FACTORS INFLUENCING USE AND ADOPTION OF CLEAN COOKING TECHNOLOGIES IN RURAL HOUSEHOLDS: A CASE STUDY OF BONDO SUB-COUNTY, KENYA

By

Otieno Roy Odongo

Z50/88326/2019

A Research Thesis Submitted to the University of Nairobi, in Partial Fulfillment of the requirements for the Award of the Degree of Master of Arts in Environmental Policy

November, 2019

DECLARATION

This thesis is my original work and has never been submitted for the award of a degree in the University of Nairobi or any other University.

Otieno Roy Odongo

M.A Environmental Policy

Center for Advanced Studies in Environmental Law & Policy

University of Nairobi

Signed: ……………………………………

Date: ………………………………………

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

Professor Stephen O. Anyango

Center for Advanced Studies in Environmental Law & Policy

University of Nairobi

Signed: ……………………………………

Date: ………………………………………

Professor Nicholas O. Oguge

Center for Advanced Studies in Environmental Law & Policy

University of Nairobi

Signed: ………………………………………..

Date: …………………………………………..

ACKNOWLEDGEMENT

I am grateful to God for granting me the gift of life to be able to live and reach this level in the academic ladder. My heartfelt gratitude goes to my Parents Hawkins and Josephine for imparting in me the values of hard work and commitment. I sincerely thank my family, led by my wife Faith Diana and our two lovely daughters Fiffie Salama and Arriella Imani for their patience and moral support throughout the period of my studies.

This work would have not been complete without the dedicated guidance of my supervisors, Professor Nicholas Oguge and Professor Stephen Anyango. I sincerely thank them for their selfless service in imparting knowledge and I am indeed proud to have learnt at the feet of these two academic gentlemen. My gratitude extends to Professor Richard Mulwa, who having been appointed to guide me in making corrections to the Thesis after the oral examination, did so with unprecedented precision and great humility. To him I say thank you very much!

To my classmates in the Master of Environmental Policy Class of 2016, you were a great lot and I benefitted immensely from your collective insights on our subject of study. Lastly, I thank the Faculty and staff at the Center for Advanced Studies in Environmental Law and Policy (CASELAP). Led by the Director Dr. Collins Odote for their pieces of advice and ensuring that, CASELAP has a conducive and ethical academic environment.

DEDICATION

I dedicate this Thesis to my daughter Abbey Simphiwe Otieno, who came to us as a gift and left soon just as we were unwrapping our gift. Your birth on 28th June 2018 lit up and brought boundless joy to our family. Your sudden departure on 19th January 2019 left a gaping hole in the hearts of your dear Papa, Mama, lovely sisters Fiffie and Arriella and all those who knew you. Though gone, you will forever remain to be part of us till we meet again. Fair thee well Abbey!

Abstract

Use of inefficient biomass pyrolysis stoves is a major driver of the degradation of biomass energy resources. As a mitigation measure, use of improved cookstoves has been promoted. However, only 14.5% of households in Siaya County and Bondo Sub-County use improved cookstoves. The objective of this study was to analyze the factors influencing use and adoption of, clean cooking technologies in rural households in Bondo Sub-County. The specific objectives were to, establish the types of cooking energy and technologies used by households. Determine the influence of household characteristics and social-interactions on the use and adoption of, the technologies and determine how, the policy and institutional set-up influences the use and adoption of, the technologies by households in Bondo Sub-County. The study theoretical framework and design, was based on the Technology Acceptance Model, using mixed methods approach. Quantitative data was obtained through household survey questionnaires. Qualitative data was obtained from literature review. The main type of cooking energy used by households in the study area was firewood (62%). The households predominantly used the traditional three stones cookstoves for cooking (62%). The results of a binomial logistic regression analysis showed that: age, income and the household's awareness of a business entity engaged in the sale and repair of improved cookstoves, significantly influenced use of improved cookstoves in the study area. Policies on biomass energy and cooking technologies are domiciled in different Government ministries. This has given rise to incoherent coordination of their implementation. There is however no policy in place at, Siaya County level that address biomass energy and clean cooking technologies. Even though, private enterprises and Non-Governmental Organizations are engaging in the promotion of clean cooking technologies, institutional involvement in promotion of clean cooking technologies is weak. This study recommends creation of more awareness on, the benefits of using clean cooking energy and technologies. That private businesses be incentivized to, engage in production, dissemination and maintenance of clean cooking technologies. That a Siaya County level policy on, biomass energy and household cooking technologies be formulated to, facilitate implementation of national policies and guarantee, funding for promotion of clean cooking technologies. In conclusion, only 26 percent of the households were using improved cookstoves. This is attributable to, the low level of awareness of the benefits of clean cooking technologies, low incomes and weak involvement of institutions in promoting clean cooking technologies in Bondo Sub-County.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADP	Annual Development Plan
BC	Black carbon
BLR	Binomial Logistic Regression
CASELAP	Center for Advanced Studies in Environmental Law & Policy
CFP	Country Focal Point
CIDP	County Integrated Development Plan
ESMAP	Energy Sector Management Assistance Programme
FGD	Focused Group Discussion
GACCS	Global Alliance for Clean Cookstoves
GVEP	Global Village Energy Partnership
ICS	Improved cookstove
KBS	Kenya Bureau of Standards
KII	Key Informant Interviews
KIRDI	Kenya Industrial Research and Development Institute
LDC	Least developed countries
LPG	Liquified Petroleum Gas
MT	Metric Tons
NAMA	Nationally Appropriate Mitigation Action
NGO	Non-Governmental Organizations
PAC	Percentage Accuracy in Classification
PEOU	Perceived ease of use
PU	Perceived usefulness
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Scientists
UNDESA	United Nations Department of Economic and Social Affairs
USAID	United States Agency for International Development
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background

About 2.5 billion people in the world rely on biomass as a source of cooking energy (IEA, 2017). As an energy source, biomass is utilized in either of two ways. Directly by burning the biomass and indirectly by converting it into solid, liquid or gaseous fuels (Abhishek et al., 2015). Solid biomass fuels constitute an energy source which is widely available, renewable and blends with the local way of life, making them fuels of choice for most households (HH) in rural Sub-Saharan Africa and South East Asia (Bagozzi, 2013). 730 million people use solid biomass fuels for cooking mostly in, poorly ventilated spaces using inefficient biomass pyrolysis technologies in Sub-Saharan Africa (IEA, 2014). With the abundance of these fuels, the use of inefficient biomass pyrolysis stoves such as the traditional three stones cookstoves is rampant (Bagozzi, 2013). This has been linked to the rapid decline of biomass energy resources due to their unsustainable harvesting and use (Rewald, 2017). The decline increases the overall costs of biomass fuels and the time spent in the collection of wood fuel especially by women and children (Rewald, 2017). The predominant type of biomass energy used by households, is wood fuel derived mainly from agricultural wastes, crop residues, surrounding bushes and forests (Kurchania, 2012).

Three hundred million metric tons (MT) of wood is consumed in Sub-Saharan Africa annually as fuel for cooking. 130-180 million MT of wood is harvested for charcoal production annually, contributing to forest degradation, biodiversity loss and in some instances, localized deforestation (World Bank, 2014). In Sub-Saharan Africa, solid biomass fuel use and charcoal-fuel production generate 120-380 million MT of carbon dioxide (CO_2) equivalent of Kyoto protocol greenhouse gases (GHG) accounting for 0.4-1.2% of global CO_2 emissions. The use of solid biomass based fuels for cooking in Sub-Saharan Africa also accounts for 6% of global black carbon (BC) emissions. BC contributes to local climate change and may be a key anthropogenic driver of global warming (Bond et al., 2013). Rural households and a smaller proportion of the urban population in Kenya, predominantly use firewood for cooking (KNBS, 2018). Charcoal use in rural and urban households in Kenya stands at about 7 % and 30 % respectively.

An estimated 21,560 deaths occur annually in Kenya because of indoor air pollution due to the use of biomass fuels for cooking (MoE & P, 2019), with a direct impact on the health of 14.6 million other Kenyans. In Siaya County 84.2 % of households use firewood for cooking with 13.2 % of the households using charcoal (SCIDP, 2018). Widespread use and adoption of improved cookstoves (ICS) has the potential of reducing the generation of carbon dioxide due to charcoal production and consumption in Sub- Saharan Africa. Of the 3 billion people relying on solid biomass fuels for cooking worldwide, fewer than 30% of them use improved cookstoves. In Sub-Saharan Africa, the situation is even dire since, less than 6% of people relying on the fuels for their cooking energy needs actually use some form of improved cookstoves (UNDP, 2009). In Kenya, less than 37 percent of households use a form of improved cooking energy technology. Most households use cooking devices with low thermal energy efficiency ratios and high negative health impacts associated with indoor air pollution (Basu, et al., 2016). In Siaya County, 71.4 percent of households use the traditional three stones stove to burn firewood for cooking and only 14.5% of the households use an improved cookstove (ICS) for their cooking needs (SCIDP, 2018).

Women and girls bear the greatest burden of the effects of inefficient cook stoves using biomass fuels (Kohlin et al., 2011). In developing countries like Kenya, cooking remains to be a woman's responsibility, hence the women not only bear the burden of cooking for their families but of also gathering and collecting the wood fuel needed for cooking. This is rarely counted as productive or compensated labour (World Bank, 2011a). With long hours spent away from home, in far and isolated places, the risk of gender-based violence like rape and physical assault for alleged trespass into private properties increases (Clancy et al., 2011). These risks to women and girls are avoidable if investments were made in efficient cook stoves and households went ahead and adopted them for long-term use. With more time spent fetching firewood and related tasks, women and girls are often left with less time to pursue other productive activities. Like, gainful employment and other ventures that can result into income for the household (Carr et al., 2010).

Successful achievement of widespread use of more efficient and clean cooking devices like the improved cookstoves, has the potential effect of contributing to the achievement of at least five of the Sustainable Development Goals (SDGs) (Rosenthal et al., 2018). For instance, reduction of under-5 deaths and related illnesses due to indoor air pollution (SDG 3); empowerment of women and girls by improving access to enabling technologies such as improved cookstoves (SDG 5); providing access to reliable, efficient and modern energy through the provision of affordable, reliable and modern energy to all by 2030 (SDG 7); Combating climate change through the implementation of climate measures in national policies (SDG 13) and the sustainable management of forests by reducing deforestation, land degradation and desertification (SDG 15).

There is evidence that considerable efforts have been made to promote clean and efficient cooking technologies. However there is also evidence that, this efforts have not led to the desired results since the use of inefficient biomass pyrolysis technologies is still rampant. At the global level, significant resources have been put into initiatives aimed at improving the household cooking energy situation especially for the least developed countries (LDCs). The Energy Sector Management Assistance Programme (ESMAP) funded by the World Bank since 1980 is one such initiative. ESMAP funded a project for clean cooking solutions for households in Kenya to the tune of six million US dollars. This project aimed to support the transition from low efficiency cook stoves to cleaner higher efficiency improved cook stoves in five counties in Kenya (World Bank, 2017). Other initiatives for improved cook stove include the Global Alliance for Improved Cook Stoves, which works in collaboration with a local organization known as the Kenya Alliance for clean cook stoves. These organizations have over the years partnered with various Government of Kenya entities to improve access to clean and improved cook stoves in Kenya. In Siaya County, projects aimed at increasing access to clean and improved cooking technologies have been implemented over the years, some of these projects include; the carbon offset project funded by myclimate, which was designed to develop improved cook stoves for distribution to households in Siaya County.

The seemingly persistent use of inefficient cooking technologies has been a subject of numerous studies around the world to understand why this is so. A review of literature shows that, the determinants of clean cooking technologies use, and adoption falls into three categories namely, socio-economic and demographic factors, stove-related factors and the policy and institutional framework in place for the management and regulation of energy sectors in general (Vigolo et al., 2018). Various studies return different results on the influence of these factors on clean cooking technologies. Some find significant influence while some studies find no significant relationships. Gender as a factor has been widely reported on as a significant factor in cookstove use and adoption. For instance, in rural India, it was suggested that female headed households had a higher likelihood of consistently using clean and efficient cooking technologies such as the ICS (Brooks et al., 2016).

The level of education of the household head has also been suggested to have significant influence on use and adoption. Low rates of ICS use and adoption were observed in a study conducted in Kiambu, Kenya attributed to low levels of education. However some studies suggest no relationships between ICS use and level of education (Kulindwa et al., 2018). Stove related factors such as design and affordability have been suggested to either positively or negatively influence their use and adoption. For instance a stove that can be used for multiple uses such as cooking and heating increases the prospects of the household using it consistently for a long period of time (Rehfuess et al., 2014). Household social interactions exposes it to the latest trends within its surroundings. Decisions to purchase a clean cooking device are often made as a result of experiences shared by others. In rural Mali a study suggested that information received from peers positively influenced household heads to purchase an improved cookstove. This has also been observed, in studies conducted in various parts of rural Kenya (SEI, 2017). Thus in an attempt to determine the factors influencing use and adoption of clean cooking technologies in Bondo Sub-County, no assumption was made to the effect that no studies had been conducted on the same subject. Rather, it was the intention of this study to compare the findings against the existing literature and fill the gaps in knowledge as to the determinants of households' use and adoption of the technologies.

1.2 Statement of the Research Problem

Use of inefficient biomass pyrolysis stoves is a major driver of the degradation of biomass energy resources (MENR, 2016). Households cooking using inefficient biomass pyrolysis stoves has resulted in adverse health and environmental effects, such as respiratory diseases and indoor air pollution in Bondo Sub-County (SCIDP, 2018). To reverse this trend, use of improved cookstoves has been promoted in the Sub County by various actors including the Government of Kenya, Non-Governmental Organizations (NGO) and Kenya's development partners such as the World Bank. In promoting the use of the improved cookstoves, efforts have been made to address the inherent characteristics of households such as gender, age, level of education, income and type of household dwelling that have been thought to influence their use and adoption. The social relations of households such as membership to social organizations and access to credit too, have been targeted to enhance uptake of clean cooking technologies. In addition to these, the Government of Kenya has made efforts to improve the household cooking energy and technology situation. This has been done through, re-aligning the management of the energy sector with the enactment of the Energy Act (MoE, 2019). The act empowers County Governments to regulate the biomass energy sector in the counties through policy formulation and enabling legislation. Further the National Government has formulated policies such as the Kenya Climate Change Framework Policy that calls for universal use and adoption of improved cookstoves to build resilience to climate variability (MENR, 2016). Provisions were made in the Kenya National Climate Change Action Plan 2014-2018 for the development and distribution of four million improved cookstoves to Kenyan households by the year 2020 (MENR, 2014).

Despite these efforts and the inherent risks of using inefficient cookstoves, only 14.5% of households in Siaya County and by extension Bondo Sub-County use improved cookstoves (Basu et al., 2016), with over 80% burning fuelwood using inefficient cook stoves to meet their cooking needs (SCADP, 2018). In response, this study set out to determine the factors influencing use and adoption of clean cooking technologies in the Sub-County and to establish if, there could be circumstances prevailing in the Sub-County that are not yet captured in the available literature that influences households' use of efficient and clean cooking devices like the improved cookstoves.

1.3 Research Questions

The Main research question in this study was: What factors influence the use and adoption of clean cooking technologies by households in Bondo-Sub County ? The sub-questions of the study were;

1. What are the types of cooking energy and technologies used by households in Bondo Sub- County ?
2. What is the influence of household characteristics and social interactions on the use and adoption of clean cooking technologies in Bondo Sub-County ?
3. How does the policy and institutional framework influence the adoption of clean cooking technologies by households in Bondo Sub-County ?

1.4 Research Objectives

The overall objective of this study was to determine factors influencing the use and adoption of clean cooking technologies by households in Bondo Sub-County. This was operationalized in the following specific objectives;

1. To establish the types of energy and cooking technologies used by households in Bondo Sub-County.
2. To determine the influence of household characteristics and social-interactions on the use and adoption of clean cooking technologies in Bondo Sub-County.
3. To determine how the policy and institutional set-up influences the adoption of clean cooking technologies by households in Bondo Sub-County.

1.5 Justification for the Study

The literature on household energy use in Kenya shows that biomass based energy sources is used to meet up to 70 % of household energy needs especially for cooking. In rural areas such as Bondo Sub-County, the percentage use of biomass energy sources for household cooking energy rises even further to reach and surpass the 80 % mark (SCIDP, 2018). There is an abundance of literature on the suggested determinants of household use of clean cooking technologies and programmes have been designed using these research findings to promote their use and adoption. The seemingly persistent non-use and non-adoption of these technologies raises the possibility that the reasons why the technologies are not being adopted have not been exhaustively addressed by research. Thus this study was designed to precisely explore the existence of this possibility that, there could be certain circumstances prevalent in the study area, that are yet to be captured in literature and that could be acting as barriers to households' use of clean cooking technologies.

The findings of this study can be used as part of baseline information on the current household cooking energy and technology use, the determining factors of households' use of clean cooking technologies and the extend of the policy and institutional influence on clean cooking technologies use in Bondo Sub-County. This can then be used to inform decisions, policy formulation and legislation on household energy and technology use in the County of Siaya. The findings of this study can be beneficial to the residents of Siaya County by providing data on their household cooking energy and technology situation to influence the channeling of resources towards alleviating their current situation. Lastly, this study can contribute to the enhancement of the existing knowledge base on the determinants of household use of clean cooking technologies and contribute in addressing the current knowledge gaps on the same.

1.6 Scope and Limitations of the Study

The study was conducted in South Sakwa Ward in Bodo Sub-County in Siaya County. The targeted population was the household heads in South Sakwa Ward regardless of whether they were using improved cookstove or not. The findings and results of the study were then intended to be generalized to the entire area of Bondo Sub-County and then to Siaya County. The study was mainly limited by the inadequate funding available which in turn limited the number of respondents to 100 households.

CHAPTER TWO: LITERATURE REVIEW

This chapter presents detailed information on the subject of study as contained in previous works of research, official reports and published Government of Kenya policies on biomass energy. It gives a synopsis on the global energy situation in general and narrows it down to the situation Africa, Kenya, Siaya County and finally Bondo Sub-County. The determinants of household cooking energy and technologies are discussed with reference to the available literature. The policy and institutional framework on biomass energy is also discussed in this section.

2.1 The Global Energy Situation

Currently, fossil fuels dominate the global energy supplies at approximately 450 exajoules[1] (EJ) per year. The dominant fossil fuels are coal at 158.9 EJ annually, oil at 165.6 EJ annually and natural gas at 125.4 EJ annually (UNDESA, 2018). Other sources include bio-fuels and waste at 52.6 EJ annually, nuclear at 27.8 EJ annually and electricity and heat at 21.4 EJ annually. In Africa, bio-fuels constitutes the largest share of its total energy supply at 14.3 EJ annually (UNDESA, 2018). Of the renewable energy in the global energy mix, biomass makes the most contribution providing 45 EJ annually (IEA, 2007) making bio-energy the most important source of renewable energy worldwide. The rate of adoption of biomass as a source of energy differs between the industrialized countries and the developing countries.

The contribution of biomass to the energy mix of industrialized countries stands at 10 % and in developing countries, it is 20-30%. In most developing countries, biomass provides up to 50-90% of their total energy demands (WEC, 2016). Renewable energy has the potential of forming up to 36% of the global energy mix by the year 2030 (Nakada et al., 2014). There has been a rapid increase in the production of liquid biofuels throughout the world aimed at the achievement of energy security and to mitigate greenhouse gas emissions. Studies have shown that small scale production of biofuels may be sustainable however, it is the long run sustainability of large scale production of biofuels that remains uncertain due to the inevitable consequences of biodiversity loss, conflicts with food production patterns and the projected net increase in greenhouse gas emissions.

[1] Exajoules is the hourly rate of consumption of electrical energy equated to 1,000,000 watts.

2.2 Energy in the Kenyan Context

Energy is one of the foundations of the Kenya Vision 2030. The vision prioritizes the development of new sources of energy to reduce the current high energy costs and increase efficiency in energy consumption (GoK, 2007). Kenya's main sources of energy supply are biomass based energy resources, fossil fuels, hydro and geothermal. Biomass based energy source constitutes the largest share of Kenya's energy supply at 10,771 kilotons of energy (ktoe) per annum, followed by fossil fuels at 4,300 ktoe per annum and electricity at 682 ktoe per annum (IEA, 2015). The total installed capacity of electricity in Kenya stands at 2,327 megawatts (MW) disaggregated into hydro (826 MW), thermal (806.9 MW), geo-thermal (652 MW), wind (26.1 MW) and co-generation (28 MW) (KNBS, 2018). Between the years 2014 and 2016, electricity access in Kenya increased from 36 % of the population to 46 %. Households in Kenya consume up to 22 % of the electricity produced in Kenya (Gordon, 2018). From 2016, the Government of Kenya targeted a connectivity rate of one million people per year for the next five years. About 70% of households use biomass as a source of energy. The dominant biomass energy used in Kenyan households are firewood and charcoal with rural households consuming up to 94 % of the total fuel wood production in Kenya (IEA-Kenya, 2018). According to the 2009, Kenya population census, over 80% of rural households use firewood as compared to 10% of urban households using firewood. Similarly, charcoal use in both rural and urban households stands at about 7 % and 30 % respectively (KNBS, 2010).

2.3 Biomass Energy

Biomass energy refers to fuel derived from organic matter. It is readily obtained from agricultural wastes and forest products. Agricultural wastes include, residual products from harvesting such as maize stocks and wheat brans, forest products include trees, branches and leaves (WEC, 2016). Other sources of biomass energy include; specially grown energy crops for the production of biofuels like bioethanol, processing wastes and municipal wastes (Kurchania 2012). 10 % of the world's energy needs is met by biomass energy sources (WEC, 2016). Firewood constitutes 68 % of total global mix of biomass energy sources, the other sources include, charcoal, pellets, forest residues, biogas, biodiesel and bioethanol (WEC, 2016).

Rural households in Kenya predominantly use firewood for cooking while a smaller proportion of the urban population also use firewood for cooking (KNBS, 2018). Charcoal use in both rural and urban households stands at about 7 % and 30 % respectively (KNBS, 2018). In Siaya County 82 %

of households use firewood for cooking with 13.6 % of the households using charcoal (SCIDP, 2018). The dominant use of biomass energy in Kenyan households, has implications on the sustainability of natural resources especially forests. Therefore, there is need to move away from the current uncontrolled production and consumption of biomass energy to a more efficient production and use system to ensure sustainability of the biomass energy resources (KFS, 2013). Biomass energy by nature, is widely available and is preferred for use due to its adaptability to small scale and large scale uses like household cooking and industrial heating (Kurchania, 2012).

The environmental benefits of using biomass energy include, reduced pressure on the non-renewable sources of energy such as fossil fuels and reduced greenhouse gas emissions through substitution for the fossil fuels (Kar & Keles, 2016). Biomass energy sustains a productivity value chain that is, economically beneficial and significantly contributes to Government revenue through taxes and income to the people involved. Unsustainable harvesting and use of biomass energy resources is the greatest threat to this value chain (KFS, 2013).

2.4 Biomass Energy, Household Health and the Environment

Though a renewable source of energy, biomass energy has inherent risks to both human health and the environment that calls for caution. These includes, the products of its combustion such as carbon dioxide and methane that has been identified as a major cause of global warming (WEC, 2016). For instance, charcoal production and consumption in Sub-Saharan Africa generates approximately 120-380 million metric tons of carbon dioxide which accounts for, approximately 1.2 % of global carbon dioxide emissions (IEA, 2014). Inefficient burning of biomass fuels leads to, incomplete combustion releasing toxic and harmful gaseous substance into the atmosphere that drive global warming (Bond et al., 2013).

