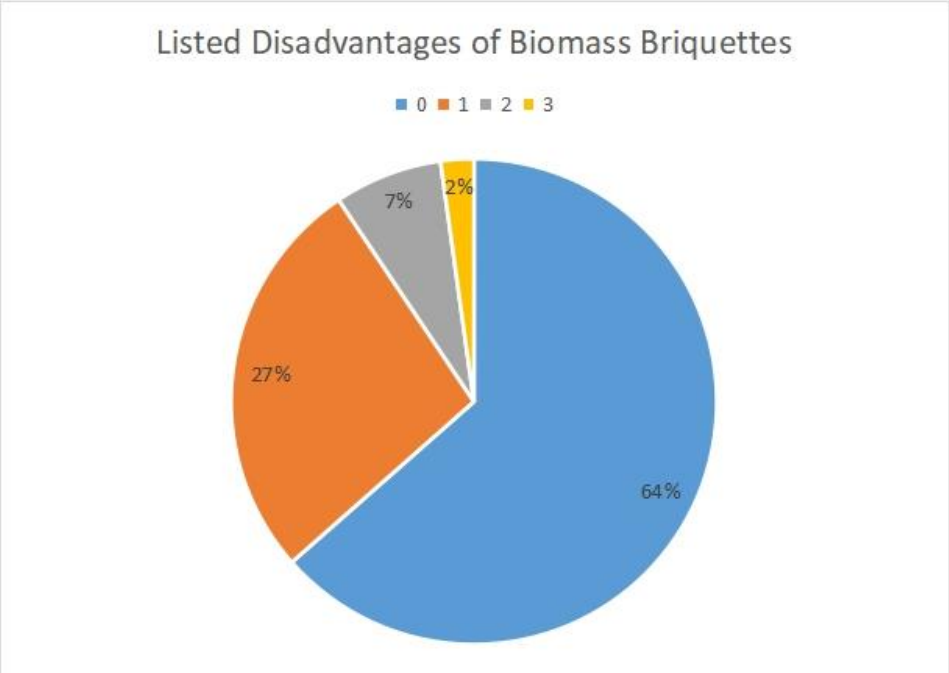
III. Disadvantages of Biomass Briquettes (BBwd)

A3 Table 21 Biomass Briquettes Weighted Disadvantages Index

Listed disadvantages of Biomass Briquettes	Weighted

0	0
2≥	1
3≤	2

Biomass briquettes were the least understood of the three RETS, 64% of the respondents could not list any correct disadvantage, 21% could list 1 correct disadvantage, 7% and 2% could list 2 and 3 correct disadvantages respectively (A3 Figure 8).



A3 Figure 8 Listed Disadvantages of Biomass Briquettes

A3 Table 22 Weighted Disadvantages of Biomass Briquettes (BBwb)

Weighted/ Score	Frequency	Percent
0	164	90.6
1	13	7.2
2	4	2.2
Total	181	100

The Average *BBwd* index score for the respondents was 0.12 (A2 Table 13**)**, which shows low level of knowledge of disadvantages of biomass briquettes. This also happens to be the lowest score for both benefits and disadvantages of the selected RETS.

In order to extract net disadvantages of RET knowledge the following equation was used;

$$RETwd = (ICSwd + Swd + BBwd)/3$$

Where

$ICSwd$ = Improved cook stove weighted disadvantages

Swd = Solar weighted disadvantages

$BBwd$ = Biomass briquettes weighted disadvantages

A3 Table 23 Descriptive Statistics for RETwd

	N	Mean	Std. Deviation	Variance
RETwd	181	0.249	0.350	0.122

From the results obtained the overall average RETwd score was 0.249±.35 (A3 Table 23) indicating a low level of awareness to the disadvantages of the selected RETS. Among the four wards sampled, Miseipei had the highest average score of 0.372±0.394 followed by Njoro, Sigotik and Mukungugu with, 0.250±0.414, 0.173±0.233, 0.172±0.290 respectively (A3 Table 24).

