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Presented by

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ASSESSMENT OF FACTORS INFLUENCING RENEWABLE ENERGY ADOPTION PROCESS AMONG HOUSEHOLDS IN URBAN KENYA, CASE STUDY OF KISUMU CENTRAL SUB- COUNTY IN KISUMU CITY

Defended on 05th September 2018 before the following committee

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DECLARATION

I Collins Omondi Owuor hereby declare that this thesis represents my personal work, realized to the best of my knowledge. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

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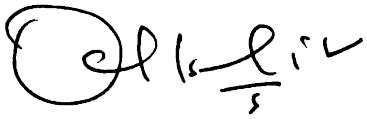
Signature:  Date: 13/09/2018

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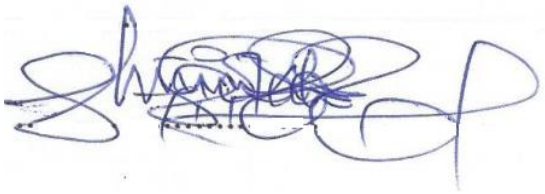
Signature:  Date: 10/09/2018

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DEDICATION

I dedicate this work to my father Michael Owuor my mother Elizabeth Awino, my brothers Vincent Otieno and Stephen Kola, Sisters Eunice, Sipporah, Rose and Zena. To my fiancée Jane Aoko, friends Edger Ng'eno and Peter Odera for your support and encouragement during the course of this study. Most importantly, to the Almighty God for the gift of life.

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LIST OF ABBREVIATIONS

ERC	Energy Regulatory Commission
CGK	County Government of Kisumu
GDC	Geothermal Development Company
GoK	Government of Kenya
UNDP	United Nations Development Program
WHO	World Health Organization
NACOSTI	National Commission of Science, Technology and Innovation
PPAs	Power Purchase Agreements
CBOs	Community based organizations
NGOs	Non-Governmental Organizations
CofeK	Consumers Federation of Kenya
KAM	Kenya Association of Manufacturers

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Abstract

Enhancing adoption of renewable energy for households is an important step to realizing energy access. To make this happen it is important to know the factors that promote and inhibit adoption of renewable energy technologies. This study assessed factors influencing renewable energy adoption among urban households with a focus on Kisumu central sub county in Kisumu city. Specifically, the study assessed promoting and inhibiting factors to adoption as well as legal and regulatory frameworks influencing adoption. Descriptive method was used with the aid of survey leveraged on the Open Data Kit platform (ODK). Direct observation, content analysis as well as with the inclusion of a key informant interview. Secondary data analysis was done on review Kenya National Bureau of Statistics report on Kisumu County. Simple random sample 384 respondents were targeted but only 331complete responses were obtained. The data was analyzed using data analysis software SPSS to find the relationship between inhibiting and promoting factors with the adoption process. The study found out that there is a gap in policy development and implementation as 61% of respondents did not appreciate efforts by Kisumu County government in promoting adoption of renewable energy. The county concentration on promotion of adoption is focused on public uses like solar panels for street lighting and security posts within their settlements and market areas. The county government is piloting a programme to promote adoption of ethanol stoves and improve its efforts on awareness creation especially among poor households. The study probed adoption in a tripartite method being associated with knowledge of various renewable technologies, decision to buy the technologies and finally installing them for their household utilization out of which the study found that most respondents had knowledge of various technologies and had seriously thought of procuring them but few had them installed owing to lack of traders, limited information on technologies and expenses regarding acquisition, repair and maintenance of devices. The study further recommends adoption of a multi-disciplinary focus for adoption awareness involving the county government as the main promoter, local energy related non-governmental organizations (NGOs) and community-based organizations (CBOs) together with studies to gauge the extent in which the to be enacted Kisumu county bill on climate change and renewables will influence adoption among residents

Key Words

Sustainability, Vulnerability, Energy citizenry, Power Purchase Agreements, Advocacy and Awareness Creation

Resume'