Biomass based fuels use in households' is one of the main causes of household air pollution (Naeher et al., 2007). Most often, households use biomass fuels in inefficient stoves. Most of these stoves aid incomplete combustion of the biomass fuels in poorly ventilated living spaces leading to, significant emissions of toxic gaseous substances such as carbon dioxide and nitrous oxide. Household air pollution in turn, has significant impacts on the health of households, approximately four million premature deaths occur annually because of household air pollution, mainly attributed to the choice of household cooking energy (WHO, 2012). Household air pollution is responsible for up to 5% of the global burden of disease (WHO, 2012). In Kenya, 21,560 deaths occur annually because of of indoor air pollution due to the use of biomass fuels for cooking (MoE & P, 2019), this additionally, has a direct impact on the health of 14.6 million other Kenyans.

Women and young children bear the greatest burden of household air pollution since they spend more time around the inefficient cook stoves preparing meals for the family. Studies have shown that the inefficient traditional cook stoves, which are typically open fires, produce very small particles in combination with carbon monoxide and other toxic fumes. These emissions are estimated to be up to 100 times above the WHO recommended limits (WHO, 2011). In addition to debilitating poverty, the toxic fumes from the open fires cause serious and life-threatening illnesses that further affect the livelihoods of these households. Prolonged exposure to smoke under poor ventilation is a major course of cataracts in the developing world affecting more women than men (WHO, 2011).

There are diverse impacts on the environment of household use of biomass energy, ranging from localized effects to global climate change (Idiata et al., 2013). Biomass energy is considered as a renewable energy source hence not much thought has been given to the implications of its use on climate change. However, unsustainable harvesting of biomass to meet household energy needs increasingly puts pressure on biomass energy sources with both local and global environmental implications (World Bank, 2011). With increased research on the nexus between household energy use and climate change, there is growing body of evidence that household energy use significantly contributes to global climate change. GHGs including carbon dioxide, methane, nitrous oxides and some instances, chlorine and bromine containing compounds are major causes of global warming and by extension, major drivers of climate change (Bond et al., 2013).

2.5 Improved Cookstoves in Kenya

Improved Cookstoves (ICS) generally refer to biomass pyrolysis stoves that, efficiently burn biomass fuels especially firewood and charcoal with significant reduction in emissions. The Global Alliance for Clean Cooking classifies the improved cookstoves into five major categories namely: Legacy and basic ICS, Intermediate ICS, Advanced ICS, Modern fuel stoves and Renewable fuel stoves. The legacy basic ICS category includes those ICS with minimal improvement over the traditional stoves like, the three stones and they are majorly produced by semi-skilled artisans.

The intermediate ICS features improvements on efficiency and normally built, using quality materials with good finishes. Their main features are that, they are portable, have a fixed chimney and highly improved. The advanced ICS features high levels of combustion efficiency with far higher reduced emissions. They have the capability to utilize gasified fuels. The modern fuel stoves utilizes both fossil fuels and electricity with zero emissions. The renewable fuel stoves utilizes non-woody fuels such as biogas, ethanol and solar (GACC, 2012).

The history of ICS in Kenya has its origin in the United Nations Conference on New and Renewable Sources of Energy held in Nairobi on 10th to 21st August 1981. At the end of the conference, the Nairobi programme of action for the development of, and utilization of new and renewable source of energy was adopted. The plan of action was necessary to facilitate the imminent energy transition from the hydrocarbon based fuels to other sources of energy. The action plan recognized the importance of biomass energy especially in developing countries. It called for the assessment and planning for biomass energy resources, research, development and demonstration of the appropriate technologies for the consumption of biomass energy. It also called for the transfer, adaptation and application of mature biomass pyrolysis technologies (UN, 1981). This led to the development of the Kenya Ceramic Jiko that was widely disseminated to households in the 1980s, and early 1990s. Since then, various variants of improved cookstoves based on the original Kenya ceramic Jiko have been introduced to the market with varying degrees of success (KCIC, 2014).

2.6 Promoting Uptake of Clean Cooking Technologies

Globally, significant resources have been put into initiatives aimed at improving the household cooking energy situation especially for the Least Developed Countries (World Bank, 2017). The United Nations in partnership with the private sector formed the Global Alliance for Clean Cookstoves (GACCS) in the year 2010, with the goal of enabling the adoption of 100 million clean and efficient cookstoves and fuels by the year 2020 (GACCS, 2014). The alliance led several initiatives in Kenya, aimed at increasing the adoption of clean cooking technologies through funding of research and grants, to industry for the development of improved cook stoves.

The Alliance has supported specific activities in Kenya aimed at promoting the adoption of improved cook stoves including; support to established businesses with a record of accomplishment in disseminating clean cooking technologies through the Spark grant; the grants have been extended to Global Village Energy Partnership (GVEP) and BURN Manufacturing to increase their capacity to produce and distribute improved cookstoves in the Kenyan market (GACCS, 2014). In 2012 and 2015, the alliance facilitated the Kenya Industrial Research and Development Institute (KIRDI) in setting up a regional testing and knowledge center for cookstoves. The alliance has collaborated with Kenya Bureau of Standards (KBS) and other global partners in developing a cookstoves standard. The standards set the parameters for, cleanliness, safety, emissions and performance. In an effort to enhance access to credit for the purchase of clean cook stoves, the alliance in conjunction with the United States Agency for International Development (USAID) and Winrock supported the establishment of a credit facility at The Kenya Union of Savings and Credit Cooperative Society (KUSCCO). With KUSCCO having a network of more than 5000 savings and credits cooperatives spread across the country, businesses and consumers were expected to benefit from this facility to expand access to clean cookstoves (GACCS, 2014).

Since 1980, the World Bank has been implementing a worldwide programme known as the Energy Sector Management Assistance Programme (ESMAP). In Kenya, the programme focused on supporting the transition from low efficiency cook stoves to cleaner higher efficiency improved cook stoves in five counties (World Bank, 2017). Energizing Development (EnDev) Kenya is a partnership between various countries formed with the aim of providing people in developing countries with access to modern energy services. EnDev's goal in Kenya is supplying more than 3 million people with improved cookstoves (EnDev, 2012). To date, EnDev has supported access to modern cooking energy in Kenya through the establishment of sustainable market structures that include the production, marketing, installation and the promotion of the use and adoption of improved cookstoves. The EnDev interventions are being implemented throughout Kenya notably in the Lake Victoria, Western, Central, North and mid-rift regions through various local and international partners including German Development Agency (GIZ) and the Netherlands Development Organization (SNV) (EnDev, 2017).

2.7 Determinants of the Use and Adoption of Clean Cooking Technologies

The determinants of the use and adoption of clean cooking technologies fall into various categories namely, demographic, economic, social and technology (stove) related factors. The demographic determinants of ICS use include gender, age, household size and level of education. the economic determinants is mainly composed of household income and to some extent, cost of the technology in question. The social determinants include, household relations that can be measured in terms of membership to social organizations such as women groups and savings and loan groups and access to credit from these groups. The technology (stove) related factors include, affordability, cost and design. Other determinants also includes fuel availability and the awareness of the benefits of using clean cooking technologies.

2.7.1 Demographic and Socio-Economic Characteristics

There are various perspectives as to the influence of gender on the use of clean cooking technologies. The main perspectives that emerge in the analysis of gender influence on the use of ICS revolve around, household power relations, assignment of cooking responsibilities and gender related cultural practices and norms (Vigolo et al., 2018). Around power relations, it is often observed that in households with married couples, it is always the male that makes important decisions on household expenditure including, the purchase of an improved cookstove (Van der kroon et al., 2014). Thus in making the decision to purchase an ICS, it is the male head of the household that holds sway. Established cultural practices and norms have assigned women the role of cooks in the households (Debbie et al., 2014). This makes women the primary users of cooking technologies and by extension the primary bearers of the negative effects of cooking using inefficient cooking devices (WHO, 2012). Previous studies have shown that, female headed households are more likely to use and adopt improved cookstoves. A study conducted in North India revealed a positive correlation between female headed households and use of improved cookstoves (Brooks et al., 2016).

In developing countries like Kenya, cooking remains to be a woman's responsibility, hence women not only bear the burden of cooking for their families, but also of gathering and collecting fuel wood needed for cooking. Women and girls spend disproportionately long hours in dangerous and isolated areas to collect fuel for cooking. This is rarely counted as productive or compensated labour (World Bank, 2011a). With long hours spent away from home in far and isolated places, the risk of gender-based violence increases, like rape and physical assault for alleged trespass into private properties (Clancy et al., 2011). These risks to women and girls are avoidable if investments were made in efficient cook stoves and households went ahead and adopted them for long-term use. With more time spent, fetching firewood and related tasks, women and girls are often left with less time to pursue other productive activities like, gainful employment and other ventures that can result into income for the household (Carr et al., 2010).

Implicitly, women and girls pay the highest price for overreliance on inefficient and harazadous cooking technologies.

With regard to households' use of more efficient and clean cooking devices, age elicits a broad spectrum of influences ranging from, significant influence to not influence at all. The influence of age of the household head on use of ICS is closely linked with, the gender of the household head. In situations where the household head is male and is above middle age (normally over 55 years), then age become a barrier to use and adoption of improved cookstoves (Vigolo et al., 2018). The age of the main cook too, plays a role in determining a household's use and adoption of ICS. It has been demonstrated that the older the main cook, the more likely she will stick to the traditional methods of cooking, effectively inhibiting the household's transition into cleaner and efficient cooking devices (Clark et al., 2017). On the contrary, research has demonstrated that households headed by younger people show a greater likelihood of using and adopting a clean cooking technology such as the ICS. A study in rural Pakistan however, found no correlation between the age of the household head and the use and and adoption of improved cookstoves (Jan et al., 2017). In a review of literature, Lewis and Pattanayak found a negative relationship between the age of the household head and the use and adoption of improved cookstoves (Lewis & Pattanayak, 2012). Thus the exact influence of age on the use and adoption of improved cookstoves is yet to be determined and this study set out to give further insights on the subject.

Household size, also known as composition of the household, is the total number of people (adults and children) living under the same roof. Often, this definition is extended to also include those whose basic needs such as clothing, food and shelter are provided for by a single benefactor (Vigolo et al., 2018). The United Nations Department of Economic and Social Affairs (UNDESA)) classifies household sizes into small and large (UNDESA, 2017). The UNDESA defines a small household as that which consists of fewer than three people and a large household as that which consists of more than five people. In Kenya the average household size is four members with smaller households (1-2 members) standing at 31.2 % (KNBS, 2018). Siaya County has an average household size of 4 members. Previous studies have found the influence of household size on the use and adoption of improved cookstoves to be either negative, positive or zero. Household size and improved cookstove use discussions revolve around, convenience, efficiency, traditions and labour (Vigolo et al., 2018). A study in India found a negative correlation between household size and adoption of ICS. That large families did not use or adopt ICS because of the difficulty experienced in, preparing meals for large families using small cookstoves (Mohapatra & Simon, 2017).

In rural Mexico, the average size of households that used and adopted ICS was larger compared to that of households that adopted ICS (Pine et al., 2011). In Busia Kenya, Smaller households were observed to be using and adopting improved cookstoves (Nyandie, 2017). In other instances, non-adoption of ICS has been linked to the abundance of labour in the household. This makes firewood collection easy, as suggested by a study conducted in peri-urban and rural areas of Kenya (Van Der Kroon, 2014). A similar scenario was observed in rural Malawi where, ICS use and adoption was low in households that had an abundance of labour for collecting firewood (Jagger & Jumbe, 2016). The need to cook for large families using efficient cooking devices is a factor in promoting use and adoption of improved cookstoves. This was the case in River State Nigeria where, households using and adopting ICS cited their need for efficient cooking devices to, cut on time and save on fuel used for cooking (Onyeneke et al., 2019). Household size has also been found not to have an influence on the use and adoption of improved cookstoves. A study in Dodola Ethiopia suggested that, household size had no influence on the use and adoption of improved cookstoves since, there was no significant difference in the mean household size of users and non-users of ICS (Mamuye et al., 2018).

Higher levels of education has been associated with positive use and adoption of improved cookstoves. In Darfur Sudan, a study suggested that households headed by, people who had achieved some educational attainment consistently used improved cookstoves (Wilson et al., 2016). A study in Kiambu, Kenya suggested that the observed low rate of ICS use and adoption could be attributed to the corresponding low levels of formal education in the study area (Kongani et al., 2019). There are further suggestions from research findings that, primary and secondary level of education has significant influence on the use and adoption of improved cookstoves. This was the case in rural Pakistan where, households whose heads had attained primary or secondary level of education had a higher propensity to use and adopt ICS (Jan et al., 2017).

With regard to gender, effects of education has been observed to be consistent in determining ICS use regardless of gender (Vigolo et al., 2018). The level of Education of a female head of household has been shown to significantly influence household cooking fuel and technology choices, the better educated the female household head is, the more likely that the household would use cleaner fuels and better technologies (Pundo et al., 2006). Further, the probability of using cleaner fuels and technologies increases with the level of education of females in the households as observed in a study in rural India. However, some studies have also suggested that the level of education of a household head, does not influence use or adoption of improved cookstoves. A study conducted in rural Mexico observed that, women who were the early adopters of a particular type of improved cookstoves did so, out of their open mindedness and progressiveness rather than due to the number of years they spent in school (Troncos et al., 2007). A negative correlation between use and adoption of improved cookstoves and level of education was also observed in rural Tanzania (Kulindwa et al., 2018).

It has been suggested that household income is both a barrier to, and enabler for the use and adoption of improved cookstoves. Household income becomes a barrier when it is such that, a household cannot afford to purchase an improved cookstove from its disposable income. It becomes an enabler on the other hand if, the household can meet its basic needs and still be able to purchase an improved cookstove from its disposable income (Vigolo et al., 2018). A study in rural Mexico observed that, adopters of improved cookstoves had higher income levels as compared to non-adopters of improved cookstoves (Pine et al., 2011). A similar trend was observed in River State Nigeria where, households using an improved cookstove had higher income as compared to those that did not use one (Onyeneke et al., 2019).
Higher levels of income gives a household the option to use and adopt other forms of clean cooking energy such as, electricity and gas and at the same time enables households to also use improved cookstoves (Vigolo et al., 2018). With increasing income, households gradually move from purchasing low level fuels such firewood to higher level cleaner fuels such as Liquified Petroleum Gas (LPG) and electricity. Even if they stick to using charcoal and firewood, they prefer using them on improved cookstoves that offers greater cooking efficiency (Vitali & Vaccari, 2014). Low income becomes a barrier to use of cleaner cooking technologies when households are prevented from switching to cleaner fuels and more efficient technologies (Vigolo et al., 2018). However, other studies have found that income has no influence on the use of more efficient and cleaner devices in households. A study in Busia, Kenya found a negative correlation between

income and use of an improved cookstove (Nyandie, 2017). Related to income is the price of the improved cookstoves, which also acts as a driver to their use and adoption (Vigolo et al., 2018). In Rural Tanzania, a percentage increase in the price of ICS resulted in reduced purchases implying that potential buyers were put off by the price increase (Kulindwa et al., 2018).

In a study in Dodola South-Eastern Ethiopia, the price of an improved cookstove was identified by household heads as the reason they were not using one since, they considered them to be expensive based on the prices quoted (Mamuye et al., 2018). Price too has an influence on the progression of households in the energy transition ladder. Whereas, low prices would encourage movement to higher cleaner and more efficient fuels, higher prices results in the reversing of the gains made (Kar & Zerriffi, 2018). The prices of alternative fuels such as LPG has been investigated to determine if they may have an influence on the use and adoption of improved cookstoves, however most of the studies have concluded that there is a negative relationship between price of alternative fuels and the use and adoption of improved cookstoves (Lewis & Pattanayak, 2012).

2.7.2 Technology Related Characteristics

Use and adoption of improved cookstoves and other clean cooking technologies is also influenced to a large extend, by the various characteristics of the stove including, the users' perceptions. These characteristic include, design, efficiency, availability of the stoves, price/cost of the stoves, repairability of the stoves and stove size. Stove design has been found to influence the decision to use and adopt the technology. The design entails the various uses a stove can be put to, its durability, costs of repair if any and the ease of replacing any parts (Rehfuess et al., 2014).

A study in China suggested that stove design significantly influenced the use of improved cookstoves in households by, addressing user needs such as fuel saving and ability of the stove to perform multiple tasks such as, space heating and cooking (Shen et al., 2014). The general attitude towards a technology can negatively influence the decision to use and adopt. Negative attitude towards improved cookstoves has been found to, act as a barrier to their use and adoption (Vigolo et al., 2018). In Kenya, improved cookstove affordability associated with low income levels has been identified as a major barrier to their use (CCAK, 2017).

Availability of fuel has been found to influence improved cookstove use and adoption. Though, there is varied opinion as to the exact influence of fuel availability with, some studies showing that it does positively influence ICS use while others find negative relationships to ICS use and others still, find no effect at all (Vigolo et al., 2018). For instance, when fuel is obtained at a cost, households prefer using cooking technologies that minimize fuel usage but achieve higher cooking efficiency (Jagger & Jumbe, 2016). On the hand, when fuel is obtained at no cost and can be easily obtained by mere gathering and collection, household tend to shun the use of efficient cooking technologies such as improved cook stoves (Mamuye et al., 2018). Fuel availability itself is determined by its cost and accessibility.

Various studies have identified awareness of the benefits of using improved cookstoves as a driver for their use and adoption together with, other clean and efficient cooking technologies. The benefits of using clean cooking technologies include, improved health and environmental outcomes such as, reduced or elimination of indoor air pollution that leads to reduced or no incidences of respiratory infections (WHO, 2012). Increased awareness of the negative effects of using traditional inefficient cooking technologies has been found to positively influence their up-take, mainly as a mitigating action (Poddar & Chakrabarti, 2016). Increased awareness on the environmental benefits of, using efficient and clean cooking technologies such as reduced deforestation and environmental conservation increases the likelihood of households using and adopting improved cookstoves (Jagger & Jumbe, 2016). Other studies have however, failed to establish a positive relationship between use and adoption of improved cookstoves and awareness of their benefits. A study in the peri-urban areas of Kampala Uganda, found no relationship between awareness of the benefits of using ICS and their use and adoption (Vigolo et al., 2018).

2.7.3 Social interactions and Use of Improved Cookstoves

There is literature suggesting that social interactions influence, a household's decision on the use and adoption of clean cooking technologies. For instance, household heads in rural Mali, decided to purchase a cookstove after interacting with their peers who had purchased the improved cookstove and were using it (Bonan et al., 2017). There are various ways through which, social interactions act to influence household behaviour with regard to energy use (Bonan et al., 2017). Social interactions can act to influence household decisions through social learning. Social learning is, the action by individuals resulting from the observation of the actions of others and decisions taken by other people (Devoto et al., 2010). Secondly, social interactions can act to influence individual household behavior through imitation effect. Imitation effect is the influence on an individual's preference by the decisions of other people known to him or her (Bandiera et al., 2006). The positive and negative decisions of an individual interact with, the observed decisions of peers to produce a third channel for social interactions action known as, constraint interaction which in turn influences the decisions of all (Bonan et al., 2017).

Social learning theorists postulate that human behaviour is primarily driven by, needs, drives and impulses all of which operate at the subconscious level. However, these primitive stimuli inherent within the individual, interact with external factors to determine the behavioural patterns of an individual (Bandura, 1971). Thus an individual would decide to use an ICS after, experiencing the adverse consequences of using traditional cookstoves on a neighbor. Implying that, the individual is acting to mitigate the effects of an observed consequence. Social interactions have been proven to influence the decision of households to use and adopt the ICS. A study in rural Mali on social interaction and technology adoption, showed that people purchased improved cookstoves based on information received from peers whose opinions mattered within the neighborhood (Bonan et al., 2017).

Social relations is a major driver of behaviour change in communities. Use and adoption of new technologies call for, a shift on how people do things. Thus social relations act as an arena for learning new behaviour and letting go of old non-beneficial practices (Kahan et, al 2011). Social relations have been an integral component in the diffusion of new agricultural technologies in developing countries (Beaman & Dillon, 2014). A study in rural Uganda showed that, interaction with a buyer of an ICS made household heads to have positive opinions about them (Beltramo et al., 2015). A study in Kenya showed that, ICS users who interacted with other ICS users showed a stronger will to continue using the stoves for a longer period of time. Hence, adoption of the stoves was more likely (SEI, 2017).

Membership to social organizations is a key determinant to behaviour change. Group membership influences the behaviour of an individual to the extent that, it is considered a risk for one to behave differently from the other group members (Vulturius & Wanjiru, 2017). Past studies have suggested that, marketing improved cookstoves through social groups like women groups lead to increased sales and eventual use and adoption. A study in Kenya suggested that, targeting women groups with cookstoves promotional and marketing activities increased the rate of use and adoption (Vulturius & Wanjiru, 2017). Marketing cookstoves through the groups, leverages on the already established social networks and the shared sense of identity in the groups. In Mali, membership to informal groups such as, family groupings and women groups increased the use and adoption of improved cookstoves (Bonan et al., 2017).

Access to credit is an enabler to the adoption of clean cooking technologies. A study in Ethiopia suggested that, access to credit influences adoption of clean cooking technologies such as electric cookers and accelerates fuel transition (Mala & Timilsina, 2014). A study in South Africa suggested that, credit availability does not influence consumer preferences and willingness to pay for improved cookstoves (Mare & Annegarn, 2017). Previous studies on the barriers to the use and adoption of clean cooking technologies have amongst other factors identified, difficulty in accessing credit as a major barrier (Puzzolo et al., 2013). Provision of loans to households has been successfully used as, a strategy to promote clean cooking technologies in Bangladesh (World Bank, 2010). The model in Bangladesh utilized existing credit facilities to, channel loans to households for the purchase of improved cookstoves. Availability of loans to the clean cooking technologies sector has been hampered by the notion that, the cooking technologies projects are too small to meet the threshold set by most financial institutions for the provision of loans (GACCS, 2011).

2.8 The Policy and Institutional Framework

In Kenya, policies addressing biomass energy and clean cooking energy are contained in various policy documents namely: the Sessional Paper No. 4 on Energy of 2004, the Climate Change Framework Policy, the Forest Policy and the National Environment Policy. There are also plans and strategies where biomass energy use and clean cooking technologies are addressed. These include: the Kenya National Climate Change Action Plans and the Sustainable Energy for All strategy.

2.8.1 Sessional Paper No. 4 on Energy of 2004

The objective of the policy was to ensure, cost effective, affordable adequate and quality energy supply for development needs in a sustainable manner to, conserve and protect the environment (MoE, 2004). It identified unsustainable harvesting and use of biomass resources as a challenge and called for, the promotion of efficient technologies especially for their use in households (MoE, 2004). It further identified a number of constraints to the effective intervention of policy in the use of biomass resources including that; biomass is considered a low profile energy despite its prominence in the Kenyan energy mix; that the high poverty incidence in the country has been a major impediment in the shift from traditional biomass energy to modern energy sources. It further noted that, there is an imbalance between the demand for fuelwood and the supply pointing to, an over-reliance on wood fuel and other biomass energy resources (MoE, 2004).

To this end, the sessional paper proposed a number of measures to be undertaken to reverse the situation including: the increase of the rate of efficient cookstoves adoption to 30 % by the year 2020; the increase of the efficiency of improved cookstoves to 40-45 % by the year 2020 and the building of the capacity of artisans to manufacture, install and maintain efficient cookstoves through training. The paper provided a clear institutional arrangement for the management of other sources of energy like, electricity and fossil fuels. However, the policy did not give a clear institutional identity for biomass fuels. This has contributed to the unstructured governance being witnessed in the biomass energy sector, with a multiplicity of governmental entities regulating the activities in the sector. The responsibility for the implementation of this policy lies with the Ministry of Energy.