A3 Table 24 Summary of RETwd data for wards in Njoro Sub-County. Mean±SE

	Ward							
	Misepei		Njoro		Sigotik		Mukungugu	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
RETwd	0.372	0.394	0.250	0.414	0.173	0.233	0.172	0.290

A3.3 Independent variable: *Socioeconomic status*

Was defined as the position and status of the head of household in the community as dictated by his/her household income, asset-based wealth level, educational level, and status in society.

The variable will be operationalised in Likert scale categories of:

A3 Table 25 Operationalization of Variable Socioeconomic status

POSITION AND STATUS IN THE COMMUNITY	WEIGHTED
Very high Status	5
High Status	4
Moderate Status	3
Low Status	2
Trivial or no status	1

The socioeconomic status variable was constituted by educational level, household income level, asset based wealth index, and status in society, which was constructed into an index by summing up of the four indicators.

The indicators were operationalised as follows:

A3.3.1 Education level

The respondents were questioned on the household head's level of education.

A3 Table 26 Indicator Education Level (Edl)

	Education Level	Weight
1	No education -Pre-primary -	1
2	Primary -	2
3	Secondary -	3
4	College -	4
5	Graduate and post graduate -	5

A3.3.2 Household Income

Household income was divided into 5 categories

A3 Table 27 Household Income Groupings

Income Range	Weight
0-5,000	1
5,001-15,000	2

15,001-30,000	3
30,001-50,000	4
Above 50,001	5

A3.3.3 Asset based wealth index:

Principal components analysis (PCA) was employed to generate household asset-based proxy indices. Household were later grouped into quintiles, from wealthiest to the poorest.

A3 Table 28 Asset Based Wealth Status (Abws)

Household Wealth Index	Weight
Poorest	1
Somehow Poor	2
Average	3
Above Average	4
Wealthiest	5

A3.3.4 Status in Society/ Leadership Position

A3 Table 29 Indicator Status in Society (SIS)

	Status in Society	Weight
1	Ordinary citizen	1
2	Religious Leader	2
3	Elder	3
4	Member of County Assembly	4
5	Member of Parliament	5

SES = (Edl+HHI+Abws+SIS)/4

Where

Edl = education level

HHI= Household Income

Abws = Asset Based Wealth Index

SIS= Status in Society

A3.4 Independent variable: Actors promoting renewable energy use

Is defined in this study as the existence of Government and Non-Governmental Organizations (civil society organizations) and other players who promote the use and improve effective adoption of RETs through trainings, demonstrations and other community outreach activities.

The variable was operationalized in Likert scale categories of:

A3 Table 30 Operationalization of Variable actors promoting renewable energy use

ACTORS PROMOTING RETs ADOPTION	WEIGHTED
Very Many	5
Many	4
Moderate number	3
Few	2
Trivial	1

The actors promoting renewable energy use variable will be constituted by number of actors promoting RETs, trainings conducted on RETs and demonstration sites for RETs,

The indicators will be operationalized by construction of indices over the range of responses collected.

A3 Table 31 Number of Actors Promoting RETs

ACTORS PROMOTING RETs ADOPTION	WEIGHTED
Very Many Actors	5
Many Actors	4
Moderate number of actors	3
Few Actors	2
No Actors	1

A3 Table 32 Trainings conducted on RETs

TRAININGS CONDUCTED ON RETs	WEIGHTED
Very Many Trainings	5
Many Trainings	4
Moderate number of Trainings	3
Few Trainings	2

No Training	1

A3 Table 33 Demonstration sites for RETs

DEMONSTRATION SITES FOR RETs	WEIGHTED
Very Many Demonstrations	5
Many Demonstrations	4
Moderate Demonstrations	3
Few demonstrations	2
No demonstrations	1

A3.5 Intervening variable: Government policies

Is defined in this study as the existence of policies, regulations and laws that enhance and improve effective adoption of RETs. A content analysis of National policy documents covering renewable energy technologies in Kenya is analysed.

APPENDIX 4: POLICY

A4 Table 1 KEBS Cook Stove and Related Technology Standards (Kenya Bureau of Standards.)