L'amélioration de l'adoption des énergies renouvelables pour les ménages constitue une étape importante dans la réalisation de l'accès à l'énergie. Pour ce faire, il est important de connaître les facteurs qui favorisent et entravent l'adoption des technologies d'énergie renouvelable. Cette étude a évalué les facteurs influençant l'adoption de l'énergie renouvelable chez les ménages urbains, en mettant l'accent sur le sous-comté central de Kisumu dans la ville de Kisumu. Plus précisément, l'étude a évalué les facteurs favorisants et empêchant l'adoption ainsi que les cadres juridiques et réglementaires influant sur l'adoption. La méthode descriptive a été utilisée à l'aide d'une enquête exploitée sur la plate-forme Open Data Kit (ODK). Observation directe, analyse du contenu et inclusion d'un entretien avec un informateur clé. L'analyse des données secondaires a été effectuée sur la base d'un rapport du Kenya National Bureau of Statistics sur le comté de Kisumu. Échantillon aléatoire simple 384 répondants ont été ciblés mais seules 331 réponses complètes ont été obtenues. Les données ont été analysées à l'aide du logiciel d'analyse de données SPSS afin de déterminer la relation entre les facteurs d'inhibition et de promotion et le processus d'adoption. L'étude a révélé qu'il existe une lacune dans l'élaboration et la mise en œuvre des politiques, 61% des personnes interrogées n'ayant pas apprécié les efforts déployés par le gouvernement du comté de Kisumu pour promouvoir l'adoption des énergies renouvelables. La concentration du comté sur la promotion de l'adoption se concentre sur les utilisations publiques telles que les panneaux solaires pour l'éclairage public et les postes de sécurité dans leurs zones de peuplement et de marché. Le gouvernement du comté pilote un programme visant à promouvoir l'adoption des fourneaux à l'éthanol et à améliorer ses efforts de sensibilisation, en particulier chez les ménages pauvres. L'étude a examiné l'adoption d'une méthode tripartite associée à la connaissance de diverses technologies renouvelables, à la décision d'acheter les technologies et à les installer pour leur utilisation par les ménages. L'étude a révélé que la plupart des personnes interrogées mais peu d'entre eux les avaient installés en raison du manque de commerçants, d'informations limitées sur les technologies et des dépenses liées à l'acquisition, à la réparation et à la maintenance des appareils. L'étude recommande en outre l'adoption d'une approche pluridisciplinaire pour la sensibilisation à l'adoption impliquant le gouvernement du comté en tant que principal promoteur, les organisations non gouvernementales locales liées à l'énergie et les organisations communautaires, ainsi que des études pour mesurer le projet de loi du comté de Kisumu sur le changement climatique et les énergies renouvelables influencera l'adoption par les résidents

Definition of Significant Terms

Vulnerability: Refers to susceptibility to harm from exposure to stresses associated with environmental and social change and of a limited ability to adapt. For this study vulnerability is expounded as inadequacy of conventional urban energy systems to possess resilience against sudden shocks brought by sudden demands or threats

Renewable Energy: Also, alternative energy or sustainable energy; refers to power obtained from nature such as geothermal, solar, biogas and wind. Most have natural replenishment of stock

Modern Energy: Understood as sustainable energy which is affordable, accessible and reliable to a majority enabling them meet their needs

Adoption Process: With reference to renewable energy or this study refers to either knowledge, willingness and installation of either one or many of the above stated renewable energy technologies

Sustainability: With reference to energy, it's the provision of energy or supply of sufficient/ optimal energy, in desired quality (Modern) to meet demand without threatening current supply stock with depletion which is likely to compromise future demand from being met or resulting to negative externalities such as pollution and climate change which are a detriment to the environment

Fundi: Refers to technicians dealing with installation, repairs and maintenance of renewable energy technologies

Thesis outline

The thesis is organized as follows: Chapter one which serves as introduction including background to the study and historical perspectives of renewable energy policy and institutional environment in Kenya. Chapter two contains Literature Review includes a review of country level energy policies at international, regional and county level renewable energy options for households' barriers to household level renewable energy adoption at country and county level Problem Statement, relevance of the study, objectives, research questions and working hypothesis and highlights both theoretical aspects of the study finalizing with the conceptual framework upon which the study in anchored. Chapter three discusses the research methodology to be employed. This section covers the following subtitles Study population, sample size determination, sampling method, data collection procedure, data analysis procedure and ethical issues that buttress the study. Chapter four discusses results data analysis and discussions; it includes introduction with demographic information on respondents, Kisumu county energy policy environment, promoting and inhibiting factors to adoption of renewable energy in the study area. Chapter five presents the study conclusions and recommendations for both policy and possible topics for future research pursuits. The document finally concludes with bibliography and appendices

CHAPTER 1: INTRODUCTION

1.1 Background

Globally, cities and urban areas occupy just 2% of the entire land surface but they are home to more than half of the world's population and account for more than two-thirds of global energy use (Roberts & Gautam, 2017). Similarly, cities and other urban areas are responsible for more than 70% percent of global economy, 60% of global energy consumption, 70% greenhouse gas emissions and 70% of global waste (UN-Habitat, 2018). It is estimated that the population living in cities is expected to reach 70 percent by 2050, and energy consumption and related carbon emission is also poised to rise exponentially (UNDP-WHO, 2017).