2.8.2 The National Environment Management Policy

The National Environmental Policy of 2013 had the goal of, ensuring better quality of life for the present and future generations through the sustainable management of environmental and natural resources (MENR, 2013). The policy identified wood fuel use as a major threat to the biodiversity of the arid and semi- arid lands. The policy further noted that the continued use of firewood for cooking in households was, a major contributor to indoor air pollution and thus, proposed the promotion of efficient alternative efficient cooking technologies and the construction of well-ventilated cooking spaces. The implementation of the policy lies with the Ministry of Environment and Natural Resources.

2.8.3 The Forest Policy 2014

The forest policy was formulated to enable the sustainable development, management, utilization and conservation of forest resources (MENR, 2014). This was intended to facilitate the equitable sharing of accrued benefits for the present and future generations (Forest Policy, 2014). The forest policy 2014 seeks to address the challenges presented by the unsustainable harvesting and use of wood fuel to meet both industrial and domestic energy needs. It therefore calls for, the promotion of efficient harvesting and use of wood fuel and adoption of alternative forms of renewable energy. As a gap, the forest policy 2014, does not contain any policy statement on the promotion of clean cooking technologies in households. The responsibility for the implementation of this policy lies with the ministry of Environment and Natural Resources.

2.8.4 The Kenya National Climate Change Framework Policy (NCCFP) 2016.

Sessional Paper No. 3 of 2016 also known as the Kenya National Climate Change Framework Policy came into effect in 2016. The framework policy was developed to facilitate a coordinated, coherent and effective response to the local, national and global challenges and opportunities presented by climate change (NCCFP, 2016). The policy's main objective is to enhance adaptive capacity and build resilience to climate variability and change, while promoting a low carbon development pathway (MENR, 2016).

The policy acknowledges the widespread use of biomass energy in Kenya especially, charcoal and firewood and calls for, the efficient production and use of the biomass energy resources to enhance energy security and build resilience to climate change. This, through sustainable harvesting of forest resources and the promotion of efficient cook stoves. The implementation of this policy lies with the Ministry of Environment and Natural Resources.

2.9 Plans and Strategies

2.9.1 The Kenya National Climate Change Action Plan (KNCCAP) 2013-2017

The mitigation actions under the KNCCAP 2013-2017 provided for the undertaking of programmes to support use of ICS. This was to be done through creation of awareness of better cooking practices, enabling access to financing, enhancing the capacity of ICS producers and piloting new cookstove technologies (KNCCAP, 2013). The plan recognized the opportunity presented by the large scale use and adoption of ICS in implementing the adaptation and mitigation measures for low carbon development as envisioned in the Kenya Vision 2030. This in the context of reducing over reliance on fuel wood, reducing forest degradation and increasing access to clean energy.

2.9.2 The Kenya National Climate Change Action Plan (KNCCAP) 2018-2022

The KNCCAP 2018-2022 planned the development and dissemination of four million ICS as a mitigation measure for climate change by 2022. This was one of the strategies to implement the Nationally Appropriate Mitigation Action (NAMA) for the Kenya charcoal sector. The distribution of these ICSs was projected to reduce emissions by about 2 MtCO2e per stove per year for charcoal and 2.5 MtCO2e for firewood. The mitigation action were to be implemented through enhancing the capacity of local manufacturers, developing and enforcing quality standards and developing the ICS value chain by including private enterprises especially in distribution.

2.9.3 Sustainable Energy for All (SE4ALL): Action Plan and Kenya Investment Prospectus

The sustainable energy for all initiative is anchored in the Sustainable Development Goal (SDG) 7 on energy. The SDG 7 calls for universal access to reliable, affordable and modern energy for all by the year 2030. The SE4ALL initiative was also linked to the objective of the 2015 Paris agreement on climate change of limiting average global temperatures for "well below" 2^0 Celsius (UNFCCC, 2015). Kenya opted into the SE4ALL initiative in 2012 and a Country Focal Point (CFP) established in the directorate of renewable energy in the Ministry of Energy and Petroleum. In 2014, the CFP initiated the development of SE4ALL action plan and investment prospectus (MoE&P, 2014). The Kenya investment prospectus was developed in line with the SE4ALL initiatives goals of mobilizing stakeholders to take concrete action towards ensuring universal access to modern energy services, double the global rate of improvement in energy efficiency and double the share of renewable energy in the global energy mix (MoE&P, 2014).

The Kenya Investment Prospectus established the Kenya energy modernization project that had various components designed to promote the use and adoption of improved cookstoves. These included: the development of the cookstove sector, development of standards and labelling for cookstoves in Kenya, development of a communication strategy for clean cooking sector in Kenya, strengthening of clean cookstoves and fuels in Kenya and clean cook stoves market acceleration project. The Kenya energy modernization program addresses the SE4ALL goal and action area on modern cooking appliances.

2.10 Institutional Framework of Energy in Kenya

The energy sector in Kenya is governed and regulated by various institutions. The Ministry of Energy and Petroleum is the principal Government of Kenya agency charged with the energy sector policy formulation, governance and regulation. However the biomass energy sub-sector is regulated and managed by various government agencies (GoK, 2019).

2.10.1 Ministry of Energy & Petroleum

The Energy Act 2019 mandates the Cabinet Secretary for Energy and Petroleum to formulate a national energy policy and have it reviewed every five years. The cabinet Secretary is further mandated to draw and review integrated energy plans for the country. The ministry is responsible for the overall planning and budgeting for the energy sector in Kenya.

2.10.2 Ministry of Environment Forestry & Natural Resources

This ministry spearheaded the formulation of the National Environment Policy , the Forest Policy of 2016 and the Climate Change Framework Policy. The National Environment Policy contains policy statements on the management of biomass energy resources and promotion of clean cooking technologies such improved cookstoves. Similar policy statements are contained in the Forest Policy and the Climate Change Policy. These, therefore, gives the ministry a stake in the management and regulation of the biomass energy sub-sector

2.10.3 The County Governments

The fourth schedule of the Constitution of Kenya on the distribution of functions between the National and County Governments, mandates County Government to perform electricity and gas reticulation and to regulate energy (GoK, 2010). The Energy Act, 2019, also mandates the County Government to develop county energy plans to feed into the national energy plans (GoK, 2019). The act further mandates the County Governments with the regulation and licensing of biomass production, transport and distribution. Included in this provision is the regulation and licensing of charcoal and biogas (GoK, 2019).

2.11 Gaps in Literature

An analysis of literature reveals that most studies conducted have focused entirely on the influence of Household characteristics on the use of clean cooking technologies. Most of the findings have concluded that individual household characteristics such as income, size, gender and level of education are barriers to use and adoption of clean cooking technologies. There is however a gap on how factors like social interactions and the policy framework interact with household characteristics to influence the household's decision process in using and adopting clean cooking technologies.

2.12 The Analytical Framework

2.12.1 Theoretical Framework.

This study is guided by the Technology Acceptance Model (TAM) which explains and predicts users' behaviour towards using a technological innovation (Davis & Bagozzi, 1989). The model gives a general explanation of the determinants of the acceptance of technology by users (Davis & Bagozzi, 1989). The model is helpful both in the prediction of user behaviours and explanation of the behaviours with regard to users' acceptance of technology.

TAM posits that users' perceived usefulness (PU) of a technology and the users'percieved ease of use (PEOU) of the technology determines their attitude towards using a technology. This in turn influences the users' behavioral intention to adopt or not to adopt the technology in question (Davis & Bagozzi, 1989). Perceived usefulness refers to the degree to which a person believes that using a particular system would enhance his or her job performance (Davis & Bagozzi, 1989).

Further, TAM holds that actual technology use is determined by behavioral intention and the behavioral intention is influenced by both the user's attitude towards using the technology and the perceived usefulness of the technology (Davis & Bagozzi, 1989). Previous studies have established that users' use and adoption of new technology is largely driven by their perceived utility of the technology and their perceived benefits from the use of the technology (Elinda et al., 2016). This is in line with the TAM's central postulate that, perceived usefulness, perceived ease of use and perceived utility determines a user's behavioural intention, which in turn determine a user's adoption of a technology (Davis & Bagozzi, 1989).

Relevance of the TAM to this study

The central thesis of the TAM is that the intention to adopt or not to adopt a technology, is influenced by the interaction between the users' perceived usefulness of the technology together with perceived ease of use of the technology and how these considerations influences the user's attitude towards the technology (Davis & Bagozzi, 1989). This study aimed to establish why households are slow in adopting clean cooking technologies by analyzing the relationships between household characteristics, social interactions, and the policy and institutional set-up for the development and dissemination of clean cooking technologies to households.

To understand how these relationships, influences a household's choice of cooking technology, we need to understand the household's perceptions, intentions and attitudes towards the adoption of clean cooking technologies. To this end, TAM helps in understanding how external factors (household characteristics, social interactions, and policy and institutional set-up) shapes the household's decision process to adopt clean cooking technologies. The TAM breaks down the decision process by showing how a household's intention to adopt clean cooking technologies is influenced by perceived usefulness of the technology, perceived ease of use and its attitude towards using the technology.

2.12.2 The Conceptual Framework

Concepts are abstractions and symbols that represents a behavioural phenomenon or one of its properties (Nachmias & Nachmias, 1996). Concepts function as enablers of communication that gives the researcher, various perspectives of the phenomenon under study that allows the generalization of experiences and observations. Concepts also serve as components of theory, making them the most critical elements of a theory because they define its contents and attributes (Nachmias & Nachmias, 1996). For instance in this study, the concepts "policy" "institutions", "household characteristics" and "social-interactions" defines and shapes Davis & Bagozzi's Technology Acceptance Model (TAM) that predicts actual technology use (clean cooking technologies) as a function of policy, institutional framework, household characteristics and social interactions. Thus concepts when linked in a systematic and logical way, leads to theories.

A conceptual framework is a systematic and logical arrangement of the various components of a research project. It presents the research problem, research questions and objectives, the literature reviewed, the theory applied, the research methodology, the results and findings and the desired outcomes of the research (Kivunja, 2018). In this study, the circular model of a conceptual framework is applied to represent the business as usual scenario where, households continue their harmful practices of using inefficient cooking technologies that lead to degradation and depletion of biomass energy resources leading to harmful environmental and health effects (**Figure *1***).

The research having identified the continued use of inefficient cookstoves despite efforts to promote clean cooking technologies, intervenes to study the determinants of households' use and adoption of clean cooking technologies, the types of cooking energy and technologies used in households and the policy and institutional framework in place for household cooking energy and technologies. The intervention was expected to result in increased awareness of the benefits of using clean cooking technologies in households and to promote increased production, distribution and sale of clean cooking technologies. This would then influence households to use and adopt clean cooking energy and technologies such as improved cookstoves which would eventually lead to a safe and healthy environment, reduced incidences of respiratory infections, sustainable harvesting and use of biomass energy resources and enable an informed review or formulation of policy on household cooking energy and technologies. An understanding of the complete functioning of the household decision process and how this is influenced by the external factors is important in answering the question as to why households are not adopting clean cooking technologies and how to reverse the trend and achieve sustainable use of biomass energy resources.

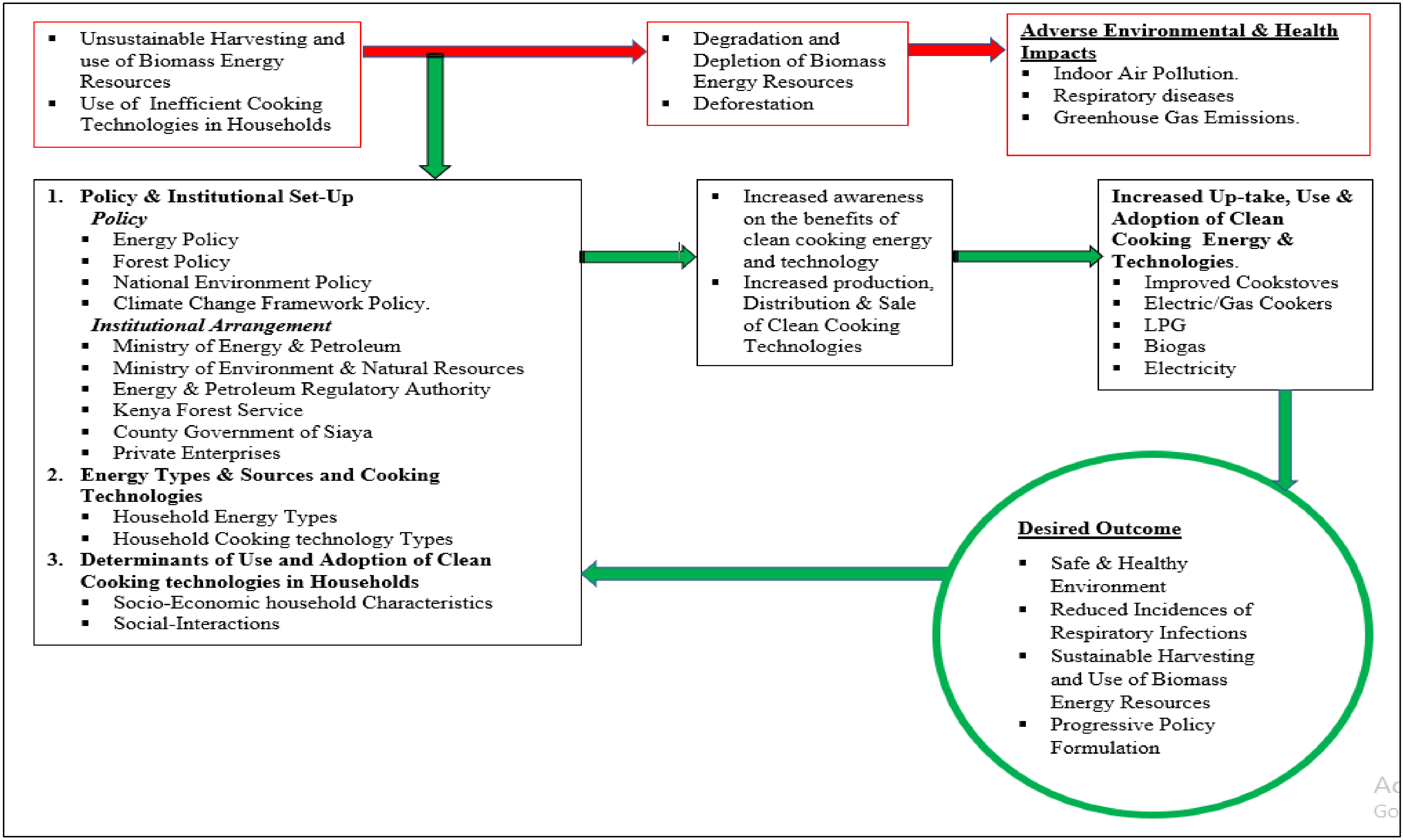


Figure 1: The study Conceptual Framework

Source: Author, 2019

CHAPTER THREE: METHODOLOGY

This chapter contains the study study methodology which includes the study site and the research design. Under research design, the data types and sources are discussed, the sampling method and sample size is presented, and the data collection and analysis methods used are also discussed.

3.1 The Study Site

Siaya County is one of the 47 Counties of Kenya. It has a land surface of approximately 2,530 km^2 and a water surface on Lake Victoria of approximately 1,005 km^2. The County borders Homa Bay County to the South across Lake Victoria, Kakamega and Vihiga Counties to the North, Busia County to the North West and Kisumu County to the South East. The higher altitude parts of the County experiences an annual rainfall of between 800 mm-2,000 mm (temperatures ranges of between 16.3^0 C- 22.50^0 C). The lower altitude section experience an annual rainfall of between 800-1,600 mm (temperatures ranges of between 21^0 C- 22.50^0 C) (SCIDP, 2018). The County is divided into six Sub-Counties namely: Bondo, Gem, Rarieda, Ugunja, Alego Usonga and Ugenya. According to the Kenya National Bureau of Statistics, the County has a population of 842,304 people (398,986 males and 43,318 females).

This study was conducted in South Sakwa Ward in Bondo Sub-County. The Ward is one of the six County Assembly Wards in the Sub- County. The other five wards are: West Yimbo, Central Sakwa, Yimbo East, West Sakwa and North Sakwa. The ward is approximately 30 Km South East of Siaya Town and approximately 15 Km South of Bondo Town. There are four Sub-Locations in the ward namely: Nyaguda, Got Abiero, East Migwena and West Migwena. South Sakwa Ward has a population of approximately 23,260 people (SCIDP,2018). The Ward has been chosen for this study because, initiatives to promote use of improved cookstoves were implemented in the area as part of the larger Siaya County. Thus it is ideal to be used as case study of factors influencing use and adoption of clean cooking technologies in rural areas. **Figure 2** below shows a map indicating the location of Siaya County in Kenya, the location of Bondo Sub-County in Siaya County, the location of the actual study site (South Sakwa Ward) in Bondo Sub-County and its relative location in Siaya County.

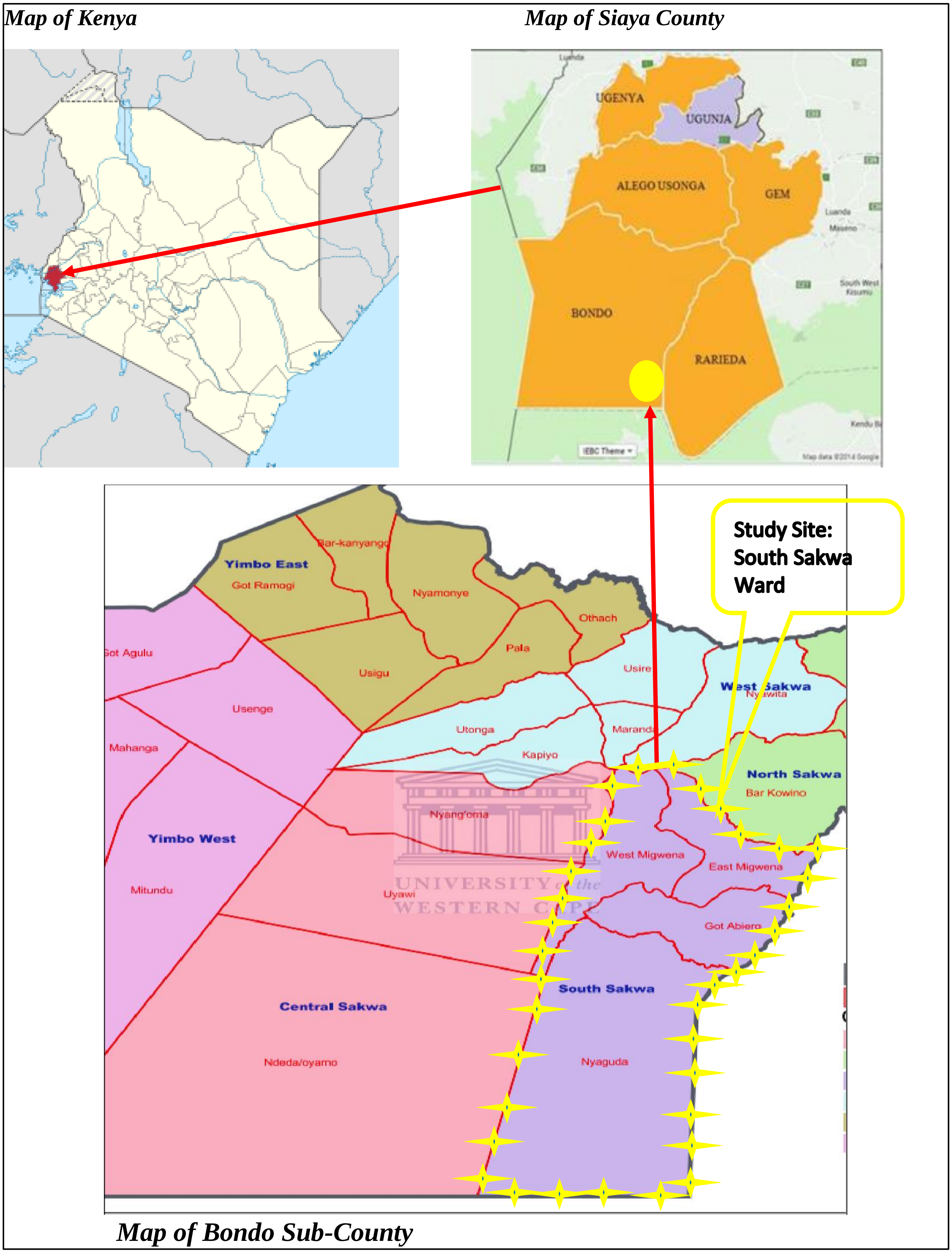


Figure 2: Map showing location of Siaya County in Kenya, location of Bondo Sub-County in Siaya County and the location of South Sakwa Ward (study site) in Bondo-Sub County and in Siaya County.

3.2 Research Design

The objective of this study was to determine factors influencing use and adoption of clean cooking technologies by households in Bondo Sub-County. The mixed methods design of research was adopted for this study. It involves collecting, analyzing and combining both quantitative and qualitative data in a study (Creswell & Clark, 2011). The main premise of the method is that, the combination of both qualitative and quantitative methods leads to a more comprehensive understanding and analysis of research questions (Creswell et al., 2003). There are different types of mixed methods research, whose use depends on the needs and objectives of the researcher (Creswell & Clark, 2011). This study required the use of both quantitative and qualitative data and the concurrent collection of both. To this end, the embedded design of mixed methods research was adopted. This is a design that involves concurrent collection, analysis and interpretation of qualitative and quantitative data (Almalki, 2016).

3.2.1 Data Types, Needs and Sources

Primary and secondary qualitative and quantitative data was needed for this study. The data was obtained from various sources and applied to answer each of the three research questions. This study needed primary data (qualitative and qualitative) on types of energy used by households for cooking, types of technologies used by households for cooking, households' socio-economic and demographic characteristics (gender, age, level of education, marital status, income, type of dwelling, membership to social groups, access to credit etc).

The main source of the primary data was household heads. The secondary data needed for this study was on the policy and institutional framework on biomass energy and cooking technologies. The main source for the secondary data was the existing policy documents, previous works of research, sectoral reports, plans and strategies on energy, the environment and climate change. The policies reviewed included the National Forest policy, the National Environment Policy, the Climate Change Framework Policy and the Sessional Paper No. 4 on Energy of 2004. The sectoral plans and strategies reviewed included the National Adaptation Plan the National Climate Change Action Plan 2013-2017 and the Climate Change Response Strategy.

3.2.2 Sampling Procedure & Sample Size

Following the mixed method design of this study, mixed sampling methods were used in the study. First, purposive sampling technique was used to select Siaya County from the other 47

Counties of Kenya because projects on promoting use of improved cookstoves have been implemented in the County by the Government of Kenya and Non-Governmental Organizations. Bondo Sub-County and South Sakwa were also purposively selected for the reason that improved cookstove promotion projects had been undertaken within their jurisdictions as parts of the larger Siaya County. Purposive sampling is a non-probability sampling technique where the sampling units are subjectively selected (Creswell et al., 2017).

Having purposively selected the study site, a simple random sampling technique was applied to select respondents for the household questionnaires. Simple random sampling is a basic probability sampling design where all elements in a population are given an equal and known non-zero probability of being selected (Nachmias & Nachmias, 1996). The Average Household size in Kenya is 4.4 persons per household (KNBS, 2012). The Total Population of South Sakwa Ward is 23,260 people (KNBS, 2012). Thus the households in South Sakwa Ward was determined by dividing the population with the average household size (KNBS, 2012)

$$\frac{Total\ Population}{Average\ Household\ Size} = \frac{23,260}{4.4} \cong 5,286 \qquad (1)$$

The sample size for the study was determined using the Nassiuma formula (Nassiuma, 2000). the coefficient of variation is assumed at 0.5 at the desired tolerance level of confidence, at 95% level (0.05).

$$n = \frac{NC^2}{C^2 + (N-1)e^2} \qquad (2)$$

Where *n* is the desired sample size; *N* is the number of households; *C* is the coefficient of variation (0.5) (occurrence of the phenomenon under study in the population); *e* is the tolerance of desired level of confidence, at 95% level i.e. 0.05 Thus:

$$n = \frac{5286(0.5)^2}{0.5^2 + (5286-1)0.05^2} = \frac{1321.5}{13.46} = 98.2 \qquad (3)$$

However 100 households were sampled for this study.