	Title statement	KS Number	Other call number	Publication, distribution etc. (Imprint	Summary	Index Term	Series statement added entry - title
I.	**COOK STOVES**						
1	Biomass stoves - Performance requirements	KS 1814:2018	97.040.20	2018	Specifies the performance requirements for biomass stoves.	Cooking appliances.	
2	Cylinders for acetylene - Basic requirements - Part 2: Cylinders with fusible plugs.	KS ISO 3807-2:2000	23.020.30	2000	Specifies the basic requirements for acetylene cylinders with shell made from steel and equipped with fusible plugs with a maximum nominal water capacity of 150 L	Gas cylinders	Published in: Kenya Gazette Notice No. 7169 of 2000-11-03
3	Ethanol fuelled cooking	KS	97.040.20	2018	Covers the requirements	Cooking	

	appliances-Specification.	2759:2018			for ethanol fuelled appliances for cooking and heat generation in households.	ranges.	
4	Specification for non-pressure stoves (Second Edition).	KS 1064:2000		2000	Covers the requirements for the capillary - fed, multi-wick type, non-pressure stoves	Non-pressure stoves	Published in: Kenya Gazette Notice No. 7169 of 2000-11-03
5	Domestic biogas stoves - Specification	KS 2520: 2014	ICS 97.040.20	2014	Covers construction, operation, safety requirements and methods of test for stoves intended for use with biogas	Biogas Domestic biogas stoves	
II. LIGHTING SOLUTIONS							
6	*Specification for paraffin lighting appliances for domestic use (Third Edition).	KS 1063:2000		2000	Specifies construction and performance requirements for lighting appliances intended by	Paraffin lighting appliances	Published in: Kenya Gazette Notice

					manufacturers for domestic use and using paraffin as the fuel. It covers pressure and non-pressure appliances for indoor and/or outdoor use		No. 7169 of 2000-11-03
III. BIOFUELS							
7	Solid biofuels - Fuel specifications and classes - Part 2: Graded wood pellets.	KS ISO 17225-2: 2014	27.190; 75.160.10	2014(Adopted 2016)	Determines the fuel quality classes and specifications of graded wood pellets for non-industrial and industrial use.	Fuel specifications. Biofuels. Graded wood pellets. Fuel specifications and classes. Bioenergy.	
8	Solid biofuels - Fuel specifications and classes	KS ISO 17225-3: 2014	27.190; 75.160.10	2014(Adopted 2016	Determines the fuel quality classes and specifications of graded wood briquettes.	Fuel specifications and classes. Bioenergy.	

9	Solid biofuels - Fuel specifications and classes Part 4: Graded wood chips.	KS ISO 17225-4: 2014	27.190; 75.160.10	2014(Adopted 2016).	Determines the fuel quality classes and specifications of graded wood chips	Fuel specifications and classes. Bioenergy	
1	Solid biofuels - Fuel specifications and classes Part 5: Graded firewood.	KS ISO 17225-5: 2014	27.190; 75.160.10	2014(Adopted 2016)	Determines the fuel quality classes and specifications of graded firewood.	Solid biofuels. Graded firewood. Fuel specifications and classes. Bioenergy	
1	Solid biofuels - Fuel specifications and classes Part 6: Graded non-woody pellets.	KS ISO 17225-6: 2014	27.190; 75.160.10	2014(Adopted 2016)	Determines the fuel quality classes and specifications of graded non-woody pellets.	Solid biofuels. Graded non-woody pellets. Fuel specifications and classes. Bioenergy	
1	Solid biofuels - Fuel	KS ISO	27.190;	2014(Adopted	Determines the fuel	Solid biofuels.	

	specifications and classes Part 7: Graded non-woody briquettes.	17225-7: 2014	75.160.10	2016)	quality classes and specifications of graded non-woody briquettes.	Graded non-woody briquettes. Fuel specifications and classes. Bioenergy	