According to the International Energy Agency- EIA (2017), energy is integral in the provision of clean and safe water, sanitation and healthcare, additional benefits of modern energy services like efficient lighting, space heating and mechanical power, transport and information telecommunication. The link between energy access to achievement of Sustainable Development Goals (SDGs) has been vastly documented in literature over time and lack of access to energy has been proven to undermine progress towards their achievement (Yumkella, Modi, Bazilian, & Nussbaumer, 2011).

The rate of renewable energy adoption for domestic uses is one of the opportunities that developing countries can seek to adopt so as to accelerate the pace of socioeconomic development (AFREPREN/FWD, 2006). Other than increasing income per household, greater efficiency in household expenses can increase disposable income and hence uplift the living standards of the given segment of the population. In light of this, renewable energy adoption is therefore one of the areas that needs to be explored as a means of improving livelihoods in developing countries. Access to energy is one of the indicators used to determine the socioeconomic status of a population. In urban areas, energy access and use follow socioeconomic patterns with; high income neighborhoods consuming greater quantities of energy per capita when compared to people who live in low income neighborhoods. While energy access in rural areas is generally worse than energy access in urban areas in developing countries, there are differences in energy access and usage profiles among urban dwellers. Additionally, much effort has gone towards increasing

energy access to rural areas, with renewable energy playing a greater role, compared to conventional energy. While access to conventional energy is greater in urban areas, there is still a case for targeted policies to enhance energy access in urban areas in households. In the same way that renewable energy is used to expand access in rural areas, there is a need to find out whether they can have the same impact in in urban areas. This study therefore concerned itself with the factors that influence adoption of renewable energy for households in urban areas.

With projected population increases in Kisumu city, additional supply of energy is integral in maintaining optimality of Kisumu energy systems and security. However, diruptions in the supply systems at different levels of economic activities is likely to cost 1-2 % of the annual development potential of cities with serious ramifications to the functioning of the economies (Yamagata & Sharifi, 2016). Likewise the Afro barometer (2016) estimates that 59% of Kenyan urban dwellers describe their power supply as highly unreliable.Its worth noting the projected significant increases in energy demand have implications for energy availability, accessibility, affordability and acceptability owing to changing lifestyles of urban dwellers and dietary needs which are often energy intensive.

Nationally the energy mix of urban areas is dominated by non- clean and inefficient fuels such as biomass which accounts 56% urban energy use for cooking (GoK, 2013). Despite having a higher propensity to utilize renewable energy technologies, urban populations still partake to more energy intensive activities using traditional fuels. Therefore, high quantities of feedstock or fuel is consumed in the process with consequent implications to health, pollution, environment, economic growth manifested into a high expenditures against their limited incomes (Karekezi , Kimani, & Onguru, 2008).

1.2 Policy Regime

The role of government in the adoption of renewables cannot be understated. It is governments that have the responsibility and capacity to create an enabling environment to help address socioeconomic challenges experienced in any community. This is critical at the policy development level. An enabling policy environment usually results in an enabling business

environment which in turn leads to progress in any particular area of focus. In this regard, policy development processes remain critical to the needs of any nation, as agents of development (Abdullah, 2009).

In devolved government systems such as Kenya, the role of policy becomes even more critical. This is because policies made by the central government provide an overarching framework for the development of lower level policies. Local governments are therefore key players in the formulation of local policies which play a large role in the day to day decisions of citizens (Maina & Rotich, 2016). Local governments, such as county governments are closer to the needs of the people on the ground and hence the policies developed at this level have a greater local effect. At a national level, policies provide general direction and address issues such as external financing, regional cooperation, and joint investments involving multiple players (Pundo & Fraser, 2006). Local level policies are therefore better placed to address issues of adoption, provision of business cases required to support entrepreneurial interest in renewables and providing a supportive climate for the development of renewables.

The renewable energy adoption trends among low income households would have differences with adoptions habits in high income households. In general, high income households may not be motivated to adopt renewables purely based on price, since energy costs typically account for smaller fractions of their running expenses. On the other hand, energy costs for low income households tend to be critical since they form large portions of the running expenses incurred by such households. In addition to costs, issues of awareness play a critical role in adoption decisions. High income households typically have higher levels of education among its members compared to low income households. The result is that people in high income households may have greater appreciation for the benefits of renewable energy compared to persons from low income households (de Heer , 2017). This factor too can affect renewable energy adoption decisions. In this respect, renewable energy adoption patterns can be expected to vary when households are analyzed according to income levels.