3.2.3 Data Collection Procedure and Tools

Both primary and secondary data was collected and used in this study. Various data collection tools were used to collect the data namely:

Questionnaire

Structured household questionnaires were administered specifically to household heads in the study area. Enumerators administered the questionnaires on a face to face basis. It contained both closed and open ended questions which were arranged according to the study objectives. The data captured by the tool was on household energy types, types of cooking technologies used in households, household characteristics and their social relations, economic activities, water use and sanitation practices. The tool also captured data on private enterprises and public benefit organizations involvement in promoting clean cooking technologies

Key Informant Interview Guides

These were used to collect data mainly for triangulating information received from the households on institutional involvement in the promotion of clean cooking energy and technologies. The tool was administered to various heads of departments or their representatives. The departments targeted included the Siaya County Kenya national Forest Service, the Siaya County Economic Planning Department, the Energy department and the department of gender and social services. The tool was also administered to a cookstove artisan in Bondo Town. Administered by the researcher

Focus Group Discussion Guide

The guide was administered to a group of women who were engaging in the sale of charcoal and improved cookstoves at the main market in Bondo Town. The data obtained was used triangulate the data obtained from households on household cooking energy types ad technologies and their prices.

3.2.4 Data Analysis

Preparation and Analysis of Data from the Household Questionnaires

The data collected was consolidated and entered into the Statistical Package for Social Scientists (SPSS) software in preparation for analysis. The data was then ran on SPSS using the statistical tables function to establish the general trends in each of the variables measured. Chi-square tests of association and binomial logistic regression analysis were used to establish relationships between the dependent variable and the various independent variables in the study and to establish significances. Specifically, data on household characteristics and social interactions was fitted into a binomial logistic regression model to determine their level of significance in determining the use and adoption of improved cookstoves in households.

The Binomial Logistic Regression Model

Binomial logistic regression is one of the generalised linear models which are variations of linear models like multiple regression that has the capability to analyse dependent variables that are dichotomous and nominal(Tabachnik & Fidell, 2014). The binomial logistic regression does not predict the dependent variable directly, rather a logit of the dependent variable is predicted. A logit is the natural log of the odds of an event occurring (Tabachnik & Fidell, 2014). The binomial logistic regression was used to predict the factors influencing households' use and adoption of improved cookstoves.

The general linear regression model is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_n X_n + \varepsilon \quad (4)$$

The logit model based on the logistic distribution is specified by:

$$P_i = E(Y = 1|X_i = F(Z_i) = F(\alpha + \sum_{i=1}^{n} \beta_i X_i = \frac{1}{1 + e^{-z}} \quad (5)$$

Where:

$$Z_i = \alpha + \sum_{i=1}^{n} \beta_1 X_1 \ldots . \beta_n X_n + \varepsilon_i \quad (6)$$

$$P_i = \frac{e^{z_i}}{1 + e^{z_i}} \; and \; (1 - P_i) = \frac{1}{1 + e^{z_i}} \quad (7)$$

The odds ratio is given by:

$$\frac{P_i}{1 - P_i} = e^{z_i} \quad (8)$$

Taking a natural logarithm of eq. (8) we obtain

$$logit\ (Y_i) = \ln\left(\frac{P_i}{1 - P_i}\right) = \alpha + \sum_{i=1}^{n} \beta_1 X_1 \ldots . \beta_n X_n = Y_i \quad (9)$$

Where: Y_i is the dependent variable (Adoption or non-adoption of ICS; P_i is the probability that Y_i=1,if a household adopts ICS; 1- P_i is the probability that Y_i = 0, if a household does not adopt ICS; $\beta_i \dots \beta_n$ is the slope coefficients of the explanatory variables to be estimated; $X_i \dots X_n$ is the independent (explanatory) variables; e is the base of the natural logarithm; ε_i is the stochastic error term and $\ln\left(\frac{P_i}{1-P_i}\right) = Y_i$ is the probability that a household uses and adopts ICS also known as the logit.

Coding was used to analyse the qualitative data. It involved grouping data into themes and categories. The data was first examined, compared and conceptualized and then analysed to find relationships with the phenomenon under study. This was used to analyse policies on biomass energy and clean cooking technologies to determine the role of policy on use and adoption of clean cooking technologies and the data obtained from Key Informant Interviews (KII) and Focussed Group Discussion (FGD). The results of the study have been presented in prose form and visually using frequency tables, cross tabulation tables and graphs to show the percentage and mean distribution of data.

CHAPTER FOUR: RESULTS & DISCUSSIONS

In this chapter, the results of the study are presented based on the collected and analysed data. The chapter begins with a summary of, the key variables used in the study. These include; the demographic and socio-economic characteristics of the households, the social interaction patterns of the households, the general trends of the households' use of cooking energy and technologies and the involvement of institutions in the promotion of clean cooking solutions. The results are then presented following the order of each of the three specific objectives in relation to, the use and adoption of clean cooking technologies in the study area.

4.1 Demographic and Socio-Economic Characteristics of Households

The socio-demographic analysis showed that, mean age of household heads was 43 (range 18-72) years; mean monthly income was Ksh. 8,174 (range 1,500-35,000); mean household size was 6 (range 1-13) people; mean number of schooling years was 8 (range 0-14) years. There were more female respondents (65) than male respondents (35) in the study area. The 41 households who were buying their cooking fuel spent an average of Ksh. 1,112 per month. The households using improved cookstoves indicated that the average cost of one was Ksh. 762 (**Table 1**).

Table 1: Summary of household characteristic mean, SEM, std.dev and range

			N	Mean	Std. Error of Mean	Std. Deviation	Range
Gender	Male	35					
	Female	65	100				
Age (years)			100	43	1.2	12.0	18 -72
Years in School			100	8	0.2	2.5	0 -14
Number of Children			94	4	0.2	2.0	0 - 10
Household Size			100	6	0.3	2.6	1 - 13
Monthly Average Income (Ksh.)			100	8174.00	722.5	7225.2	1500.00 - 35000.00
Monthly Expenditure on Cooking Fuel (Ksh.)			41	1112.00	99.2	635.0	100.00 - 3000.00
Cost of ICS (Ksh.)			26	762.00	55.6	283.7	350.00 - 1500.00

Source: South Sakwa Ward

There is high income disparity in the study area given the high standard deviation (7225.2) from the mean of the household incomes.

Marital Status

Most of the households had two partners living together in marriage at 70 percent. Twenty-seven percent and one percent of the households were headed by widows and a widower respectively. only two percent of the households were headed by people who were single (**Figure 3**)

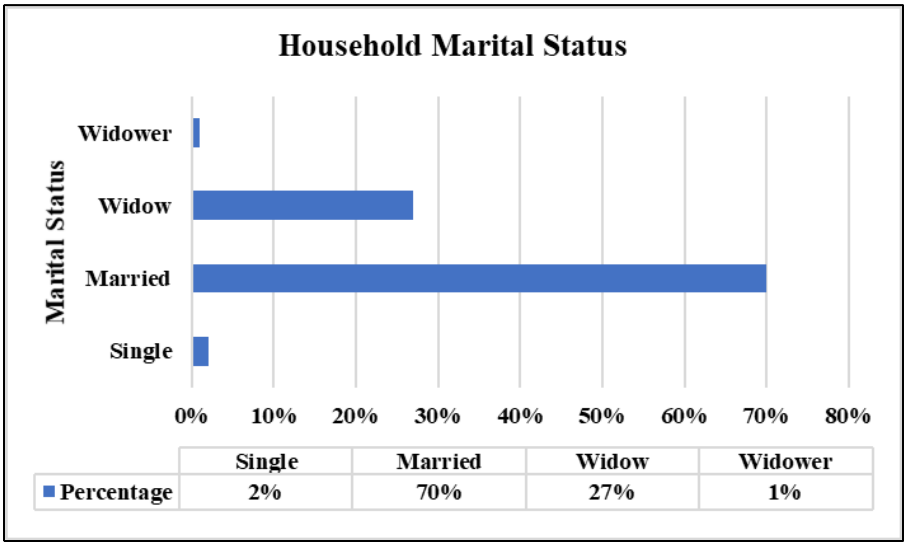


Figure 3: Households' marital status

Occupation of Household Heads

Most of the household heads in the study area were farmers at 40 percent, 34 percent of the household heads were engaged in small scale trading and 15 percent were employed as casual laborers. Fishermen and civil servants each made up 4 percent of the household heads' occupation and 3 percent were engaged in charcoal burning (**Figure 4**).

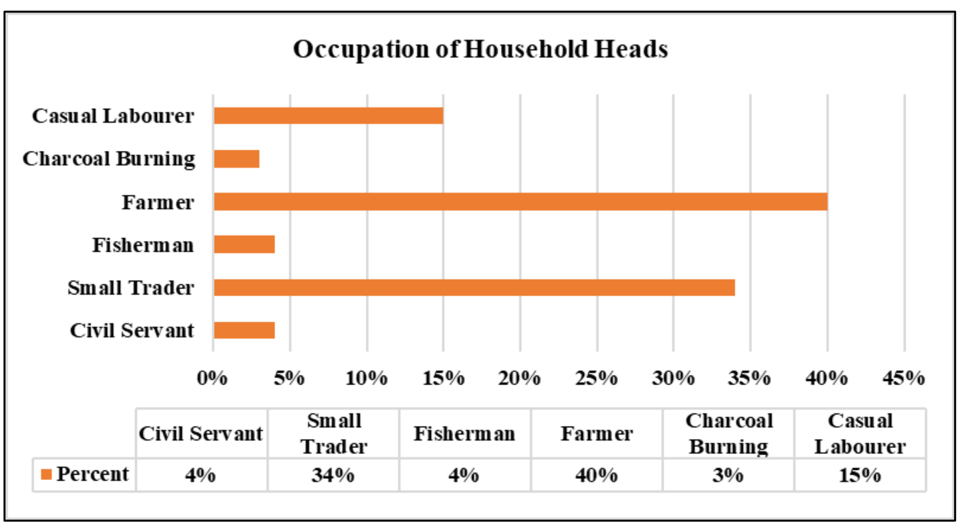


Figure 4: Household heads' occupation

Type of Dwelling and Availability of Separate Cooking Area

Semi-permanent houses were the dominant type of dwelling owned by the households interviewed at 78 percent, followed by other types of dwelling such as, temporary structures and tents at 13 percent. Four and five percent of households were living in permanent and mud-walled-grass-thatched houses respectively. Seventy-four percent of the households had a separate cooking area from the main house as compared to 26 percent who did not have (**Table 2**).

Table 2: Households' type of dwelling and availability of separate cooking area

Type of Dwelling	**%age**	
Mud-walled-grass thatched	5	
Semi-permanent	78	
Permanent	4	
Other	13	
Total	100	
Availability of separate cooking area		**%age**
	Yes	74
	No	26
	Total	100

Source: South Sakwa Ward

Households' Membership in Social Organizations and Access to Credit

Out of the 100 households interviewed, sixty nine percent were members of a social organization (group) and the rest were not (31 %). Of the households who were members of a group, 69.6 percent accessed credit from the groups and 30.4 percent did not have access to credit from the groups in which they were members (**Table 3**)

Table 3: Households' membership in social organizations and access to credit

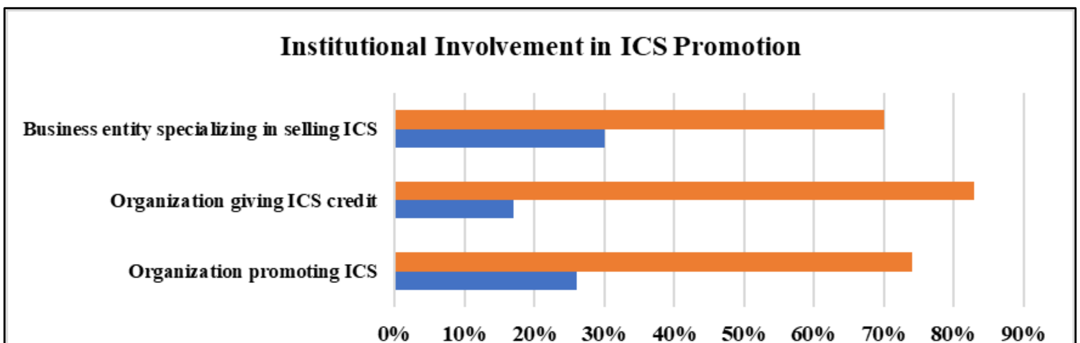
Households' Membership to Social Organizations		
	n	**%age**
Member of a group	69	69%
Not member of a group	31	31%
Total	100	100%
Household Access to Credit from the Groups		
	n	**%age**
Access Credit	48	69.6%
Does NOT Access Credit	21	30.4%
Total	69	100.0%

Source: South Sakwa Ward

Access to credit has been established to be a barrier to the use of improved cookstoves by households. The Global Alliance for Clean Cookstoves noted that, financiers are reluctant to extend credit to the clean cooking solutions sector. Citing the low credit rating assigned to the sector by the lenders. Lack of access to credit has mainly affected the manufacture of clean cookstoves since, enterprises involved cannot meet the minimum credit thresholds set by the potential financiers (Accenture, 2018).

Institutional Involvement in Improved Cookstove Promotion

The respondents were asked if they were aware of any institution or organization involved in the following activities; promotion of the use of improved cookstoves, issuance of credit for the purchase of improved cookstoves and sale and servicing of improved cookstoves. On the general promotion of improved cookstove use, 74 percent of the respondents were not aware of any organization involved. Twenty-six percent of the respondents were ware of an organization promoting use of improved cookstoves. Eighty-three percent of respondents were not aware of any organizations/institutions giving credit for the purchase of ICS. Seventeen percent of respondents were not aware of such an organization/institution. Seventy percent of the respondents were not aware of the existence of a business entity specializing in the sale and servicing of improved cookstoves. Thirty percent of the respondents acknowledged that they knew of a business entity selling and servicing improved cookstoves. (**Figure 5**)



	Organization promoting ICS	Organization giving ICS credit	Business entity specializing in selling ICS
No	74%	83%	70%
Yes	26%	17%	30%

Figure 5: Households' awareness of organizations/institutions promoting use of ICS

Institutions play an important role of providing information to households on clean cooking solutions. Besides this, they also have the potential of giving households access to financial support for the acquisition of clean cooking devices such as the improved cookstoves (Lewis &

Pattanayak, 2012). One way through which Government can finance the clean cooking sector is through provision of subsidies at various levels of the clean cooking value chain. Subsidies have been shown to be effective if, provided at the manufacturer level. The consumers (households) then benefit through the resulting price transfers through the value chain (Lewis & Pattanayak, 2012). The results here show very minimal involvement of institutions in supporting clean cooking solutions.

4.2 Cooking Energy Typologies and Cooking Technologies

In this section, the results of various types of cooking energy and technologies used by household in the study area is presented. It is then followed by a discussion on how they influence, households' use and adoption of clean cooking technologies (improved cookstoves).

4.2.1 Cooking Energy Typologies

The predominant cooking energy used by households in the study area was firewood at 62 percent. Thirty-six percent of the households were using charcoal and just 2 percent were using Liquified Petroleum Gas (LPG) (**Figure 6**).

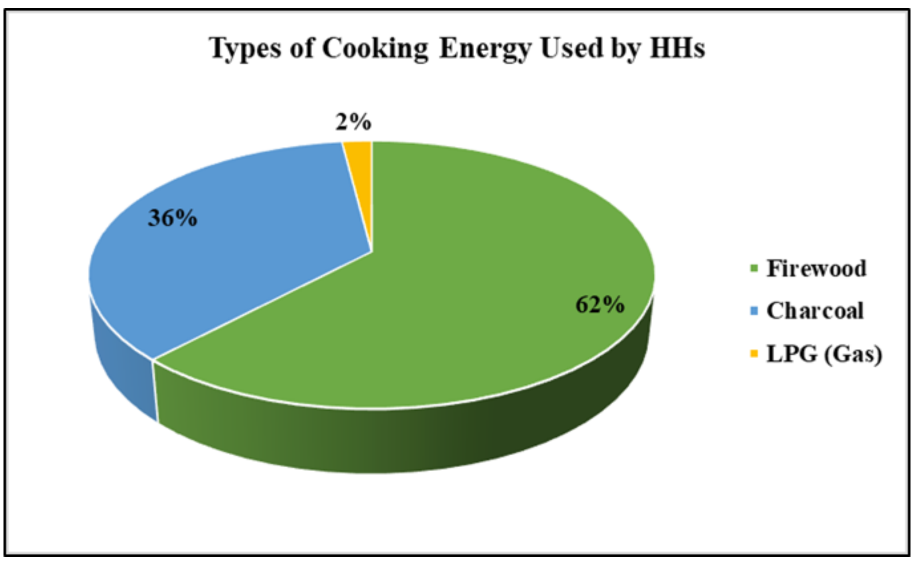


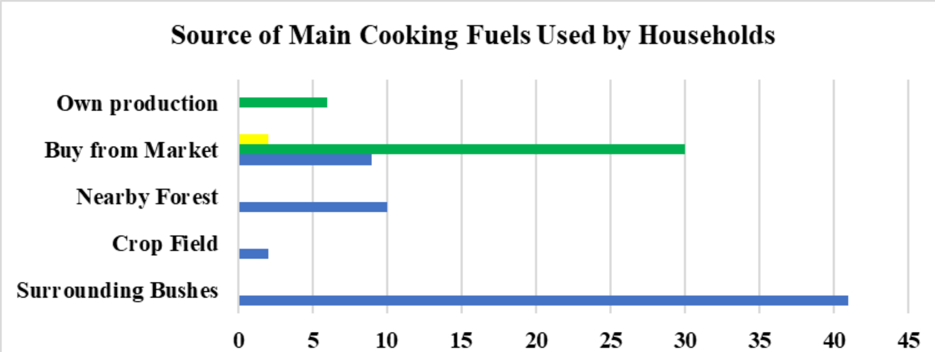
Figure 6: Main types of cooking energy used by the households

From the results, households in the study area predominantly used biomass based solid fuels (charcoal and firewood) for their cooking needs. According to the Siaya County Integrated Development Plan 2018-2022, 82 percent and 13.6 percent of households use firewood and charcoal respectively for their cooking needs. Charcoal use in the study area at 36 percent is above the national average of charcoal use in rural areas which stands at 7 percent (KNBS, 2010).

Overall, use of biomass based solid fuels in the study area at 98 percent is above the Siaya County average of 95.6 percent (SCIDP, 2018).

Source of the Main Types of Energy Used By Households

The households obtained their main type of cooking energy from various sources. Out of the 62 households using firewood, 41 were obtaining it from the surrounding bushes, 10 from a nearby forest and 2 were collecting it from the crop fields. Nine of the households using firewood were buying it from the local markets. Of the 36 households using charcoal, 30 were buying it from the local market and six were producing the charcoal they consumed on their own. The users of LPG were re-filling their cylinders in Bondo Town (**Figure 7**).



	Surrounding Bushes	Crop Field	Nearby Forest	Buy from Market	Own production
LPG (Gas)	0	0	0	2	0
Charcoal	0	0	0	30	6
Firewood	41	2	10	9	0

Figure 7: Sources of the main types of energy used by households

From the analysis, the firewood used by the households is mostly obtained from the commons (surrounding bushes, crop fields and nearby forest). That, only a very small proportion of firewood users obtains it at a cost points to the commonly held believe that, the easy access to firewood as a cooking energy is a barrier to the use and adoption of clean cooking technologies (Mamuye et al., 2018).

Payment for the Types of Energy Used by Households

A total of 41 households were buying the fuel used for cooking. Twenty-two percent of the households buying cooking fuel were using firewood, 73.2 percent were using charcoal and 4.9

percent were using LPG. Fifty-nine households were not buying the fuel used for cooking, out of which 89.8 percent were using firewood and 10.2 percent were using charcoal (**Figure 8**).

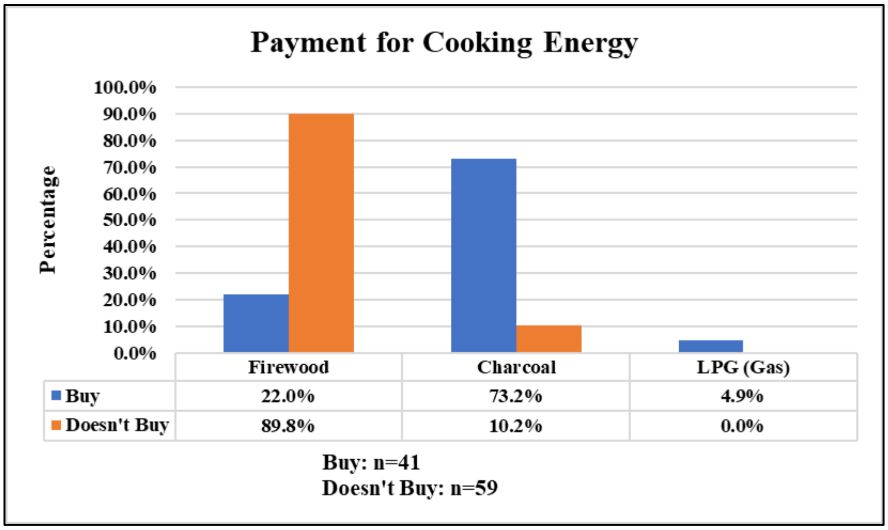


Figure 8: Payment for type of cooking energy used by households

The cost of fuel is a determinant of fuel availability and accessibility thus, fuel obtained at no monetary cost can be said to be widely available and easily accessible. From the results, firewood is widely available and can be accessed easily since most of the households obtain it at no monetary costs. However there are labour and time costs which are often not accounted for (World Bank, 2011a).

Willingness to Pay for Cooking Fuel and the Use of Improved Cookstoves

Of the households who were using an improved cookstove, 84.2 percent were buying the cooking fuel used and only 15.4 percent were not buying the fuel used. Of the households who were not using an improved cookstove, only 25.7 percent were buying the fuel used and 74.3 percent were not buying the fuel used (**Figure 9**).