Sourced from Kenya Bureau of Standards Online catalogue

APPENDIX 5: SAMPLE QUESTIONNAIRE

Type	Question	Response
	Survey Date	2019-02-26
	Survey Start Time	15:11:00.000+03
	Enumerator Name	Martin Njoroge
	GPS location	-0.42440833333333333 35.92503333333333 2266.3 5.0
Household Demographic Details		
	Ward	Nesuit
	Sub-Location (Nesuit Ward)	Sigotik
abc	Village	Tachasis A
abc	Household Head Name	Peter Langat
Household ID		
123	Respondent Age	35
	Respondent Gender	Male

	1. Marital status (hh)?	Married
	2. Can you read or write?	Yes
	3. Highest level of education attained by household head?	Secondary
	4. Do you engage in informal /business activity?	Yes
abc	5. What is your current occupation/ job	Security
	6. Does your household receive any remittances from members not currently living here?	No
123	7. How long has your family lived in this constituency?	25
123	8. How many people currently reside in your household?	7
Repeat group: Leadership Position in Community		
	10.1 Knowledge of the energy source?	• Firewood • Charcoal • Agro-waste • LPG • Kerosene • Petrol • Diesel • Electricity • Solar/home system • Batteries-dry cell • Batteries car • Sawdust
Repeat group: 10.2 Household Energy Use		
	Who decides on how much & when to purchase ${etype}?	Spouse
	How has the Household changed its use of this ${etype} in the last 3 years	Increased
	Which Energy sources do you use in your household	Firewood
	What effect has ${echange} change in use of ${etype} brought to the household?	• Increased time • Less convenient • Increased costs
	Where is ${etype} obtained from?	Public forest
	Who in the household is mainly responsible for ${etype} payment?	Head
	Who is responsible for bringing ${etype} to the household?	Spouse
abc	What is the total quantity of ${etype} acquired by your household in the last 30 days?	100

123	What is the total cost your household paid for ${etype} in the last 30 days?	400
◉	What is the 1st main activity you use ${etype} for	Food preparation
1.0	What is the Total time spent obtaining ${etype} per trip(hrs)	0.5
1.0	Distance covered in km from your homestead to obtain ${etype}	0.1
abc	Number of trips per month to get ${etype}	4
◉	Who decides on how much & when to purchase ${etype}?	Spouse
◉	How has the Household changed its use of this ${etype} in the last 3 years	Constant
◉	Which Energy sources do you use in your household	Agro-waste
☰	What effect has ${echange} change in use of ${etype} brought to the household?	• Saved time • More convenient • Lowered costs
◉	Where is ${etype} obtained from?	Own farm
◉	Who in the household is mainly responsible for ${etype} payment?	Spouse
◉	Who is responsible for bringing ${etype} to the household?	Spouse