1.3 Energy Sector Policy and Institutional Framework in Kenya

The Minister of Energy and Petroleum (MoEP) is responsible for the formulation and articulation of energy policies and for creating an enabling environment for all operators. Kenya's energy policy and institutional framework is anchored by the National Energy Policy (2004) and Energy Act (2006) (Saoke et al, 2017).

1.3.1 Energy Policy and Regulatory Framework

The following legislations, institutions and policies exists in Kenya both at the national and county levels.

a) Sessional Paper No. 4 of 2004

The Sessional Paper No. 4 of 2004 is a policy document that stipulates various power restructure programs leading to liberalization of the energy sector. Its vision is to promote equitable access to quality energy services at least cost while protecting the environment (The Ministry of Energy, 2004). The paper thus gives the legal framework intent for cost effective, affordable and adequate quality energy services available to the domestic economy on a sustainable basis over the period 2004-2023. The sessional Paper incorporates strategies to promote contribution of the renewable energy sources for generation of electricity. With operationalization of the Energy Act No. 12 2006, it provides an appropriate regime for harnessing and increasing electrical supply with indigenous renewable energy sources (MoEP, 2012). It further encourages the Cabinet Secretary responsible for energy to promote development and use or renewables, establishment of cogeneration in sugar and agriculture related industries and carry out prefeasibility and feasibility studies on renewable energy potential in Kenya (Saoke et.al, 2018).

b) Energy Act No. 12 of 2006

One of the main proposals of the Sessional Paper was the enactment of an Energy Act to succeed the Electric Power Act No. 11 of 1997 and the Petroleum Act, Cap 116 of 1994 to facilitate a single platform for regulation and enhancement of all energy resources in the country. It further provides for the establishment of Energy Regulatory Commission (ERC), The Energy Tribunal and the Rural Electrification Authority (REA). The Act also outlines the functions and powers of these bodies (GoK, 2006). The other Acts that impact the energy sector include:

c) The Standards Act

Chapter 496 of the Laws of Kenya that provides for establishment of minimum quality specifications, mode, materials and apparatus for energy used in the country. This Act is vital in regulation of standards for acceptance of renewable energy technologies within the country (The Republic of Kenya, 2013)

d) The Environmental Management and Co-ordination Act, 1999

Which regulates the environmental aspect of the energy sector. Adoption of renewable energy by both households and industries; ensures environmental integrity including the emissions reduction of greenhouse gases, enhances energy supply and security reducing the country expenditure on import bills for fossil fuels and associated price volatility. At the household, reliability is improved together with improvement of indoor air quality. Lastly, it enhances economic competitiveness and opportunities for women and youth (EMCA, 1999).

e) The Physical Planning Act

Chapter 286 of the Laws of Kenya that provides for zoning of areas for storage, distribution and retailing of petroleum fuels and construction of electric power sub-stations and other infrastructure. With respect to renewable energy the physical planning act as used in zoning for residential properties, can be used to enhance other regulations like the solar hot water heating regulations of 2012 for seamless adoption (Saoke et. al, 2018)

f) The County Government Act

That provides for the regulation required to implement the provisions relating to devolved government and to give effect to chapter 11 of the Constitution, to provide for county government powers, functions and responsibilities to deliver services and for connection purposes. The County Government mission is to plan and develop energy initiatives as stipulated in the 4th schedule of the Constitution of Kenya 2010. Part 2 of the fourth schedule stipulates

"County governments shall be responsible for county planning and development including electricity and gas reticulation".

To ensure equity among counties as far as provision of services under this schedule is concerned, the national government equalization fund is given to counties on a need. basis (Osiemo, 2012). The County Government of Kisumu is promoting uptake of green energy technologies and implementing climate change strategies to transition to a low carbon and resilient economy (CGK, 2018).

g) Feed-in Tariff (FiT) Policy

Introduction of feed-in tariffs (FiT) in 2008 was to provide investment security to renewable electricity investors by creating market stability, reduce administrative and transaction costs associated with conventional procurement process and encourage private investors in establishment of Independent Power Production (IPPs). The FiT were reviewed in 2010 and 2012. The tariffs apply to grid-connected plants and are valid for a 20-year period from the beginning of the Power Purchasing Agreement (PPA), with approval of the PPAs granted by the ERC (Saoke et. al, 2018; Ministry of Energy, 2012).

h) United Nations Framework Convention Climate Change (UNFCCC)

Since the constitution of Kenya 2010 domiciled all international treaties Kenya has ratified, the UNFCC becomes part of its policy mechanism used in promotion of renewable energy development. For purposes of reducing greenhouse gases state parties undertake the following under the policy; emission trading among countries, joint implementation of projects and Clean Development Mechanism (CDM) projects encouraging Kenya and other developing countries meet their emission targets under the framework (Osiemo, 2012).

i) Solar Hot Water Heating Regulations 2012

The regulations mandate local authorities to ensure premises within their jurisdictions with hot water requirements exceeding 100 litres install and use solar water heating systems (ERC, 2012). The regulations provide for calculation of hot water each household consumes based on the numbers per household and bedrooms.