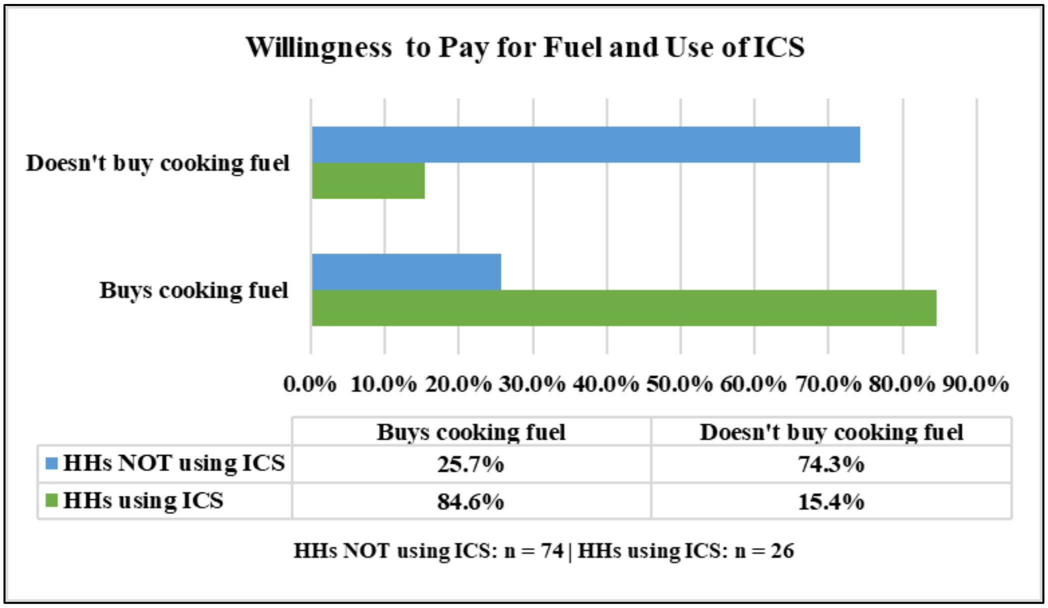


Figure 9: Willingness to pay for cooking fuel and households' use of improved cookstoves

A chi-square test of association showed a significant association between use of improved cookstoves and buying of cooking fuel ($x^2(1) = 27.6, p = 0.00, p < 0.05$). Previous studies have suggested that when fuel is obtained at no cost, households tend to shun the use of more clean and efficient cooking technologies (Mamuye et al., 2018). Further, when fuel is obtained at a cost, there is preference for the use of more efficient and fuel saving cooking technologies such as improved cookstoves (Jagger & Jumbe, 2016). The cost of cooking fuel also has a direct effect on the households' willingness to pay for the anticipated incremental benefits of cleaner cooking solutions. Willingness to pay for cleaner cooking solutions also limits the households' access to cleaner fuels and cleaner and efficient cooking technologies (World Bank, 2015).

4.2.2 Types of cooking technologies used by households

Most households in the study area used the traditional three stones stove for cooking at 62 percent. Twenty-six percent were using improved cookstoves and 10 percent and 2 percent were using metallic jikos and gas cookers respectively (**Figure 10**).

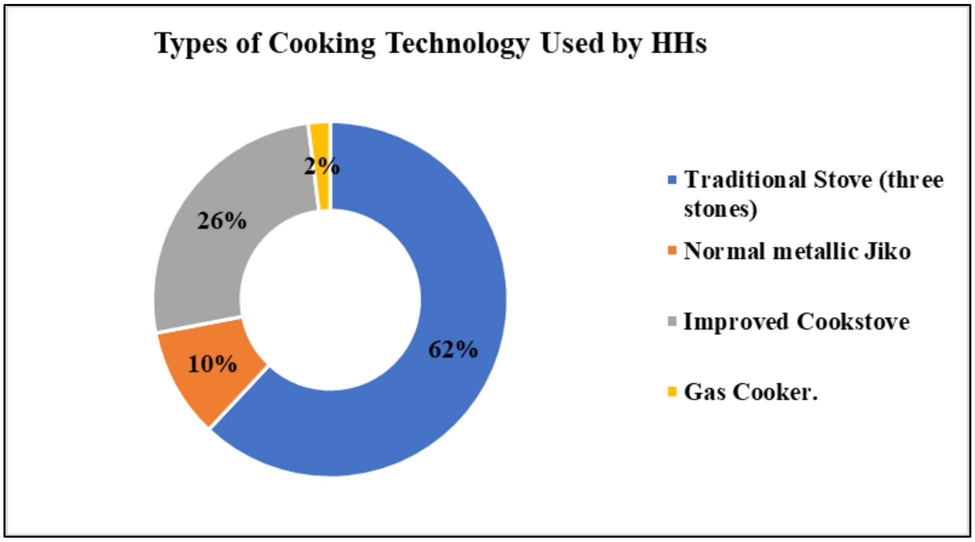


Figure 10: Cooking technologies (devices) used by households

The predominant use of the traditional three stones cookstove in the study area at 62 percent is slightly below the Siaya County average of 71.4 percent (SCIDP, 2018). Use of improved cookstoves in the study area at 26 percent is slightly above the Siaya County average of 14.5 percent but below the national average of approximately 37 percent (KNBS, 2010).

Association Between Type of Cooking Energy and type of Cooking Technology

All the households using firewood (62) for cooking were also using the traditional three stones stove, all the households using a metallic jiko (10) and an improved cookstove (ICS) (26) were using charcoal as a cooking energy and the LPG users (2) were using it on a gas cooker (**Table 4**)

Table 4: Crosstabulation of type of energy and type of cooking technology (Device)

	Type of Cooking Technology (Device)				
Type of Cooking Energy	Traditional Stove (three stones)	Normal metallic Jiko	ICS	Gas Cooker	Total
Firewood	62	0	0	0	62
Charcoal	0	10	26	0	36
LPG (Gas)	0	0	0	2	2
Total	62	10	26	2	100

Source: South Sakwa Ward

This results show a relationship between the type of cooking energy and the type of cooking technology (device) use by households in the study area. The results of a chi-square test shows that there is a significant relationship between the type of fuel used for cooking and the type of cooking technology (device) used ($x^2(1) = 200, p = 0.00, p < 0.05$).

4.3 Factors influencing Use and Adoption of Clean Cooking Technologies

In this section the factors influencing use and adoption of clean cooking technologies are presented and discussed. These were determined using the binomial logistic regression model. First the results of the binomial logistic regression analysis are presented and explained, after which each of the variables included in the model are discussed in detail.

4.3.1 The Binomial Logistic Regression Model

Data Coding

Dependent Variable Coding

The dependent variable in this study was households' use of improved cookstove. in the regression model it was coded as; No = 0 and Yes = 1 (**Table 5**)

Table 5: Dependent Variable Coding

HHs use of improved cookstove	
Original Value	Internal Value
No	0
Yes	1

Source: Binomial Logistic Regression (BLR) Analysis

Categorical Independent Variable Coding

The categorical independent variables used in the model required a "Yes" or "No" response during data collection. The responses were coded as; No = 0 and Yes = 1 in the binomial logistic regression model (**Table 6**)

Table 6: Categorical Variables Codings

		Frequency	Parameter coding (1)
Does the Household have a separate cooking area from the main house?	No	26	0
	Yes	74	1
Are you a member of any social organization?	No	31	0
	Yes	69	1
Do you know of any business entity that specialize in the sale and servicing of improved cookstoves	No	70	0
	Yes	30	1
Gender	Male	35	0
	Female	65	1

Source: BLR Analysis

The column "parameter coding" shows the values assigned to each of the independent categorial variables responses.

4.3.2 Binomial Logistic Regression Results

In this section, the results of the logistic regression analysis is presented. It includes the tests used to determine the suitability of the model for this analysis. Explanation of the variances in the dependent variable. The accuracy of the prediction of the occurrence of the phenomenon under study in the population and the variables used in the model equation. In general, the data was checked for the seven assumptions of binomial logistic regression analysis and it was found to be compliant. In that, the dependent variable was dichotomous and nominal. That the independent variables were either measured in a continuous or nominal scale. There was independence of observations in both the dependent and independent variables. There were more than fifteen observations for each variable (there were actually 100 observations). The relationship between the continuous independent variables and the logit transformation of the dependent variable was linear. The other assumptions satisfied by the data was that the independent variables were not highly correlated to one another (no multicollinearity[2]) and lastly that there were no significant outliers[3] in the continuous independent variables.

The Model Fit

The overall significance of the model was determined using the omnibus tests of model coefficients[4]. The model was found to be statistically significant ($p = 0.00$, at $P < 0.05$) as referenced by the model row (**Table 7**).

Table 7: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	87.967	8	.000
	Block	87.967	8	.000
	Model	87.967	8	.000

Source: BLR Analysis

[2] When two or more explanatory variables are related to each other “multicollinearity” occurs.
[3] “Outlier” is a term used to represent observations in a set of data that appear differently from observed trends before performing a binomial logistic regression analysis.
[4] The "Omnibus Tests of Model Coefficients", is a test used to show the reliability of the model in predicting categories

Variations in the Dependent Variable

The explained variation in the dependent variable based on the model ranges from 58 % to 85 % as explained by the Cox & Snell R Square and Nagelkerke R Square[5] (**Table 8**).

Table 8: The Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	26.644[a]	.585	.858
a.Estimation terminated at iteration number 9 because parameter estimates changed by less than .001.			

Source: BLR Analysis

Dependent Variable Prediction and Classification

The percentage accuracy in classification (PAC) measure was used to classify the cases as observed and as predicted by the model. The model correctly classified 94.0 percent of the cases given by the "overall percentage" row (**Table 9**).

Table 9: Classification table

Observed			Predicted		
			Do you use improved cookstove?		Percentage Correct
			No	Yes	
Step 1	Do you use improved cookstove?	No	72	2	97.3
		Yes	4	22	84.6
	Overall Percentage				94.0

Source: BLR Analysis

The sensitivity[6] measure was applied to correctly predict that 84.6 percent of households who, used an improved cookstove were also, predicted by the model to have been using improved cookstoves. As given by the "percentage correct" column in the "Yes" row of the observed categories (**Table 9**).

The specificity[7] measure was applied to predict that 97.3 percent of households who were not using an improved cookstove were, correctly predicted by the model not to have been using an improved cookstove as given by the "percentage correct" column in the "No" row of observed categories (**Table 9**).

[5] The Cox & Snell R Square and Nagelkerke R Square are methods used to calculate the explained variation.
[6] Proportion of cases with the observed characteristic ("Yes" for ICS use) and were correctly predicted by the model
[7] Proportion of cases without the have the observed characteristic ("No" use of ICS)

Variables in the Equation (Table 10)

The "B" column gives the coefficients used in the model to predict the probability of households using an improved cookstove. It shows the change in the *log* odds that occur for a one unit change in an independent variable when all other independent variables are held constant. The "S.E" column gives the standard error associated with the coefficients. It is used to test for significant difference from zero of the parameters.

The "Wald" column gives an indication if the independent variables are significant in the model. That is, if they add value to the model. For instance from the results it is shown that age (p=0.03), income (p=0.01) and knowledge of business selling ICS (p=0.03) added significantly to the model prediction. But gender (p=0.08), years in school (p=0.85), household size (p=0.83) and separate cooking area (p=0.55) did not add significantly to the model.

The "df" column shows the degree of freedom for the independent variables. Each of the independent variables is allowed one degree of freedom. The "p" column gives the p-value to test for significance at p=0.05. The Exp(B) column gives the change in odds for each increase in one unit of the independent variables. For example, for household income, an increase in one unit (i.e. higher income) increases the odds by 1.00. Meaning that the odds of a household using an improved cookstove (coded as yes) is 1 times greater for households with higher income as opposed to households with lower incomes. The last column (95% C.I.for EXP(B)) gives the lower and upper limits of the odds values at 95 % confidence level.

Table 10: Logistic regression predicting likelihood of use and adoption of improved cookstoves based on household characteristics and social interactions

	B	S.E.	Wald	df	*p*	Exp(B)	95% C.I.for EXP(B)	
Variables in the Equation							Lower	Upper
Gender(1)	-2.43	1.37	3.12	1	0.08	0.09	0.01	1.30
Age	-0.24	0.11	4.72	1	0.03	0.79	0.64	0.98
Years in School	-0.06	0.30	0.04	1	0.85	0.94	0.52	1.70
Household Size	0.05	0.25	0.05	1	0.83	1.06	0.64	1.73
Income	0.00	0.00	6.38	1	0.01	1.00	1.00	1.00
Group Membership(1)	-1.01	1.40	0.52	1	0.47	0.37	0.02	5.69
Knowledge of Business Selling ICS(1)	3.04	1.37	4.93	1	0.03	20.99	1.43	308.35
Separate Cooking Area(1)	0.88	1.45	0.37	1	0.55	2.40	0.14	41.13
Constant	3.80	4.88	0.60	1	0.44	44.52		

Source: BLR Analysis

The Empirical Results

The binomial logistic regression was performed to ascertain the effects of age, number of years spent in school, household size, household income, gender, household membership to a group, knowledge of a business selling improved cookstoves and the availability of separate cooking space on the likelihood that households would use and adopt improved cookstoves. The logistic regression model was statistically significant, ($\chi^2(8) = 27.402$, $p < 0.05$). The model explained 86.0% (Nagelkerke R^2) of the variance in households' use of improved cookstoves and correctly classified 94.0% of cases.

Of the eight independent (predictor) variables, only three were statistically significant: age ($\beta = 0.79, p = 0.03, p < 0.05$) , income ($\beta = 1.00, p = 0.01, p < 0.05$) and knowledge of a business entity specializing in the sale of improved cookstoves ($\beta = 20.99, p = 0.03, p < 0.05$) (**Table 10**). Increasing age was associated with, an increased likelihood of not using an improved cookstove. Households with higher incomes had 1 time higher odds of, using an improved cookstove as compared to lower income households. Knowledge of a business entity specializing in, the sale of improved cookstoves increased the odds of households using an improved cookstove by 20.99 times (**Table 10**).

4.3.3 Discussion of the Empirical Results

Having determined the influence of household characteristics and social interactions on the use and adoption of improved cookstoves in the previous section. These factors are then discussed in detail in this section. The discussions here shows the observed trends of the household characteristics and social interactions. The discussions are based on the households using improved cookstoves and the households that were not using improved cookstoves. The discussions illustrate these factors as they operate in the study area and gives similar, or differing scenarios observed elsewhere in Kenya, Africa and the world as contained in the available literature on the same.

4.3.3.1 Gender and Use of Improved Cookstoves

Fifty three percent of the male respondents indicated that the households were using ICS. Of the female respondents, 46.2 percent indicated that the households were using ICS. Twenty-eight percent of the male respondents indicated that, the households were not using ICS and 71.6 percent of the female respondents indicated that the households were not using ICS (**Figure 11**).

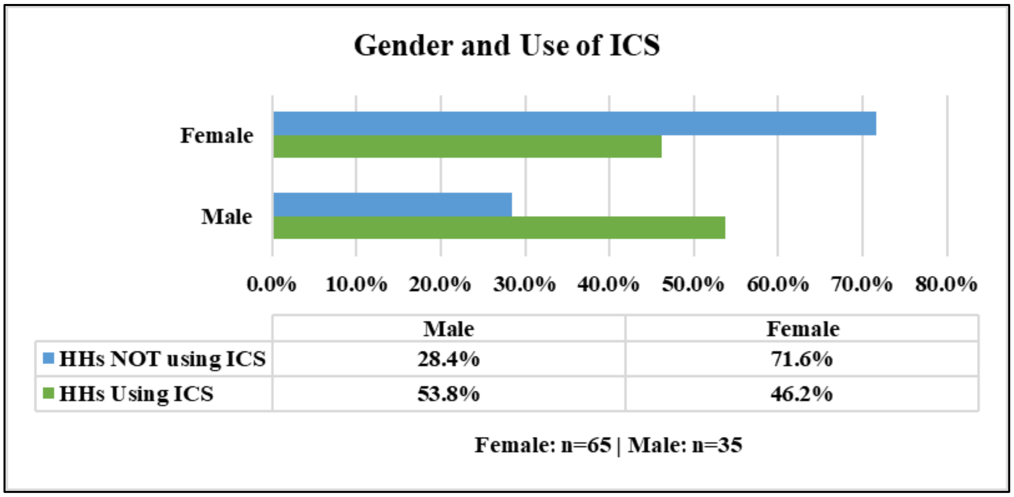


Figure 11: Gender and the use of ICS

The results suggested that, male headed households used improved cookstoves as compared to female headed households. Available literature suggests that, female headed households are more likely to use and adopt clean cooking technologies such as improved cookstoves (Vigolo et al., 2018). A study conducted in North rural India suggested a positive correlation between, female headed households and use of improved cookstoves (Brooks et al., 2016). This study, however, finds no significant relationship ($\beta = 0.09, p = 0.08, p < 0.05$) between gender and the use of improved cookstoves as given by the binomial logistic regression analysis results.

This finding confirms the results of a study conducted in India where, gender had no significant contribution to the use of improved cookstoves (Mohapatra & Simon, 2017). Gender can be a barrier to, the use and adoption of improved cookstoves. Socio-cultural practices have naturally assigned roles in households. In these roles, women are primarily assigned the cook role while men, make kitchen related decisions such as the purchase of improved cook stoves (Debbi et al., 2014). That women can only use what their husbands provide for them to cook, underscores the negative influence of socio-cultural practices on the use and adoption of improved cookstoves (Kohlin et al., 2011). Given that women bear the greatest burden for the impacts of cooking using inefficient cooking technologies (WHO, 2012). ICS promotion activities and strategies should be designed to address the challenges faced by women. Such as discrimination against women in terms of decision making in the household (Bloomfield & Malla, 2014).

4.3.3.2 Age and Use of Improved Cookstoves

Of the households using ICS, 11.5 percent were in the age group 18-25, 53.8 percent were in the age group 26-35, 34.6 percent were in the age group 36-45. None of the households headed by people above 46 years old were using ICS. Out of the 74 households that were not using ICS, 2.7 percent were in the age group 18-25, 16.2 percent were in the age group 26-35, 31.1 percent were in the age group 36-45, 23 percent were in the age group 46-55 and 27 percent were above 56 years of age (**Figure 12**).

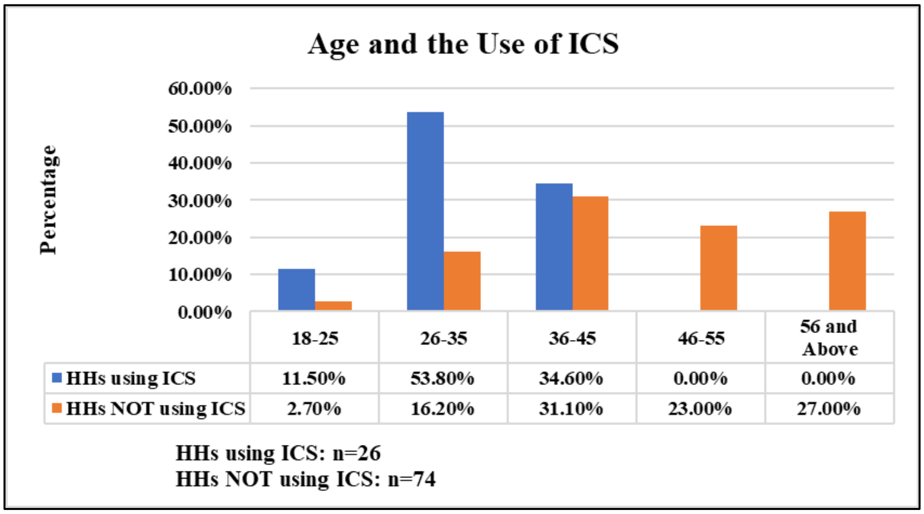


Figure 12: Age and households' and use of ICS

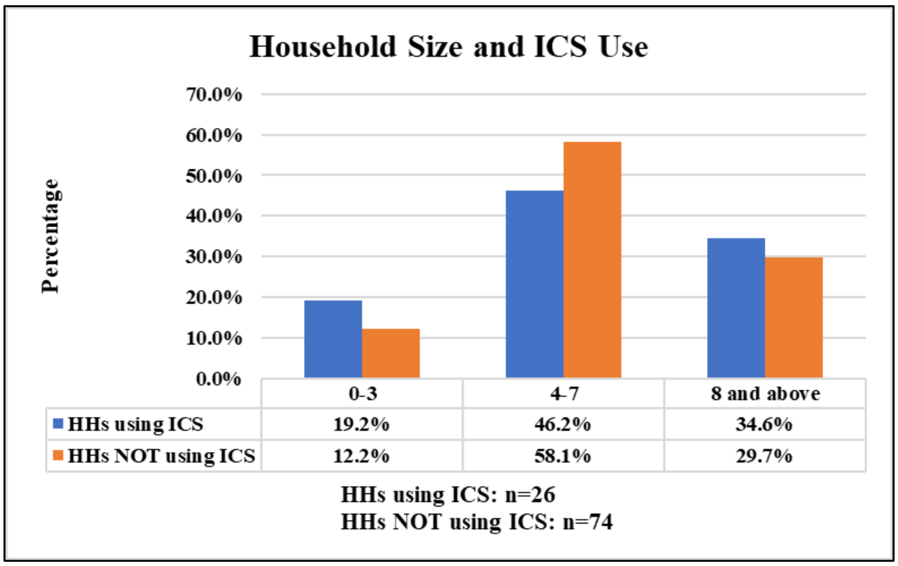
The above findings suggest that, households headed by younger people (45 years and below) were more likely to use improved cookstoves. This is confirmed by the results of the logistic regression analysis which showed that, households headed by younger people had a higher likelihood of using and adopting improved cookstoves ($\beta = 0.79, p = 0.03, p < 0.05$). The analysis also revealed that, increasing age of the household head increased the likelihood of households not using and adopting improved cookstoves. Previous research findings have suggested similar trends where, households headed by persons below the age of 55 years tend to be open to the use of improved cookstoves (Vigolo et al., 2018).

Younger households have been shown to have higher probabilities of using improved cookstoves than older households. In previous studies, age was shown to positively influence a household's decision to use and adopt clean cooking technologies. Specifically, lower age groups had higher odds of discarding the use of traditional cooking methods for more clean and efficient technologies such as improved cook stoves, LPG and electricity (Wolf et al., 2017). Further, it has been shown that lower age groups have a higher likelihood of purchasing an improved cookstove, with a higher likelihood of consistent use and ultimate adoption (Vigolo et al., 2018).

Some studies have also established that age of the main cook has a significant influence on the type of cooking device, with older age groups acting as a barrier to the adoption of clean cooking technologies mainly because of the difficulty in changing long standing cooking methods (Thomas EA et al., 2016). Other studies, however, have held that age has no significant influence on the use of improved cookstoves. For instance a study in rural Pakistan, found no significant relationship between the age of the household head and use of improved cookstoves (Jan et al., 2017).

4.3.3.3 Household Size and Use of Improved Cookstoves

Of the households using improved cookstoves, 19.2 percent was composed of 0-3 people, 46.2 percent was composed of 4-7 people and 34.6 percent was composed of eight people and above. Out of the households not using improved cookstoves, 12.2 percent was composed of 0-3 people, 58.1 percent was composed of 4-7 people and 29.7 percent was composed of more than 8 people (**Figure 13**).



	0-3	4-7	8 and above
HHs using ICS	19.2%	46.2%	34.6%
HHs NOT using ICS	12.2%	58.1%	29.7%

Figure 13: Household size and the use of improved cookstoves

This study did not find any significant relationship ($\beta = 1.06, p = 0.83, p < 0.05$) between household size and the use and adoption of improved cookstoves from the results of the logistic regression analysis conducted. This finding is consistent with a study conducted in Nyeri, Kenya where there was a negative correlation between household size and use of improved cookstoves (Nyankone, 2018). Mohapatra and Simon also found a negative correlation between household size and the use of improved cookstoves. They attributed this to the increase in the cost of transitioning to new cooking technologies as the household's cooking needs increases.

This finding is however inconsistent with results of previous studies where household size was shown to positively influence the use and adoption of clean cooking technologies. For instance, larger households tend to stick to traditional cooking technologies (Wolf et al., 2017). Larger households have also been found to be reluctant to adopt cleaner cooking technologies because of the abundance of labour for firewood collection mainly for use in inefficient cooking stoves (Vigolo et al., 2018). Further, the perception that improved cook stoves are too small to be adequately used for cooking for larger families has discouraged their use and adoption (Vigolo et al., 2018).

4.3.3.4 Number of Years Spent in School and Use of Improved Cookstoves

Out of the households using improved cookstoves, 3.8 percent had spent zero years in school, 73.1 percent had spent 8 years in school, 19.2 percent had spent 12 years in school and 3.8 percent had spent 14 years and over in school. Out of the 74 households not using improved cookstoves, 2.7 percent had spent zero years in school, 70.3 percent had spent 8 years in school, 21.6 percent had spent 12 years in school and 5.4 percent had spent 14 years and above in school (**Figure 14**).