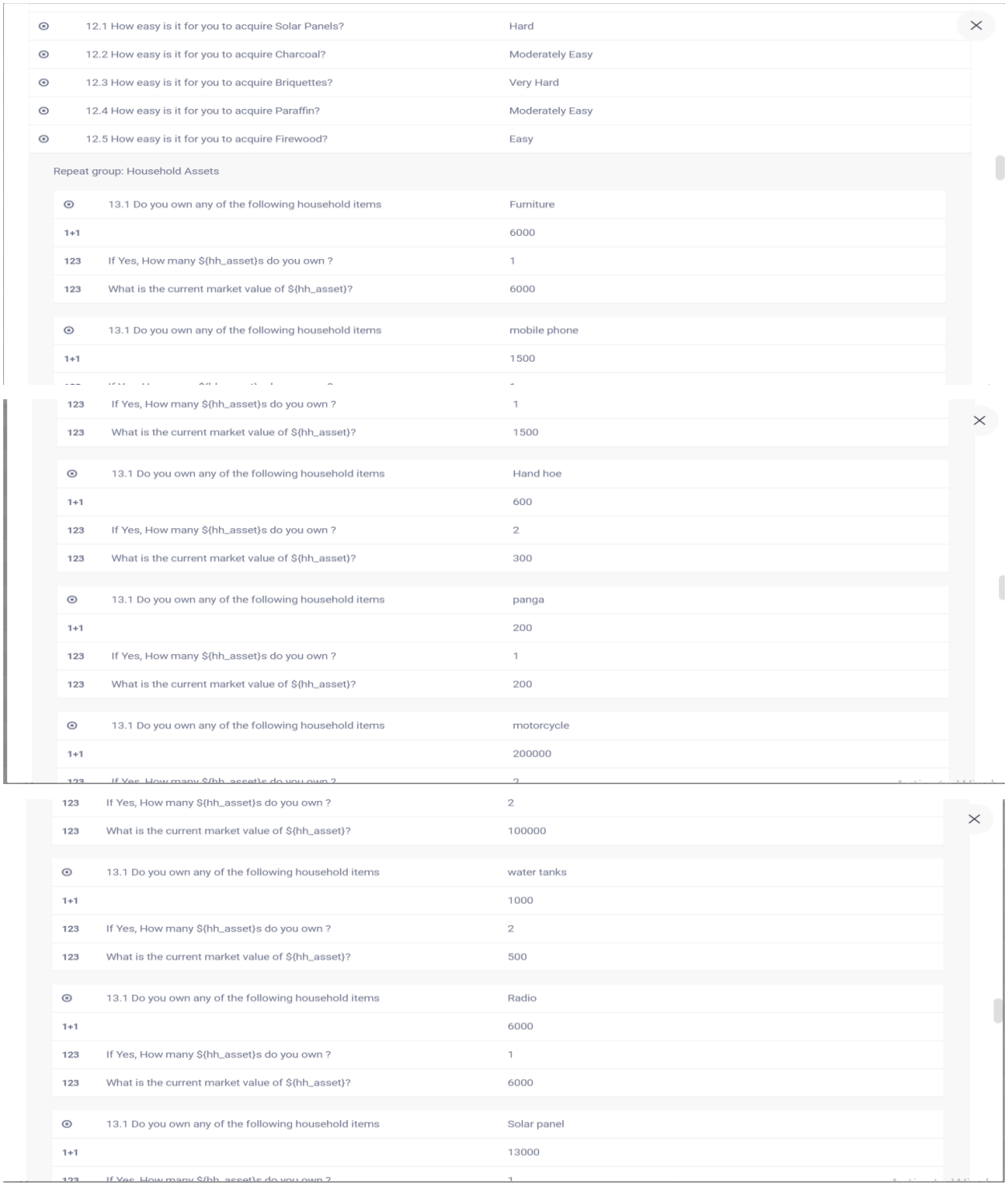
abc	What is the total quantity of ${etype} acquired by your household in the last 30 days?	160
123	What is the total cost your household paid for ${etype} in the last 30 days?	0
◉	What is the 1st main activity you use ${etype} for	Food preparation
1.0	What is the Total time spent obtaining ${etype} per trip(hrs)	0.0
1.0	Distance covered in km from your homestead to obtain ${etype}	0.0
abc	Number of trips per month to get ${etype}	0
◉	Who decides on how much & when to purchase ${etype}?	Head
◉	How has the Household changed its use of this ${etype} in the last 3 years	Constant
◉	Which Energy sources do you use in your household	Solar/home system
☰	What effect has ${echange} change in use of ${etype} brought to the household?	• Saved time • More convenient • Lowered costs
abc	If Other Energy Use please specify	Radio
◉	Where is ${etype} obtained from?	Sun

◉	Where is ${etype} obtained from?	Sun
◉	Who in the household is mainly responsible for ${etype} payment?	Head
◉	Who is responsible for bringing ${etype} to the household?	Head
1.0	Distance covered in km from your homestead to obtain ${etype}	0.0
123	What is the total cost your household paid for ${etype} in the last 30 days?	0
◉	Do you have a 2nd use for ${etype}?	Yes
◉	If yes, what is the 3rd main activity you use ${etype} for	Other
◉	What is the 1st main activity you use ${etype} for	Lighting
◉	Do you have a 3rd use for ${etype} ?	Yes
◉	If yes, what is the 2nd main activity you use ${etype} for	Phone charging