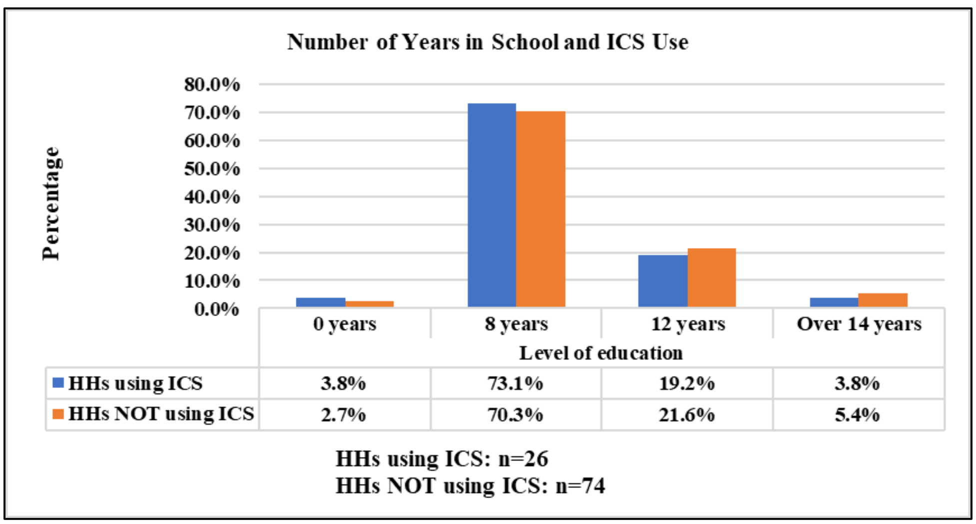


Figure 14: Years spent in school by household heads and use of ICS

From the results, there is an observed trend showing that ICS was predominantly used by households where the head had spent 8 years in school. It is also observable that non-ICS use is also dominant amongst the households whose heads had spent 8 years and above in school. The results also shows that the percentage of households whose heads had spent zero years in school but are not using ICS (2.7%) is lower than that of households with zero years spent in school but are using ICS (3.8%).

The logistic regression analysis result shows that number of years spent in school by the household head had no significant ($\beta = 0.94, p = 0.85, p < 0.05$) influence on the use of improved cookstoves in the study area. This is confirmed by available literature showing that level of education may not have a significant influence on the use and adoption of improved cookstoves. As observed in rural Tanzania, higher or lower levels of education did not positively correspond to the use or non-use of ICS (Kulindwa et al., 2018). Other studies have suggested a positive correlation between level of education and use of improved cookstoves. In rural Pakistan, households whose heads had attained a primary level or secondary level of education had a higher propensity of using ICS (Jan et al., 2017). A similar trend was also observed in Kiambu, Kenya where low rates of ICS adoption was attributed to low levels of education (Kongani et al., 2019).

4.3.3.5 Household Income and Use of ICS

In the income range of Ksh. 0-8,174, approximately 97 percent were not using ICS and only 3.1 percent were using ICS. Of the households within the income range of Ksh. 8,175-16,349, 53.8 percent were using ICS and 46.2 percent were not using ICS. In the income range of Ksh. 16,350 – 24,524, 100 percent were using ICS the same applied to the income range of Ksh. 24,525-35,000 (**Figure 15**). The data reveals a trend showing that households in the lower income range (0-8,174) are constrained to use ICS. This seems to change with progression into higher income ranges above the mean income of households in the study area.

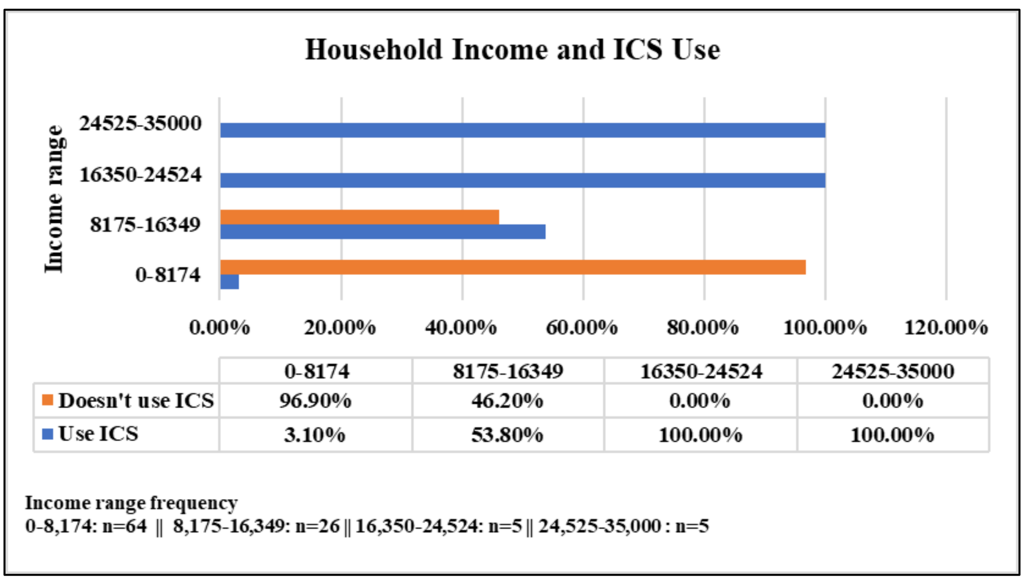


Figure 15: Average income of households and the use of ICS

The results of the logistic regression analysis shows that, households with higher monthly income had a higher probability ($\beta = 1.00, p = 0.01, p < 0.05$) of using an improved cookstove than households with lower incomes as given by the binomial logistic regression analysis results.

A study in rural India showed that households with higher income, used clean and efficient cooking devices consistently as compared to low income households who preferred traditional inefficient cooking devices (Rehfuess et al., 2014). A similar study in northwest rural Pakistan, showed that households with higher income had a willingness to use clean cooking technologies (Jan, 2011).

The World Health Organization indoor air quality guidelines identified income as an enabler of use and adoption of clean cooking technologies. Low income is a barrier to adoption while higher income is an enabler of use and adoption (Puzzolo et al., 2013). In Kenya, a study in Busia County showed that household level of income was a barrier to use of improved cookstoves. Low level income households tended not to use the stoves (Nyandie, 2017). There have been study findings indicating that household income is not relevant to use and adoption. For instance, a study in Nepal found that households' income levels did not determine the use of improved cookstoves, as wealthy landowners only sparingly used the improved cook stoves to prepare certain meals (Barnes, 2012). This is an observation in patriarchal societies/communities where, despite high household incomes, the use of traditional technologies for cooking is prevalent (Kumar et al., 2014). In such settings, households actually spend disproportionate amounts of income on lower quality fuels and technologies (Puzzolo et al., 2013).

4.3.3.6 Membership to Social Organizations and Use of Improved Cookstoves

Sixty-nine percent of households using an improved cookstove belonged to a group and almost a similar number at 68.9 percent did not belong to a group. Of the households not using improved cookstoves, 30.8 percent belonged to a group and 31.1 percent were not members of a group (**Figure 16**).

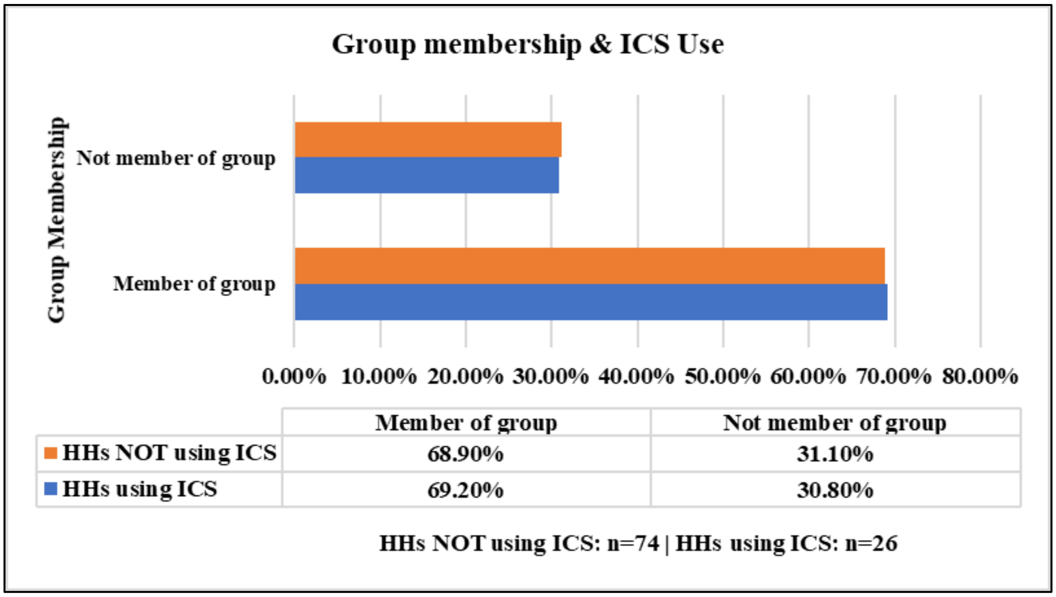


Figure 16: Households' membership to social organizations and the use of ICS

The results of the logistic regression analysis showed no significant relationship ($\beta = 0.37, p = 0.47, p < 0.05$) between household membership to a group and the use of an improved cookstove. A study conducted in Kenya showed that, social relations do not significantly influence use and adoption of clean cooking technologies if, the interactions do not involve sharing information on the technologies (SEI, 2017). For instance a comparison between two groups of stove users showed that, the stove users who shared specific information on the benefits of using the stoves within their social cycles influenced more people to use the stoves. On the contrary, stove users who did not discuss the benefits of stove use with their peers, reported that none of their peers were influenced to use the stoves (SEI, 2017). When information received from groups by households was ranked, health came first, followed by nutrition, environment, education and energy in that order (**Table 11**). Information on household energy ranked last explaining why despite 69% of households being members of a social organization, ICS use and adoption still remained low in the study area.

Table 11: Ranking of the categories of information received from groups by household heads

Category of Information Received from Groups	HHs Using ICS	HHs NOT Using ICS	Rank
Health	14	38	1
Nutrition	10	26	2
Environment	9	22	3
Education	11	23	4
Energy	4	6	5

Source: South Sakwa Ward

Social relations have an influence on the decision on whether to purchase a clean cooking device. Households' decisions can be influenced positively or negatively by the experiences of neighbors, relatives or acquaintances who have purchased and used the technology before (Puzzolo et al., 2013). Membership to a social grouping exposes households to these kind of experiences and thus, plays an important role in the dissemination of information on clean cooking technologies. Social learning theorists agree that individuals use and adopt new technologies based on, the information they receive from peers, or in social groups that they belong to (Conley et al., 2008). The social groups provide a channel for disseminating information on the benefits and availability of cooking technologies. Thus tailor-made information on clean cooking technologies should be disseminated through them.

Knowledge on the most preferred groups by households will help in reaching out to a larger percentage of the population. As observed in a previous study, marketing strategies that target established social groups like women groups have a greater impact on the use and adoption of clean cooking technologies (Hart et al., 2013). Household heads in the study area had concurrent membership in women groups, savings & loan groups and family based groupings. Therefore, clean cooking technologies marketing campaigns should be targeted at these groups to promote the use of the technologies. To leverage on this readily available communication channel, a future Siaya County policy on clean cooking technologies, should take into consideration the role played by the social organizations as information dissemination points in the rural communities. Indeed, literature on social learning and adoption of clean cooking technologies, agrees that household decisions to purchase a clean cooking device is influenced to a large extent, by similar actions taken by peers and experiences of notable individuals within the community (Bonan et al., 2017).

The social organizations provide an effective platform for households to access affordable credit to finance various activities including purchasing clean cooking devices. Food ranked first as the use for the loans households obtained from the groups, followed by school fee, investment and medical expenses in that order (**Table 12**). The ranking was the same for both households using and not using an ICS. None of the household heads used the credit to buy an ICS.

Table 12: Ranking of the use of loans households obtain from groups in which they are members

Use of Loans from Groups	HHs Using ICS	HHs NOT Using ICS	Rank
Food	10	31	1
Pay School Fee	9	29	2
Invest in Income Generating Activity	7	16	3
Pay Medical Expenses	2	9	4

Source: South Sakwa Ward

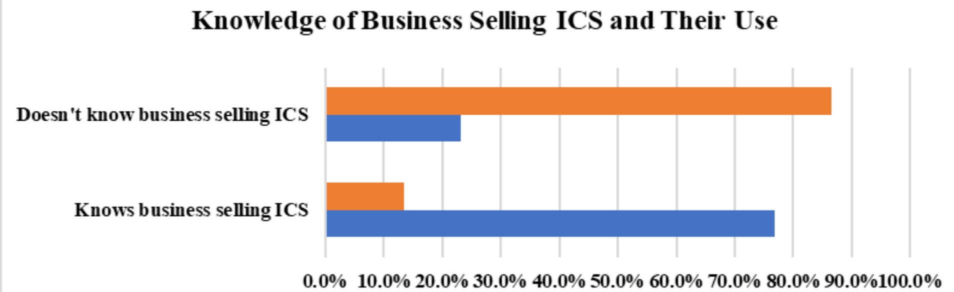
Limited or no access to credit is a barrier to the use and adoption of clean and efficient cooking technologies (Vigolo et al., 2018). A chi-square test of association showed no significant relationship between use of an improved cookstove and access to credit ($x^2(1) = 0.003, p = 0.95, p < 0.05$). A study in South Africa on the consumers' willingness to pay[8] for improved cookstoves determined that, access to credit was not relevant to use and adoption of the stoves (Mare &Annegarn, 2017).

Disposable income of the household is a major determinant of the willingness to pay for a good or service (Xiong, 2018). Loans are an integral part of the households' income basket. Therefore, as observed in this study, households prefer using the loans they get for other purposes other than purchase of improved cookstoves. Given the competing needs for the use of household income, purchase of clean cooking technologies, ranks low probably because, firewood is obtained at zero absolute costs and thus, it makes no sense to invest in expensive appliances for the burning of the same (Palit et al., 2014).

4.3.3.7 Existence of a Business Entity engaged in Sale of Improved Cookstoves

The results shows that 76.9 percent of households who used improved cookstoves knew of the existence of a business entity specializing in the sale of improved cookstoves. 23.1 percent of improved cookstove users did not know of the existence of a business entity selling improved cookstoves while only 13.5 percent of those not using improved cookstoves did not know of the existence of a business entity selling ICS. An overwhelming 86.5 percent of households not using improved cookstoves did not know of the existence of a business entity specializing in the sale of improved cookstoves (**Figure 17**).

[8] A consumer's willingness to pay is the maximum price which the consumer can pay to access a given good or service (Gall-Elly, 2009).



	Knows business selling ICS	Doesn't know business selling ICS
HHs NOT using ICS	13.5%	86.5%
HHs using ICS	76.9%	23.1%

HHs Using ICS: n=26 | HHs NOT using ICS: n=74

Figure 17: Households' knowledge of a business entity selling ICS

The results of the logistic regression analysis showed a significant relationship ($\beta = 20.99, p = 0.03, p < 0.05$) between knowledge of the existence of a business entity selling improved cookstoves and their use. The availability of a network of clean cooking technologies vendors within communities have been found to positively accelerate their use and adoption (Silk et al., 2012). These vendors play certain roles in the promotion of clean cooking technologies. Including acting as opinion leaders and providing specific product related information to the would be users (Silk et al., 2012). A business model with sound design, production, sales, marketing and cookstove maintenance services have been found to be key in successfully implementing cookstoves programs (GSF, 2016). The findings of this study concurs with the findings of previous studies. That, business models that support after-sales servicing of clean cooking technologies, positively impacts on the households' decision to purchase, use and adopt clean cooking technologies.

4.4 Influence of Policy and Institutional set-up

4.4.1 The Policy Environment

In Kenya, policy statements on biomass energy and promotion of clean cooking technologies are contained in various policies. The key ones are: Sessional Paper No. 4 on Energy of 2004, the National Environment Management Policy 2013, the Forest Policy 2014 and the Climate Change framework. The climate change framework comprises of, the Kenya Climate Change Action Plan 2013-2017, the Kenya Climate Change Action Plan 2018-2022 and the Kenya Climate Change Framework Policy of 2016.

Sessional Paper No. 4 on Energy of 2004 is currently, the main policy document on energy in Kenya. It identified unsustainable harvesting and use of biomass resources as a challenge and called for, the promotion of efficient technologies especially for their use in households. It further identified a number of constraints to the effective intervention of policy in, the use of biomass resources including that; biomass is considered a low profile energy despite its prominence in the Kenyan energy mix; that the high poverty incidence in the country has been a major impediment in the shift from traditional biomass energy to modern energy sources. It further noted that, there is an imbalance between the demand for fuelwood and the supply. Pointing to an over-reliance on wood fuel and other biomass energy resources. To this end, the sessional paper proposed a number of measures to be undertaken to reverse the situation including: the increase of the rate of efficient cookstoves adoption to 30 % by the year 2020; the increase of the efficiency of improved cookstoves to 40-45 % by the year 2020 and the building of the capacity of artisans to manufacture, install and maintain efficient cookstoves through training. The paper provided a clear institutional arrangement for the management of other sources of energy like, electricity and fossil fuels. However, the policy did not give a clear institutional identity for biomass fuels. This could be the reason for, the unstructured governance of the biomass energy sector with, a multiplicity of governmental entities regulating the activities in the sector.

The National Environmental Policy of 2013 had the goal of, ensuring better quality of life for the present and future generations. This, through the sustainable management of environmental and natural resources. The policy identified wood fuel use as a major threat to the biodiversity of the arid and semi- arid lands. The policy further noted that, the continued use of firewood for cooking in households was a major contributor to indoor air pollution. Thus, it proposed the promotion of efficient alternative cooking technologies and the construction of well-ventilated cooking spaces.

The Forest Policy 2014 had a goal of sustainably managing forest resources for intergenerational equity. It identified biomass energy use as a major threat to the sustainable management of forests in Kenya given that, over 80% of households relied on biomass energy for cooking and heating. It called for the promotion of efficient harvesting and use of wood fuel and the promotion of renewable forms of energy.

The Climate change framework in Kenya is composed of a strategy, a plan, a policy and an act of parliament namely: the Kenya Climate Change Action Plan (KNCCAP 2013-2017), Kenya Climate Change Action Plan (KNCCAP 2018-2022), the Kenya Climate Change Framework Policy and the Climate Change Act No. 11 of 2016. The Climate change framework outlined the strategies and plans for the adaptation to and mitigation of climate change and provided a policy and legal framework for the management of the adaptation and mitigation measures. The framework in particular provided for the sustainable harvesting and use of biomass resources for energy purposes.

The Kenya National Climate Change Action Plan (KNCCAP) 2013-2017 provided for, mitigation actions that included implementation of programmes to support the use of improved cookstoves. The plan set out to create awareness on better cooking practices, provide access to financing, enhance the capacity of improved cookstoves producers and piloting new cookstove technologies (KNCCAP, 2013). The plan recognized the opportunity presented by large scale use and adoption of improved cookstoves in, meeting the targets set under adaptation and mitigation measures for low carbon development as envisioned in the Kenya Vision 2030.

The Kenya National Climate Change Action Plan 2018-2022 planned for, the development and dissemination of four million improved cookstoves as a mitigation measure for climate change by the year 2022. The distribution of the improved cookstoves was projected to reduce emissions by about 2 $MtCO_2e$ per stove per year for charcoal and 2.5 $MtCO_2e$ for firewood. The mitigation actions were to be implemented through, enhancing the capacity of local manufacturers, developing and enforcing quality standards and developing the ICS value chain by including private enterprises especially in distribution.

The Sessional Paper No. 3 of 2016 also known as the Kenya National Climate Change Framework Policy came into effect in 2016. The framework policy was developed to facilitate a coordinated, coherent and effective response to the local, national and global challenges and opportunities presented by climate change (NCCFP, 2016). The policy's main objective was to enhance adaptive capacity and build resilience to climate variability and change, while promoting a low carbon development pathway. The policy acknowledged the widespread use of biomass energy especially charcoal and firewood in Kenya. It called for the efficient harvesting and use of the biomass energy resources to, enhance energy security and build resilience to climate change.

Through, amongst other measures the sustainable harvesting of forest resources and the promotion of efficient cook stoves.

4.4.1.1 Comparative Policy Analysis

The Kenyan Policy framework on biomass energy use is more advanced compared to similar policy framework in Bangladesh. Bangladesh has an almost similar biomass energy use scenarios where over 65 % of its primary energy needs are met by biomass energy (GoB, 2015). The biomass energy sources in Bangladesh are mostly agricultural residues and forests products. This is a biomass energy scenario that would call for a clear policy direction on the management of the sector. However, the Bangladesh National Energy Policy has no specific policy measures on the mitigation actions on biomass energy use and harvesting. In this regard, the Kenyan policy framework has clearly identified widespread use of improved cookstove as a mitigation measure. On this, the Kenyan policy framework is similar to those in Tanzania and Rwanda where emphasis has been put on the promotion of clean cooking technologies.

4.4.1.2 Policy Gaps

All the policies, plans and strategies are in agreement that unsustainable harvesting and use of biomass energy resources is a threat to the environment. Further, all the studied policy documents identify widespread use and adoption of clean cooking technologies as a feasible mitigation measure to reverse the resultant negative environmental, social and economic effects. Incoherent institutional framework for the management of biomass energy resources is noted across all the policy documents. All the policies have been formulated by separate Government departments. For instance the Sessional paper No.4 on Energy of 2004 is under the ministry of energy, the Environment policy, the Forest Policy and the Climate Change Framework Policy are under the ministry of environment and Natural Resources. The policy directions on biomass energy resources are to be implemented by the Kenya Forest Service. Which is an autonomous Government Parastatal. The implementation of the policy direction under the National Environment Policy is not clearly stated. The lack of institutional coherence presents a challenge to effective implementation of policies on biomass energy. This further impacts on the effective coordination of the promotion of clean cooking technologies. At the County level, the Siaya County Government is yet to formulate a policy for management of its biomass energy resources. However, the County Government has attempted to address the challenges of the household cooking technologies and biomass energy use through, development plans like the Annual Development Plan and the County Integrated Development Plan (CIDP).

For instance, in the Annual Development Plan (ADP) for the period 2018-2019, the water, energy and natural resources sector set out to enable sustainable access to safe water and sanitation in a clean and secure environment. To achieve this, the sector identified affordable clean energy as an enabler for this initiative. Through, the promotion of clean renewable energy by increasing the use of renewable energy technologies such as biogas and improved cookstoves. The ADP-2018/2019 identified the unsustainable use of biomass resources to meet household energy demand as a major environmental threat. It went on to say that this, has negative impacts on the County's forest resources. It then identified promotion of the use of improved cookstoves in households as a mitigation measure. These measures were put in the development plan without a proper policy framework. The absence of a sound policy and legal framework meant that, funding for these activities could not be guaranteed and that a comprehensive governance framework was virtually non-existent. This is evidenced by the fact that, in the Siaya County budget for the financial years 2018/2019 and 2019/2020 there were no funds allocated to actualize the provisions made in the development plans. Further, the lack of a County level policy on biomass energy resources and technologies is a challenge for the effective implementation of the existing national policies. The lack of funding for improved cookstove promotion was further emphasized by the Director in charge of energy in Siaya County.

4.4.2 Role of Institutions in Influencing Use and Adoption of Clean Cooking Technologies

Of the households using an ICS, 26.9 percent were aware of an organization promoting their use while 73.1 percent were not aware of entities promoting ICS. Of the households not using an ICS 25.7 percent were aware of an entity promoting their use while 74.3 percent were not aware of such entities (**Figure 18**).

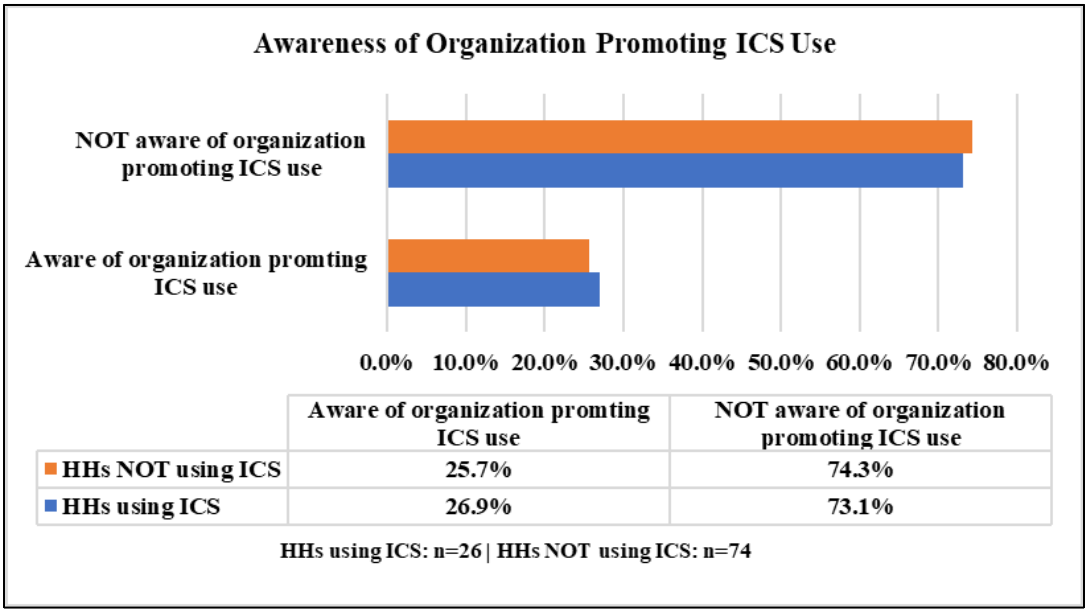


Figure 18: households' awareness of an organization promoting use of improved cookstoves

This results show that there is very little institutional involvement in the promotion of improved cookstoves in the study area. Because most of the households (both users and non-users of ICS) have not, been engaged by any organization promoting use of improved cookstoves. This study finds a negative correlation ($x^2(1) = 0.02, p = 0.90, p < 0.05$) between the use of improved cookstoves and awareness of an organization that promotes their use.

An analysis of the types of organizations identified to have been involved in the promotion of improved cookstoves, shows that no Government affiliated entity carried out improved cookstove activities in the study area. The households ranked private business entities first as involved in promoting use of improved cookstoves followed by NGOs/CBOs (**Table 13**).

Table 13: Ranking of entities promoting use of ICS

		HHs Using ICS	**HHs NOT Using ICS**	
Awareness of an Entity promoting ICS Use % age	Yes	26.9	25.8	
	No	73.1	74.2	
Entity Promoting Use of ICS				**Rank**
Private Business Entity		4	14	1
NGO/CBO		3	5	2
Government (National & County)		0	0	3

Source: South Sakwa Ward

Regardless of this observations, the overall involvement of institutions (private and public) in promoting ICS use in the study area was low given that only 26% of households were aware of an entity involved. The Energy Act 2019, at article 75 exclusively gives the National Government both the power and responsibility to promote renewable energy including but not limited to biomass, biodiesel, bioethanol, charcoal, fuelwood, solar, wind and biogas (MoE, 2019). It is the responsibility of Government under the act to, promote development of appropriate technologies for the consumption of renewable energy such as biodigesters, improved cookstoves and solar systems (MoE, 2019). Specifically, the act empowers the County Government to engage in awareness creation and dissemination of information on the efficient use and conservation of energy (MoE, 2019). From the findings, the low rate of ICS use and adoption in the study area can be attributed to lack of Government involvement in their promotion

The lack of Government involvement in ICS promotion is manifested in inadequate or no budgetary allocations for the sector in Siaya County according to the Director of Energy. For instance, in the financial year 2017/2018, the County Government of Siaya made provisions for the promotion of renewable energy sources (SCIDP, 2018). This was specifically targeted at the promotion of improved cookstoves to reach 100 households by the close of the 2017/2018 financial year. However, this target was never met and none of the 100 households were reached. The County Government Department of Water and Environment attributed this to slow disbursement of funds from the National Government and inadequate capacity in terms of personnel (SCIDP, 2018). A study in rural northwest Pakistan showed that lack of Government involvement in the promotion of ICS was a major barrier to their use and adoption (Jan, 2011). Similarly a study in Ndhiwa, Homa Bay County showed that use and adoption of improved cookstoves was highest in areas where farmers were in constant contact with Government agricultural extension workers (Okuthe, 2014). Thus, involvement of Government at all levels, is crucial to the realization of increased use and adoption of clean cooking technologies.

The Energy Act 2019 provides for the establishment of a fund for the promotion of efficient energy use and conservation within the Counties (MoE,2019). Thus, there is already a legal framework in place which the County Government of Siaya can use to address the challenges of inadequate funding for the development and promotion of clean and efficient cooking technologies. Therefore, the County Government of Siaya is obligated to develop a policy on renewable energy that will guide the implementation of existing national policies and leverage on the opportunities presented by the provisions of the Energy Act 2019. This policy will be instrumental in streamlining the roles already being played by the NGOs/CBOs and private businesses in promoting the use of improved cookstoves in the study area.

Existing literature suggests that using the local network of institutions such as NGOs/CBOs and private business enterprises is instrumental in the promotion of improved cookstoves (Puzzolo et al., 2013). Indeed, this study has established a significant relationship between the existence of private enterprises engaged in the sale and servicing of improved cookstoves and their use and adoption. The decision by households to use and adopt clean cooking technologies is often limited by a host of factors, amongst them the absence of after-sales services and support (GSF, 2016). A study in India showed that, users requested for designated repair points as a condition for purchase (Barnes et al., 2012).

Ineffective repair and maintenance services have been found to be a major factor negatively affecting the use and adoption of improved cookstoves by households (Puzzolo et al., 2013). A business model with sound design, production, sales, marketing and cookstove maintenance services have been found to be key in successfully implementing cookstoves programs (GSF, 2016). The findings of this study concurs with the previous findings that business models that support after-sales servicing of clean cooking technologies positively impacts on the households' decision to purchase, use and adopt clean cooking technologies. The findings underscores the importance of private enterprises in promoting the use and adoption of clean cooking technologies. The role of organizations in the promotion of these technologies, goes beyond mere information sharing. It encompasses financial support to households through, the provision of subsidies at various levels of the clean cooking energy value chain. Up-to and including provision of financial assistance to households for the purchase of clean cooking technologies (Lewis & Pattanayak, 2012). For instance, in a bid to promote the use of biogas, the Nepalese Government provided subsidies to investors which was responsible for extending the biogas marketing system to low income households and farmers in rural areas (Bajgain et al., 2005). This positively influenced the use and adoption of biogas as a cooking energy in Nepal. Thus, sustained involvement of institutions both governmental and private has a positive impact on the widespread and sustained use of clean cooking technologies (Silk et al., 2012). Government initiatives like, Government backed price-based promotional offers have been found to be effective in achieving sustained use and adoption of clean cooking technologies (Silk et al., 2012).

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Biomass based solid fuels such as charcoal and firewood is predominantly used by Kenyan households to meet their cooking energy needs. The Kenya National Bureau of Statistics estimates the prevalence of these cooking energy types to be at 70 percent and above. This study confirms this to be true since 98 percent of households in the study area used either charcoal or firewood as their main form of cooking energy. Further this confirms the hypothesis that, given the abundance of firewood, and the readily available labour for its collection in the form of women, girls and children, it will continue to be the fuel of choice for households in the rural areas. The preference for firewood is further enhanced by the prevailing household power relations, where decisions involving use of household income is often made by men. This, regardless of the fact that it is women and girls who spent most time cooking using firewood and charcoal and consequently bears most of the negative health impacts associated with burning firewood using inefficient cooking technologies, often in poorly ventilated spaces.

Widespread use and adoption of improved cookstoves has been identified as a mitigation measure for, the negative health and environmental effects of burning biomass based fuels using inefficient biomass pyrolysis stoves. This study finds that, households' use and adoption of improved cookstoves as a clean cooking technology is determined by a multiplicity of factors that operate both within the household and outside the household. For instance, age of the household head and income of the household were found to significantly influence households' use of improved cookstoves. The third factor (existence of a business entity specializing in the sale of improved cookstoves) operates from without the households. It only becomes significant when, household heads interact with other people. Thus, underscoring the influence of households' social interactions on use and adoption of improved cookstoves.

The existing policies on biomass energy and clean cooking technologies are contained in a number of different policies. These policies are domiciled in different Government departments, highlighting the incoherent institutional and governance framework for the biomass energy sector. Unlike energy sources like fossil fuels and electricity, the biomass energy sector has no clear-cut management structure in terms of institutions and funding. At the Siaya County level, no policy exists on the management of harvesting and use of biomass energy. The provisions made in development plans at the County level remain unimplemented due to lack of funding attributable to lack of policy and legislation to guarantee provision of funds in the annual budgetary cycles.

This study finds that private enterprises play a crucial role in the dissemination and promotion of improved cookstoves. The existence of trained cookstove artisans and availability of private enterprises selling the cookstoves, has been shown to positively influence their use and adoption. This further demonstrates the importance of a strong institutional framework, both governmental and private, in promoting use and adoption of clean cooking technologies. The study concludes that, use and adoption of clean cooking technologies especially the ICS is low in the study area at only 26 %. This could be attributed to a host of factors such as affordability of the ICS, lack of awareness on ICS benefits, non-implementation of policy, lack of county level policies and weak institutional set-up.

5.2 Recommendations

i. There should be increased promotion and creation of awareness on the benefits of clean cooking technologies such as the improved cookstove. This should be done through existing social groups such as churches, saving & loan groups and CBOs.
ii. Private enterprises and businesses should be given incentives in the form of tax breaks and subsidies to gainfully and sustainably engage in the production, dissemination and maintenance of clean cooking technologies.
iii. The County Government of Siaya should formulate a policy on biomass energy use and cooking technologies to facilitate implementation of national policies and guarantee funding for the development and promotion of clean cooking technologies.

6.0 References

A.K. Kurchania. (2012). Biomass Energy. In B. e. al, *Biomass Conversion: The Interface of Biotechnology, Chemistry and Materials Science* (pp. 91-122). Berlin: Springer-Verlag Brlin Heidelberg.

Abhishek et al. (2015). Biomass pyrolysis—A review of modelling, process parameters and catalytic studies. *Renewable and Sustainable Energy Reviews, 50*, 1081-1096.

Abhishek Kar and Hisham Zerriffi. (2018). From Cookstove Acquisition to Cooking Transition: Framing the Behavioural Aspects of Cookstove Interventions. *Energy Research and Social Science, 42*, 23-33.

Accenture. (2018). *Financing Growth in the Clean Cookstoves and Fuels Market: An Analysis and Recommendations.* New York: Global Alliance for Clean Cookstoves.

Ajzen, I. a. (1975). *Belief, Attitude, Intention, and Behaviour: An Introduction to Theory and Research.* Reading: MA:Addison-Wesley.

Alam M, S. J. (1998). Urban Household Energy Use in India: Efficiency and Policy Implications. *Energy Policy*(26), 885-891.

Almalki, S. (2016). Integrating Quantitative and Qualitative Data in Mixed Methods Research-Challenges and Benefits. *Education and Learning, 5*(3), 288-296.

Andadari, R.K, P. Mulder and P. Rietveld. (2014). Energy Poverty Reduction by Fuel Switching. Impact Evaluation of the LPG Conversion Program in Indonesia. *Energy Policy, 66*, 436-449.

Bajgain S and Shakya IS. (2005). *The Nepal Biogas Support Program: A Successful Model of Public Private Partnership for Rural Household Energy Supply.* Kathmandu, Napal: Ministry of Foreign Affairs. The Netherlands; SNV-Biogas Sector Partnership-Nepal.

Bandiera, O., Rasul, I. (2006). Social Networks and Technology Adoption in Northern Mozambique. *The Economic Journal, 116*, 869-902.

Bansal, M, R.P. Saini, and D.K. Khatod. (2013). Devlopment of Cooking Sector in RUral Areas in India- A Review. *Renewable and Sustainable Energy Reviews*(17), 44-53.

Barbara G. Tabachnik & Linda S. Fidell. (2014). *Using Multivariate Statistics* (6th ed.). Harlow, England: Pearson.

Barnes.D.F and Openshaw K. (2012). *Cleaner Hearths, Better Homes: New Stoves for India and the Developing World.* New Delhi: Oxford University Press.

Baskar C, B. S. (2012). *Biomass Conversion: The Interface of Biotechnology, Chemistry and Materials Science.* (XXXVIII ed.). New York: Springer.

Basu A. et al. (2016). *Nationally Appropriate Mitigation Action on Access to Clean Energy in Rural in Rural Kenya through Innovative Market Based Solutions.* New York: United Development Programme (UNDP).

Blackden, M. & Wodon, Q. (2006). *Gender, Time Use and Poverty in Sub-Saharan Africa.* New York: World Bank Group.

Bonan, J., Battiston, P., Bleck, J., Boucher, P., Pareglio, S., Sarr, B and Tavoni, M. (2017). *Social Interaction and Technology Adoption: Experimental Evidence from Improved Cookstoves in Mali.* Milano: Mitigation, Innovation & Transformation Pathways.

Bond T.C, et al. (2013). Bounding the role of black carbon in the climate system: A scientific assessment. *Journal of Geophysical Research (JGR), 118*(11), 5380–5552.

Brooks N., Bhojvaid V., Marc Jeuland., Lewis J.J., Patange O. and Pattanayk S.K. (2016). How Much do Alternative Cookstoves Reduce Biomass Fuel Use? Evidence from North India. *Resource and Energy Economics, 43*(C), 153-171.

Campbell BM, V. S. (2003). The Energy Transition in Action: Urban Domestic Fuel Choices in a Changing Zimbabwe. *Energy Policy, 31*, 553-562.

Carr,M. & Hartl, M. (2010). *Lightening the Load: labour Saving technologies and Practices for Rural Women.* s.l: International Fund for Agricultural Development (IFAD) and Practical Action Publishing.

Charles Kivunja. (2018). Distinguishing Between Theory, Theoritical Framework, and Conceptual Framework: A Systematic Review of Lessons from the Field. *International Journal of Higher Education, 7*(6), 44-53.

Chava Frankfort-Nachmias & David Nachmias. (1996). *Research Methods in the Social Sciences* (5th ed.). London, Great Britain: St Martin's Press, Inc.

Clancy, J.S. et al. (2011). *Gender Equity in Access to and benefits from Modern Energy and Improved Energy Technologies.* s.l: Nor/Soer-konsulenterne.

Clark S., Carter E., Shan M., Ni K., Niu H., Tseng J.T.W., Pattanayak S.K., Jeuland M., Schauer J.J., Ezzati M., Wiedinmyer C., Yang X. and Baumgartner J. (2017). Adoption and Use of a Semi-Gasifier Cooking and Water Heating Stove and Fuel Intervention in the Tibetan Plateau, China. *Environmental Research Letters*, 075004.

Cohen, J., Cohen, P., Est, S., Aiken, L. (2003). *Applied Multiple Regression/Correlation Analysis for the Behavioural Sciences.* New York: Routledge.

County Government of Siaya. (2018). *Programme Based Budget 2018-2019.* Siaya, Kenya: Department of Finance and Economic Planning, Siaya County.

Creswell J.W & Plano Clark. (2011). *Designing and Conducting Mixed Methods Research* (2nd ed.). CA: Sage Publications, Inc.

Creswell J.W & Plano Clark V.L. (2007). *Designing and Conducting Mixed Methods Research.* Carlifonia: Sage Publications.

Daniel L. Wilson, Jeremy Coyle, Angeli Kirk, Javier Rosa, Omnia Abbas, Mohammed Idris Adam and Ashok J. Gadgil. (2016). Measuring and Increasing Adoption Rates of Cookstoves in a Humanitarian Crisis. *Environmental Science and Technology, 50*(15), 8393-8399.

David. J Idiata et al. (2013, April). Wood Fuel Usage and the Challenges on the Environment. *International Journal of Engineering Sciences, 2*(4), 110-114.

Devoto, F., Duflo, E., Dupas, P., Pariente, W and Ponus, V. (2010). Hapiness on Tap: Piped Water Adoption in Urban Morocco. *American Economic Journal: Applied Economics, 2*(2), 241-275.

Dhanapati Subedi et al. (2016). Explanatory Sequential Mixed Method Design as the Third Research Community of Knowledge Claim. *American Journal of Educational Research, 4*(7), 570-577. doi:10.12691

Drigo, R. et al. (2015). *Analysis of wood fuel supply, demand and sustainability in Kenya.* Nairobi: Global Alliance for Clean Cook Stoves.

Emma Gordon. (2018). *The Politics of Renewable Energy in East Africa.* London: The Oxford Institute for Energy Studies.

EnDev. (2012). *Dynamic Markets for Improved Cooking Devices in Kenya.* Eschborn: Energizing Development.

EnDev. (2017). *Progress Report: Energizing Development Phase II.* Eschborn: Energizing Development.

Eva A. Rehfuess, E. P. (2014). Enablers and Barriers to Large-Scale Uptake of Improved Solid Fuel Stoves: A Systematic Review. *Environmental Health Perspectives, 122*(2), 120-130.

Eva A. Rehfuess, Elissa Puzzolo, Debbi Stanistreet, Daniel Pope and Nigel G. Bruce. (2014). Enablers and Barriers to Large-Scale Uptake of Improved Solid Fuel Stoves: A Systematic Review. *Environmental Health Perspectives, 122*(2), 120-130.

Evan A. Thomas, Sarita Tellez-Sanchez, Carson Wick, Miles Kirby, Laura Zambrano, Ghislaine Abadie Rosa, Thomas F. Clasen and Corey Nagel. (2016, March 17). Behavioural Reactivity Associated With Electronic Monitoring of Environmental Health Interventions-A Cluster Randomized Trial with Water Filters and Cookstoves. *Environmental Science & Technology, 50*(7), 3773-3780.

Ewan Bloomfield and Bikram Malla. (2014). *Gender and Livelihood IMpacts of Clean Cookstoves in South Asia Study.* London: Global Alliance for Clean Cookstoves.

Fikadu Mamuye, Bekele Lemma, Teshale Woldeamanuel. (2018). Emissions and Fuel Use Performance of Two Improved Stoves and Determinants of their adoption in Dodola, South Eastern Ethiopia. *Sustainable Environmental Research, 28*, 32-38.

Foster, A.D, Rosenzweig, M.R. (2010). Microeconomics of Technology Adoption. *Annual Review of Economics, 2*(1), 395-424.

Francesco Vitali and Mentore Vaccari. (2014). Socio-Economic Survey as a Support Tool During Scaling Up of Improved Stoves in the Logone Valley (Chad/Camerron). *Sustainability, 6*, 1427-1447.

Fred Davis and Richard Bagozzi. (1989). User Acceptance of Computer Technology: A Comparison of Two Theoritical Models. *Management Science, 35*(8), 982-1003.

Gall-Ely, M. L. (2009). Definition, Measurement and Determinants of the Consumer's Willingness to Pay: a Critical Synthesis and Directions for Further Research. *Recherse et Applications en Marketing (French Edition)*, 91-113.

Garson, D. G. (2012). *Crosstabulation.* Asheboro, USA: Statistical Publishing Associates.

GLPGP. (2013). *Kenya Market Assessment.* New York: Global LPG Partnership (GLPGP).

Government of Kenya (GoK). (1999). *Environmental Management and Coordination Act.* Ministry of Environment & Natural Resources. Nairobi: Government Printer.

Government of Kenya (GoK). (2004). *Sessional Paper No. 4 on Energy of 2004.* Minitry of Energy. Nairobi: The Government of Kenya.

Government of Kenya (GoK). (2007). *The Vision 2030.* Ministry of Finance and Economic Planning . Nairobi: The Government Printer.

Government of Kenya (GoK). (2010). *The Constitution of Kenya.* State Law Office. Nairobi: The Government Printer.

Government of Kenya (GoK). (2013). *National Climate Change Action Plan 2013-2017.* Ministry of Environment & Natural Resources, The Climate Change Directorate. Nairobi: The Government Printer.

Government of Kenya (GoK). (2014). *Forest Policy 2014.* Kenya Forest Service, Ministry of Environment, Water and Natural Resources. Nairobi: The Government Printer.

Government of Kenya (GoK). (2016). *Sessional Paper No.3 of 2016 on National Climate Change Framework Policy.* Climate Change Directorate, Ministry of Environment & Natural Resources. Nairobi: The Government Printer.

Government of Kenya (GoK). (2018). *National Climate Change Action Plan 2018-2022.* Minsitry of Environment & Natural Resources. Nairobi: The Government Printer.

Government of Kenya (GoK). (2019). *The Energy Act.* Ministry of Energy & Petroleum. Nairobi: The Government Printer.

Gregor Vulturius and Hannah Wanjiru. (2017). *The Role of Social Relations in the Adoption of Improved Cookstoves.* Stockholm: Stockholm Environment Institute, Working Paper 2017-01.

GSF. (2016). *Gold Standard Improved Cookstove Activities Guidebook; Incresing Committents to Clean Cooking Initiatives.* Geneva: Gold Standard Foundation.

Guofeng Shen, Wewie LIN, Dingli YUE and Zuoli LIU. (2014). *Factors Influencing the Adoption and Sustainable Use of Clean Fuels and Cookstoves in China.* Beijing: Global Alliance for Clean Cookstoves (GACC).

Hui. D., Deng.Q., Tian.H and Luo Y. (2015). Climate Change and Carbon Sequestration in Forest Ecosystems. In C. e. (eds), *Handbook of Climate Change Mitigation and Adaptation* (pp. 2-41). New York: Springer Science+Business Media.

Institute of Economic Affairs (IEA-Kenya). (2015). *Situational Analysis of Energy Industry, Policy and Strategy for Kenya.* Nairobi: Institute of Economic Affairs-Kenya.

International Energy Agency (IEA). (2007). *Potential Constribution of Bioenergy to the World's Future Energy Demand.* Paris: International Energy Agency.

International Energy Agency (IEA). (2014). *Africa Energy Outlook: A Focus on Energy Prospects in Sub-Saharan Africa.* Paris: Internatioanl Energy Agency.

International Energy Agency (IEA). (2017). *Energy Access Outlook 2017: From Poverty to Prosperity.* International Energy Agency (IEA). Paris: OECD/IEA.

Jan I., Ullah S., Akram W., Khan N., Asim S.M., Mahmood Z., Ahmad M.N and Ahmad S.S. (2017). Adoption of Improved Cookstoves in Pakistan: A Logit Analysis. *Biomass and Bioenergy*, 55-62.

Jan, I. (2011). *What Makes People Adopt Improved Cookstoves? Empirical Evidence from Rural Northwest Pakistan.* Norwhich: University of East Anglia.

Jennifer Browne, B. C. (2018). A guide to policy analysis as a research method. *Health Promotion International*, 1-13.

Jennyfer Wolf., Daniel Mausezahl., Hector Verastegui and Stella M. Hartinger. (2017). Adoption of Clean Cookstoves after Improved Solid Fuel Stove Programme Exposure: A Cross-Sectional Study in Three Peruvian Andean Regions. *International Journal of Environmental Research and Public Health*, 745.

Jessica J. Lewis and Subhrendu K. Pattanayak. (2012). Who Adopts Improved Fuels and Cookstoves? A Systematic Review. *Environmental Health Perspectives, 120*(5), 637-645.