2nd Energy Use

3rd Energy Use

◉	Q11.1 Do you know of renewable energy technologies?	No



	12.1 How easy is it for you to acquire Solar Panels?	Hard
	12.2 How easy is it for you to acquire Charcoal?	Moderately Easy
	12.3 How easy is it for you to acquire Briquettes?	Very Hard
	12.4 How easy is it for you to acquire Paraffin?	Moderately Easy
	12.5 How easy is it for you to acquire Firewood?	Easy

Repeat group: Household Assets

	13.1 Do you own any of the following household items	Furniture
1+1		6000
123	If Yes, How many ${hh_asset}s do you own ?	1
123	What is the current market value of ${hh_asset}?	6000
	13.1 Do you own any of the following household items	mobile phone
1+1		1500
123	If Yes, How many ${hh_asset}s do you own ?	1
123	What is the current market value of ${hh_asset}?	1500
	13.1 Do you own any of the following household items	Hand hoe
1+1		600
123	If Yes, How many ${hh_asset}s do you own ?	2
123	What is the current market value of ${hh_asset}?	300
	13.1 Do you own any of the following household items	panga
1+1		200
123	If Yes, How many ${hh_asset}s do you own ?	1
123	What is the current market value of ${hh_asset}?	200
	13.1 Do you own any of the following household items	motorcycle
1+1		200000
123	If Yes, How many ${hh_asset}s do you own ?	2
123	What is the current market value of ${hh_asset}?	100000
	13.1 Do you own any of the following household items	water tanks
1+1		1000
123	If Yes, How many ${hh_asset}s do you own ?	2
123	What is the current market value of ${hh_asset}?	500
	13.1 Do you own any of the following household items	Radio
1+1		6000
123	If Yes, How many ${hh_asset}s do you own ?	1
123	What is the current market value of ${hh_asset}?	6000
	13.1 Do you own any of the following household items	Solar panel
1+1		13000
123	If Yes, How many ${hh_asset}s do you own ?	1

123	If Yes, How many ${hh_asset}s do you own ?	1
123	What is the current market value of ${hh_asset}?	13000
	13.1 Do you own any of the following household items	Stores
1+1		15000
123	If Yes, How many ${hh_asset}s do you own ?	1
123	What is the current market value of ${hh_asset}?	15000
	14.1 Over the past one year, did anyone in your household own any livestock?	Yes

Repeat group: Livestock Owned by Household between Sept 2017-October 2018

123	How many ${livecode} were sold between September 2017 and October 2018?	0
	Do you own the following livestock	Local cow
123	How many ${livecode} did you own in September 2017	2
	Who is primarily responsible for ${livecode} ?	Spouse
	Who decides on the use of income from the sale of ${livecode} ?	Head
123	How many ${livecode} were purchased between September 2017 and October 2018?	0
123	How many ${livecode} were consumed between September 2017 and October 2018?	0
123	How many ${livecode} died between September 2017 and October 2018?	0
123	What is the current average value of ${livecode} per unit?	30000
	Who decides whether or not to sell ${livecode} ?	Head
123	How many ${livecode} were sold between September 2017 and October 2018?	0
	Do you own the following livestock	Chicken-indigenous
123	How many ${livecode} did you own in September 2017	10
	Who is primarily responsible for ${livecode} ?	Spouse
	Who decides on the use of income from the sale of ${livecode} ?	Head
123	How many ${livecode} were purchased between September 2017 and October 2018?	0
123	How many ${livecode} were consumed between September 2017 and October 2018?	0
123	How many ${livecode} died between September 2017 and October 2018?	0
123	What is the current average value of ${livecode} per unit?	500
	Who decides whether or not to sell ${livecode} ?	Head
	Do you or any member of this household belong to any group or organization?	No

Repeat group: Household Group Membership Details

Main housing

	16.1 What is the roofing material of the main house?	iron sheet
	16.2 What is the wall material of the main house?	mud
	16.3 What is the floor material of the main house	Earth/sand
123	16.4 How many rooms are used for sleeping	1
	17.1 What is household head's main occupation	Salaried employment

	17.1 What is household head's main occupation	Salaried employment
abc	18 What is the household's approximate monthly income	20000
Household Decision Making		
	19.1 Buying food	Head
	19.2 Buying cooking fuel	Head
	19.3 Buying fuel for lighting	Head
	19.4 Buying household products	Head
	19.5 Buying mobile phone credit	Head
	19.6 Buying cook stove	Head
	19.7 Saving up money for later use	Head
	19.8 Small investments (< 1000 Ksh)	Head
	19.9 Large investments (> 1000 Ksh)	Head
Cook stove Use and Purchase Details		
	20. What type of cook stove is your primary cooking device?	U shape, surrounded fire

Main cook Stove purchase details		
	22.4 What is the biggest determinant for choice of cook stove?	Popularity
Lighting Equipment Use and Purchase Details		
	23 What is the most used lighting equipment in your home?	Solar Lighting
	25.1 What kind of shop do you buy ${ltype}?	Electronics shop
abc	25.2 Which town is the ${lshop} you bought ${ltype}?	Njoro
abc	25.2.1 How far is ${lshop_town} from home?(KM)	10
abc	25.3 How much did you pay for ${ltype} the last time you bought?	13000
	25.4 What is the biggest determinant for choice of lighting equipment?	Brightness
Knowledge and ownership of RETS		
	26 Do you know anyone (else) that owns an improved cook stove?	Yes
	27 How aware are you of the benefits of improved cook stoves (ICS)?	Very
abc	28.1 List the benefits of ICS that you know?	Fuel efficient Uses many types of fuels

	29 How aware are you of the benefits of Solar Lanterns?	Moderately
abc	30.1 List the benefits of Solar Lanterns that you know?	Light at night Power radio
	31 Are you aware of the benefits of using biomass briquettes?	Not
	Q33.1 Have you participated in any meetings around the promotion of renewable energy technologies?	No
Repeat group: Capacity Building on RET details		
	34.1 Have you interacted with any University researchers or scientists in knowledge exchange and sharing?	No
Details of interaction with researchers or scientists		
	35 Do you know of any demonstration sites where you can be trained on renewable energy technologies?	No
Repeat group: Details of Demonstration Sites. Add multiple groups if available		
	36.0 Are there NGOs that operate in this area?	No
NGOs in locality		
	Survey End	15:31:00.000+03

NGOs in locality		
	Survey End	15:31:00.000+03
	start	2019-02-26T15:11:24.589+03
	end	2019-02-26T15:32:30.352+03
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APPENDIX 6: RESEARCH PERMIT FROM THE NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

THIS IS TO CERTIFY THAT:
MR. MARTIN NJOROGE KIMANI
of EGERTON UNIVERSITY, 532-217
Limuru,has been permitted to conduct
research in *Nakuru County*

on the topic: *ASSESSING THE DETERMINANTS OF ADOPTION OF RENEWABLE ENERGY TECHNOLOGY AMONG RURAL HOUSEHOLDS IN NJORO CONSTITUENCY NAKURU, KENYA*

for the period ending:
14th November,2018

Applicant's Signature

Permit No : NACOSTI/P/17/53659/18068
Date Of Issue : 15th November,2017
Fee Recieved :Ksh 1000