Jeuland, M. & Pattanayak, S.K. (2012). Benefits and Costs of Improved Cookstoves: Assessing the Implications of Variability in Health, Forest and climate Impacts. *PLoSOne, 7*(2), e30338.

Kahan D.M, J. S. (2011). Cultural Cognition of Scientific Consensus. *Journal of Risk Research*, 147-174.

Kar T. and Keles S. (2016). Environmental Impacts of Biomass Combustion for Heating and Electricity Generation. *Journal of Engineering Research and Applied Sciences, 5*(2), 458-465.

Karin Troncoso, Alicia Castillo, Omar Masera and Leticia Merino. (2007). Social Perceptions About a Technological Innovation for Fuelwood Cooking: Case Study in Rural Mexico. *Energy Policy, 35*, 2799-2810.

Kathleen Pine, Rufus Edwards, Omar Masera, Astrid Schilmann, Adriana Marron-Mares and Horacio Riojas-Rodriguez. (2011). Adoption and Use of Biomass Stoves in Rural Mexico. *Energy for Sustainable Development, 15*, 176-183.

KCIC (Kenya Climate Innovation Center). (2014). *Sector Mapping and Market Assessment on the Improved Cookstoves (ICS) Sector in Kenya.* Nairobi: KCIC.

Kenya Forest Service (KFS). (2013). *Analysis of the Charcoal Value Chain in Kenya.* Nairobi, Kenya: Ministry of Environment and Natural Resources.

Kenya National Bureau of Statistics (KNBS). (2018). *2015/16 Kenya Integrated Household Budget Survey (KIHBS).* Nairobi: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics. (2009). *Kenya Population and Housing Census 2009.* Nairobi: KNBS.

Kenya National Bureau of Statistics. (2010). *Population and Household Distribution by Socio-Economic Charecteristics.* Nairobi.

Kenya National Bureau of Statistics. (2017). *National Economic Survey.*

Kohlin, G., Sills, E., Pattanayak, S. K. & Wilfong, C. (2011). *Energy, Gender and Development: What are the Linkages? Where is the Evidence?* Washington DC: World Bank.

Kulindwa Yusuph J, Razack Lokina and Erick Ahlgren. (2018). Driving Forces for Households' Adoption of Improved Cooking Stoves in Rural Tanzania. *Energy Strategy Reviews, 20*, 102-112.

Lilian N.S. Kongani, Cohen Angu and Nzioka J. Muthama. (2019). Adoption of Improved Cookstoves in the Peri-Urban Areas of Nairobi: Case of Magina Area, Kiambu County, Kenya. *Journal of Sustainability, Environment and Peace*, 19-24.

Lori Beaman and Andrew Dillon. (2014). *The Diffusion of Agricultural Technologies within Social Networks: Evidence from Composting in Mali.* Washington, DC: International Food POlicy Research Institute (IFPRI).

Malla Sunil & Govinda R. Timilsina. (2014). *Household Cooking Fuel Choice and Adoption of Improved Cookstoves in Developing Countries: A Review. World Bank Policy Research Working Paper 6903.* Washington D.C.: The World Bank.

Mare M., & Annegarn, H.J. (2017). The Use of Willingness to Pay to Determining Customer Preferences for Improved Flame-Based Cookstove Features in Two South African Study Areas. *Social Marketing Quarterly, 23*(4), 335-353.

Mare, M. &. (2017). The Use of Willingness to Pay in Determining Customer Preferences for Improved Flame-Based Cookstove Features in Two South African Study Areas. *Social Marketing Quarterly, 23*(4), 335-353.

Ministry of Energy & Petroleum (MoE &P). (2019). *Keya Clean Cooking Study Report.* Nairobi: Government of Kenya.

Ministry of Energy & Petroleum (MoE&P). (2014). *Sustainable Energy for All; Kenya Investment Prospectus.* Nairobi: Ministry of Energy & Petroleum.

Ministry of Energy & Petroleum (MoE&P). (2016). *Sustainable Energy for All- Kenya Action Agenda.* Nairobi: Ministry of Energy & Petroleum, Kenya (MoE&P Kenya).

Ministry of Energy & Petroleum. (2016). *Sustainable Energy for All: Kenya Action Agenda; Pathways for Concerted Action Towards Sustainable Energy for All by 2030.* Nairobi.

Ministry of Environment & Natural Resources (MENR). (2013). *Analysis of Demand and Supply of Wood Products in Kenya.* Nairobi, Kenya: Ministry of Environment and Natural Resources, (MENR).

Morrissey James. (2017). *The Energy Challenge in Sub-Saharan Africa: A Guide for Advocates and Policy Makers: Part 2 Addressing Energy Poverty.* Washington, DC: Oxfam Research Backgrounders Series.

Myclimate Foundation. (2013). *Energy Efficient Cookstoves for Siaya Communites, Kenya.* Essen, Germany: Myclimate Foundation.

Naeher, l. et al. (2007). Woodsmoke Health Effects: A Review. *Inhalation Toxicology, 19*(1), 67-106.

Nyankone, B. O. (2018). *Factors Influencing Adoption of Improved Cookstoves Among Households of Thuti Location, Othaya, Nyeri County, Kenya.* Nairobi: University of Nairobi.

OECD & International Energy Agency. (2010). *Energy Poverty: How to modern Energy Access Universal in: World Energy Outlook 2010 for the UN General Assembly on the Millenium Development Goals.* Paris.

Okuthe, I. K. (2014). Assessing the Role of Institutional Factors on the Use of Improved Cook Stoves in Kenya's Homa Bay County. *International Journal of Innovations and Scientific Research, 12*(2), 390-408.

Oliver Johnson & Anne Nyambane. (2016). *County Energy Planning in Kenya: Local participation and Local Solutions in Migori County.* Stockholm Environment Institute - Africa Center. Nairobi: Stockholm Environment Institute.

Osborne, J. (2015). Logistic regression with multiple independent variables: opportunities and pitfalls. In O. J., *Best practices in logistic regression* (pp. 243-295). London: SAGE Publications.

Otieno, et al. (2016). Theory of reasoned Action as an Underpinning Technological Innovation Adoption Studies. *World Journal of Computer Applications and Technology, 4*(1), 1-7.

Palit et al. (2014). Barriers to Cookstoves. *Boiling Point; A Practitioner's Journal on Household Energy, Stoves and Poverty Reduction.*, 7-9.

Palm J & Ellegard K. (2011). Visualizing Energy Consumption Activities as a Tool for Developing Effective Policy. *International Journal of Consumer Studies, 35*, 171-179.

Pamela Jagger and Charles Jumbe. (2016). Stoves or Sugar? Willingness to Adopt Improved Cookstoves in Malawi. *Energy Policy, 92*, 409-419.

Phillipe Cullet. (1995). Definition of an Environmental Right in a Human Rights Context. *13 Netherlands Quarterly of Human Rights*, 25.

Poddar M. and Chakrabarti S. (2016). Indoor Air Pollution and Women's Health in India: an Exploratory Analysis. *Environment, Development and Sustainability, 18*(3), 667-677.

Pundo, M.O and G.C.G Fraser. (2006). Multinomial Logit Analysis of household Cooking Fuel Choice in Rural Kenya: The Case of Kisumu District. *Agrekon, 1*(45), 24-37.

Puzzolo E., Stanistreet D., Pope D., Bruce N and Rehfuess E. (2013). *Factors Influencing the Large-Scale Uptake by Households of Cleaber and More Efficient Household Energy Technologies.* London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.

Rewald Rebeca. (2017). Energy and Women and Girls: Analyzing the Needs, Uses, and Impacts of Energy on Women and Girls in the Developing World. *Oxfam Research Backgrounder Series*, 1-45.

Robert Onyeneke, Chinyere Nwajiuba, Jane Munonye, Lyke Uwazie, Nkechinyere Uwajumogu, Christian Uwadoka and Jonathan Aligbe. (2019). Improved Cookstoves and Environmental and Health Outcomes: Lessons from Cross River State Nigeria. *International Journal of Environmental Research and Health, 16*(19), 3520.

Sandeep Mohapatra and Leo Simon. (2017). Household Bargaining Over Technology Adoption. *Review of Economics of the Household, 15*(4), 1263-1290.

SCG. (2016). *Siaya County Annual Development Plan -2016-2017.* Siaya: Siaya County Government (SCG).

Schlag N & Zuzarte F. (2008). *Market Barriers to Clean Cooking Fuels in Sub-Saharan Africa: A Review of Literature.* Stockholm Environment Institute.

Sehjpal, Ritika. Aditya Ramji, Anmol Soni, and Atul Kumar. (2014). Going Beyond Incomes: Dimensions of Cooking Energy Transitions in Rural India. *Energy* (68), 470-477.

Shunichi Nakada, Deger Saygin and Dolf Gielen. (2014). *Global Bioenergy: Supply and Demand Projections.* Masdar: International Renewable Energy Agency (IRENA).

Silk BJ., Sadumah S., Patel MK., Were V., Person B., Hariss J., Otieno R., Nygren B., Loo J., Eleveld A., Quick RE and Cohen AL. (2012). *A Strategy to Increase Adoption of Locally-Produced, Ceramic Cookstoves in Rural Kenyan Households.* Atlanta: Epidemic Intelligence Service, Scientific and Professional Development Program Office.

Stanistreet Debbi, Puzzolo Elisa, Bruce Nigel, Pope Dan and Rehfuess Eva. (2014). Factors Influencing Household Uptake of Improved Solid Fuel Stoves in Low and Middle Income Countries: A Qualitative Systematic Review. *International Journal of Environmental Research and Public Health, 11*, 8228-8250.

Sunil Malla and Govinda R Timilsina. (2014). *Household Cooking Fuel Choice and Adoption of Improved Cookstoves in Developing Countries.* Washington, DC: The Worl Bank; Development Research Group, Environment and Energy Team.

Sylvia A. Nyandie. (2017). *Factors Influencing Adoption of Improved Cooking Stoves: The Case Study of Rural Households in Busia County, Funyula Sub-County, Kenya.* Nairobi: University of Nairobi.

Turgay Kar, Suleyman Keles. (2016, December). Environmental Impacts of Biomass Combustion for Heating and Electricity Generation. *Journal of Engineering Research and Applied Sciences, 5*(2), 458-465.

UNDP. (2007). *Will Tommorrow be Brighter than Today? Addressing Gender Concerns in Energy for Poverty Reduction in the Asia-Pacific Region.* Bangkok: United Nations Development Programme.

UNDP. (2009). *The Energy Access Situation in Developing Countries.* New York: UNDP, Environment and Energy Group.

United Nations. (1981). *Report of the United Nations Conference on New and Renewable Sources of Energy.* New York: United Nations.

United Nations Department of Economic and Social Affairs (UNDESA). (2017). *Household Size and Composition Around the World.* New York: United Nations.

United Nations Organization. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development.* New York: United Nations.

Vania Vigolo, Rezarta Sallaku and Federico Testa. (2018). Drivers and Barriers to Clean Cooking: A Systematic Literature Review from a Consumer Behaviour Perspective. *Sustainability, 10*(11), 4322.

Winrock International. (2017). *Clean and Efficient Cooking Technologies and Fuels: Growing Research and Evidence Base Around Health.* Washington, DC: United States Agency for International Development.

World Bank. (2010). *Improved Cookstoves and Better Health in Bangladesh.* Washington, D.C.: The International Bank for Reconstruction and Development.

World Bank. (2011). *Household Cookstoves,Environment, Health and Climate Change: A New Look at an Old Problem.* Washington, DC.: The World Bank.

World Bank. (2014). *Clean and Improved Cooking in Sub-Saharan Africa- A Landscape Report.* Africa Clean Cooking Energy Solutions Initiative (ACESS). Washington DC: The World Bank.

World Bank. (2015). *The State of the Global Clean and Improved Cooking Sector.* Washington DC: The World Bank Group.

World Bank. (2017). *Off-Grid Solar Access Project for underserved Counties in Kenya.* Nairobi, Kenya: The World Bank.

World Energy Council (WEC). (2016). *World Energy Resources.* London: World Energy Council.

World Health Organization (WHO). (2006). *Fuel for Life: Household Energy and Health.* Geneva: World Health Organization.

World Health Organization (WHO). (2009a). *Country profiles of environmental burden of disease.* Geneva: World Health Organization (WHO). Retrieved from www.who.int/quantifying_ehimpacts/countryprofiles

World Health Organization (WHO). (2011). *Health in the Green Economy Series.* Geneva.

World Health Organization (WHO). (2012). *Burning Opportunity; Clean Household Energy for Health, Sustainable Development and Wellbeing of Women and Children.* Geneva.

7.0 Appendices

7.1 Data Collection Tools

7.1.1 Household Questionnaire

FACTORS INFLUENCING USE AND ADOPTION OF CLEAN COOKING TECHNOLOGIES IN RURAL HOUSEHOLDS: A CASE STUDY OF BONDO SUB-COUNTY, KENYA

Date of Interview

- ❑ --

Interviewer's Name

- ❑ --

Gender of Respondent

- ❑ Male
- ❑ Female

County

- ❑ Siaya

Sub-County:

- ❑ Bondo

Ward.

- ❑ South Sakwa

Sub- Location

- ❑ Nyagida
- ❑ Got Abiero
- ❑ East Migwena
- ❑ West Migwena

1.0 Household Demographic and Socio-Economic Characteristics.

1.1. What is the Age of Household Head ? (record exact age)

- ❑ ---

1.2. What is Your Marital Status?

- ❑ Single
- ❑ Married
- ❑ Divorced
- ❑ Widow
- ❑ Widower

1.3. For How Many Years Did You Attend School? (record exact number of years spent in school)

- ❑ ---

1.4. Do you have any child/children?

- ❑ Yes
- ❑ No

1.5. If Yes, How Many children do you have? (record exact number of children)

- ❑ ---

1.6. How many of the above children are in school? (Primary and secondary)

- ❑ ---

1.7. Are there any of your children who are of school going age and are currently not attending school?

- ❑ Yes
- ❑ No

1.8. If, Yes what are the reasons they are not attending school?

- ❑ Lack of school fee
- ❑ Lack of schools
- ❑ Refused to go to school
- ❑ Married
- ❑ Got pregnant
- ❑ Working

1.9. Apart from your children, how many more people are you staying with in your household? (record exact number)

- ❑ ---

1.10. Total number of people living in the household (record exact number)

- ❑ ---

1.11. What is the Occupation of the household head?

- ❑ Civil servant/Teacher
- ❑ Small Trader
- ❑ Businessman
- ❑ Fisherman
- ❑ Farmer
- ❑ Charcoal Burning
- ❑ Wage Labour(Casual).

1.12. What is the Household's monthly average income? (record exact amounts)

- ❑ ---

1.13. What is the Household's main expenditure?

- ❑ Food
- ❑ Education
- ❑ Health
- ❑ Clothing
- ❑ Energy

1.14. Observe and record the type of house owned by the household

- ❑ Mud-walled-grass thatched
- ❑ Semi-permanent
- ❑ Permanent
- ❑ Other.

2.0. Household Health, Water, Sanitation and Environmental Conservation.

2.1. Has any member of the household suffered from a respiratory disease in the past on year ?

- ❑ Yes

- ❑ No

2.2. What is the household's main source of water ?

- ❑ Piped into residence
- ❑ Pipped into yard
- ❑ River/Stream
- ❑ Lake
- ❑ Borehole/Well
- ❑ Pond/Dam
- ❑ Other

2.3. How do you store your drinking water? (Closed water containers, open water containers, does not store water)

- ❑ Closed water containers
- ❑ Open water containers
- ❑ Does not store water

2.4. Observe whether the household has a latrine/toilet

- ❑ Yes
- ❑ No

2.5. Where do you wash and dry your utensils ?

- ❑ Rack
- ❑ Rooftop
- ❑ Grass/Ground
- ❑ Kitchen Sink
- ❑ Other

2.6. How do you make your water safe for drinking?

- ❑ Filtering
- ❑ Apply chemicals
- ❑ Boiling
- ❑ Do nothing
- ❑ Other

2.7. How is domestic waste disposed in the household?

- ❑ No disposal action taken
- ❑ Burning
- ❑ Dumping pit
- ❑ Dumping on the road or river

2.8. Do you take part in any environmental conservation activities?

- ❑ Yes
- ❑ No

2.9. If yes , please specify (allow for multiple responses).

- ❑ Tree planting
- ❑ Communal waste collection and disposal
- ❑ Soil erosion control
- ❑ Adoption of green farming practices
- ❑ Waste recycling
- ❑ Water conservation.

3.0 Household Cooking Energy Needs

3.1. What is the Household's main form of cooking energy?

- ❑ Firewood
- ❑ Charcoal
- ❑ Electricity
- ❑ Kerosene
- ❑ LPG (Gas)
- ❑ Solar
- ❑ Biogas
- ❑ Other.

3.1.1 Do you use improved cookstove?

3.2. What is the Household's main cooking appliance?

- ❑ Traditional Stove (three stones)
- ❑ Normal metallic Jiko
- ❑ Improved Cookstove

- ❑ Gas Cooker
- ❑ Electric Cooker
- ❑ Solar Cooker
- ❑ Other

3.3. Where do you obtain the main fuel you use from?

- ❑ Surrounding bushes
- ❑ Crop fields
- ❑ Nearby forest
- ❑ Buy from market
- ❑ Own production

a. Do you buy the fuel used for cooking?

- ❑ Yes
- ❑ No

b. If you buy the fuel how much do you spend every month (record exact amount)

- ❑ --

c. If the firewood is gathered (For HHs using firewood as main cooking energy)

- ❑ Who collects the firewood ?
    - ❑ Women
    - ❑ Girls
    - ❑ Boys
    - ❑ Men
    - ❑ Other
- ❑ How often is the firewood collected
    - ❑ Daily
    - ❑ Weekly
    - ❑ Fortnightly
    - ❑ Monthly
    - ❑ Quarterly
- ❑ What is the distance from your homestead to the place you collect the firewood?
    - ❑ 0-500 M
    - ❑ 500 M-1 KM

- ❑ Over 1 KM

3.4. If you are using Improved Cookstove

a. Where did you buy it from?

- ❑ -------------------------------------

b. How much did it cost? (give exact amount)

- ❑ -------------------------------------

c. Do you use it to prepare all your meals?

- ❑ Yes
- ❑ No

d. Do you find it better than the other cooking appliances?

- ❑ Yes
- ❑ No

e. When and if it breaks down can it be repaired?

- ❑ Yes
- ❑ No

f. Do you know someone who can repair the Jiko?

- ❑ Yes
- ❑ No

3.5. Apart from the improved Jiko do you use another cooking appliance? Please specify.

- ❑ Yes
- ❑ No

Please Specify

- ❑ Traditional three stones
- ❑ Electric cooker
- ❑ LPG cooker
- ❑ Solar cooker

3.6. Does the Household have a separate cooking area from the main house?

- ❑ Yes
- ❑ No

3.7. If you are not using Improved Cookstoves:

a. Are you aware of their existence?

- ❑ Yes
- ❑ No

b. Do you Know where you can buy one?

- ❑ Yes
- ❑ No

c. Why are you not using one?

- ❑ Expensive
- ❑ Not available in the local market
- ❑ Not aware of ICS benefits

4.0. Households' Social Interactions

4.1. Are you a member of any social organization?

- ❑ Yes
- ❑ No

4.2. If yes which of the following groupings are you a member:

- ❑ Church group
- ❑ Women Group
- ❑ Youth Group
- ❑ Savings and loan group
- ❑ Community Based Organization (CBO)
- ❑ Family group

4.3. In your group(s)do you receive information on any or all of the following topics?

- ❑ Health
- ❑ Nutrition
- ❑ Environment
- ❑ Energy
- ❑ Education

4.4. Do you access loans from any of the groups that you are a member?

- ❑ Yes

- ❑ No

4.5. If Yes, what do you use the money for?

- ❑ Food
- ❑ Invest in business
- ❑ Pay school fees
- ❑ Pay for medical expenses
- ❑ Buy ICS

5.0. Institutional Set-Up

5.0. Are you aware of any organization that promotes use of improved cookstoves?

- ❑ Yes
- ❑ No

5.1. If Yes, what type of organization is it: (allow for multiple responses)

- ❑ Government
- ❑ County Government
- ❑ NGO
- ❑ Business

5.2. Are there any organizations/Financial institutions offering loans for the purchase of Improved cookstoves

- ❑ Yes
- ❑ No

5.3. If Yes, What type of institutions are they?(allow for multiple responses)

- ❑ Commercial Bank
- ❑ Micro-Finance
- ❑ Business
- ❑ NGO/CBO
- ❑ Government
- ❑ County Government.

5.4. Do you know of any business entity that specialize in the sale and servicing of improved cookstoves

- ❑ Yes
- ❑ No

5.5. If Yes, How far is it from where you live?

- ❑ 0-5 Km
- ❑ 5-10 Km
- ❑ 10-15 Km
- ❑ Over 15 Km.

Thank you for your attention and cooperation!

7.1.2 Key Informant Interview Guide

FACTORS INFLUENCING USE AND ADOPTION OF CLEAN COOKING TECHNOLOGIES IN RURAL HOUSEHOLDS: A CASE STUDY OF BONDO SUB-COUNTY, KENYA

Key Guiding Questions to Department of Energy

1. Are their County Government strategies, plans, policies and legislations towards the promotion of clean cooking technologies?
2. What are some of the strategies used in engaging the National Government to support clean cooking technology initiatives in the County?
3. There are National policies, plans and strategies on the environment. How does the County Government utilize these instruments in the decision-making process on household energy use?
4. Household Energy use and respiratory infections are closely related. How true is this statement in the context of household cooking energy choices?
5. Are their budgetary allocations for the promotion, development and dissemination of clean cooking technologies?
6. How has the County Government/ Department utilized the opportunities presented by different partners like NGOs and private enterprises to realize wide use and adoption of clean cooking technologies?
7. Does the department have a means of tracking the progress of the use and adoption of clean cooking technologies in the County?
8. In your opinion, what are some of the barriers to adoption of clean cooking technologies by households in the County?
9. What actions can be taken to improve the usage and adoption of clean cooking technologies by households in the County.

7.1.3 Focus Group Discussion Guide

FACTORS INFLUENCING USE AND ADOPTION OF CLEAN COOKING TECHNOLOGIES IN RURAL HOUSEHOLDS: A CASE STUDY OF BONDO SUB-COUNTY, KENYA

Key Guiding Questions to Women Group

1. What are some of the ways in which you have contributed to the decision-making process on matters concerning household energy use?
2. Has the Government/County Government/NGO/CBO/Business entity contacted you to seek your input on a household energy use project?
3. Has the Government/County Government initiated and implemented any household energy use project in your area in the last five years?
4. Are you aware of any planned Government/County Government project on household energy use in your area?
5. In your various socio-economic interactions what kind of household enhancement information do you get?
6. What are some of the clean cooking technologies you are aware of?
7. In your assessment of the community, what is the most commonly used mode of cooking and source of cooking energy?
8. What are some of the things that influences your decision to use a certain energy source in your household?
9. What are the challenges, that in your opinion impact the use and adoption of clean cooking technologies in the households?
10. Suggest strategies that can be used to overcome these challenges.

7.2 Plagiarism Report

FACTORS INFLUENCING USE AND ADOPTION OF CLEAN COOKING TECHNOLOGIES IN RURAL HOUSEHOLDS: A CASE STUDY OF BONDO SUB-COUNTY, KENYA

ORIGINALITY REPORT

13%	10%	8%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	erepository.uonbi.ac.ke Internet Source	1%
2	"Handbook of Climate Change Resilience", Springer Science and Business Media LLC, 2020 Publication	<1%
3	pdfs.semanticscholar.org Internet Source	<1%