Director General
National Commission for Science, Technology & Innovation

A6 Figure 1 NACOSTI Certificate Side A

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REPUBLIC OF KENYA

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RESEARCH CLEARANCE PERMIT

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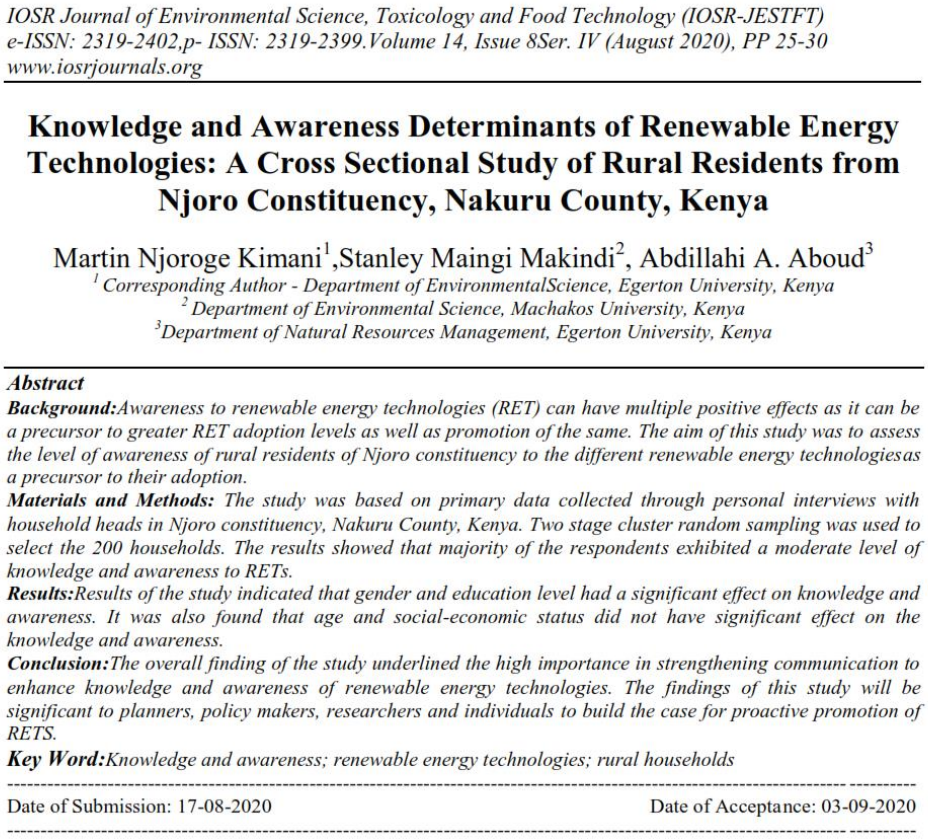
A6 Figure 2 NACOSTI Certificate Side B

APPENDIX 7: PUBLICATIONS

ABSTRACT

1. Knowledge and Awareness Determinants of Renewable Energy Technologies: A Cross Sectional Study of Rural Residents from Njoro Constituency, Nakuru County, Kenya – Published in the IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 14, Issue 8Ser. IV (August 2020), PP 25-30 www.iosrjournals.org



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Knowledge and Awareness Determinants of Renewable Energy Technologies: A Cross Sectional Study of Rural Residents from Njoro Constituency, Nakuru County, Kenya

Martin Njoroge Kimani[1],Stanley Maingi Makindi[2], Abdillahi A. Aboud[3]
[1] *Corresponding Author - Department of EnvironmentalScience, Egerton University, Kenya*
[2] *Department of Environmental Science, Machakos University, Kenya*
[3] *Department of Natural Resources Management, Egerton University, Kenya*

Abstract
Background:*Awareness to renewable energy technologies (RET) can have multiple positive effects as it can be a precursor to greater RET adoption levels as well as promotion of the same. The aim of this study was to assess the level of awareness of rural residents of Njoro constituency to the different renewable energy technologiesas a precursor to their adoption.*
Materials and Methods: *The study was based on primary data collected through personal interviews with household heads in Njoro constituency, Nakuru County, Kenya. Two stage cluster random sampling was used to select the 200 households. The results showed that majority of the respondents exhibited a moderate level of knowledge and awareness to RETs.*
Results:*Results of the study indicated that gender and education level had a significant effect on knowledge and awareness. It was also found that age and social-economic status did not have significant effect on the knowledge and awareness.*
Conclusion:*The overall finding of the study underlined the high importance in strengthening communication to enhance knowledge and awareness of renewable energy technologies. The findings of this study will be significant to planners, policy makers, researchers and individuals to build the case for proactive promotion of RETS.*
Key Word:*Knowledge and awareness; renewable energy technologies; rural households*

Date of Submission: 17-08-2020 Date of Acceptance: 03-09-2020

A7 Figure 1 Publication IOSR-JESTFT

2. Influence of Socio and Economic Factors on Adoption of Renewable Energy Technologies among Rural Households in Njoro Constituency Nakuru, Kenya – Published in the Egerton University 12th International Research Conference 2018.