Table 1.1: Summary of hot water requirements

Type of Building	**Specific hot water demand in litres/ day at 60^{o}c**
Domestic residential houses	30 per person
Educational institutions	5 per student
Health institutions	50 per bed
Hotels, hostels and lodges	40 per bed
Restaurants, cafeterias and eateries	5 per meal
Laundries	5 per kilo of clothes

Source: Energy Regulatory Commission 2012

The regulations required compliance by 2017. It further direct premises owners, architects and engineers to allow for provisions of hot water heating systems during conceptualizing and building

of premises. The regulations further give the minimum requirements for technicians approved by the ERC for purposes of installing and repairing faulty systems.

1.3.2 Institutional arrangement

Main institutions in the energy sector are as follows: -

a) Ministry of Energy and Petroleum (MoEP)

It is responsible for formulation and articulation of energy policies through which it provides an enabling environment for all stakeholders. The state department under the ministry has many functions and semi-autonomous institutions for overseeing various aspects of the energy sector. The institution tasked with promotion of renewables under the state department office is the renewable energy directorate (MEoP, 2018). The directorate is mandated to:

i. Formulate and review polices on energy efficiency and conservation
ii. Renewable energy conservation promotion and development
iii. Integrate climate change and gender aspects in efficiency and conservation programmes
iv. Formulate and review the renewable energy feed in tariff
v. Together with the Kenya Bureau of Standards- KEBS, develop technical and performance standards for renewable energy technologies and rating labels
vi. Collaboration with regional states for harmonization of regional policies and regulations on renewables
vii. Conduct feasibility studies on renewable energy as well as fund mobilization for renewable energy, energy efficiency and conservation projects

b) Energy Regulatory Commission (ERC)

Responsible for the economic and technical regulation of electric power, renewable energy, and downstream petroleum sub-sectors. Its functions also include tariff setting, review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts. The institution offers licenses manufacturers, importers, contractors and technicians of renewable energy products (Kenya Renewable Energy Association, 2018).

c) The Kenya Power

Kenya Power is a State Corporation with GoK shareholding of 50.1% and private shareholding of 49.9%. As an off taker in most projects, the institution is mandated by law to buy electricity from renewable energy generation companies by virtue of their power purchase Agreements- PPA.

d) Kenya Electrification and Transmission Company

The government established the Kenya Electricity Transmission Company Limited (KETRACO) in 2004as captured in the (Sessional paper No.4, 2004) as a state-owned agency tasked with constructing and managing (high voltage) transmission lines. The decision to create KETRACO instead of unbundling Kenya Power is attributed to the ownership structure of the latter as a partially privatized entity, which is a barrier to raising public and donor funds for grid expansion (Kiplagat et.al, 2011)

e) Kenya Electricity Generating Company Limited (KenGen)

KenGen is a State Corporation with GoK shareholding of 70% and private shareholding of 30% as at December 2011. It is mandated to generate electric power, currently producing the bulk of electricity consumed in the country. The company utilizes various sources to generate electricity ranging from hydro, geothermal, thermal to wind (Osiemo, 2012).

f) Rural Electrification Authority (REA)

The Energy Act (2006) also established the Rural Electrification Authority- REA with the mandate of accelerating the rate of rural electrification, manage the Rural Electrification Fund, tender and award contracts, licenses and permits for rural electrification including those of renewable energy independent power producers (Kiplagat et.al , 2011). In the 2000s, with the establishment of the REA with backing of the national government has succeeded to connect public facilities and bring rural homes closer to the grid. By 2014, the REA has overseen the electrification of 90 percent of the 23,000 public facilities at a cost of over 100 million USD per year. The Last Mile Connectivity Project halved the connection fee from 350 USD to 150 USD and offer customers the option to pay in instalments. REA also can equally electrify rural areas using renewables (MoEP,2017).

g) Geothermal Development Company Limited (GDC)

This is a 100% state-owned company established by the Government of Kenya as a Special Purpose prospecting the development of geothermal resources in Kenya (Kiplagat et.al, 2011).

h) Kenya Electricity Transmission Company Limited (KETRACO)

This is a GoK wholly owned company established to be responsible for the development, maintenance and operation of the national transmission grid network (The Government of Kenya, 2006).

i) Kenya Petroleum Refineries Limited (KPRL)

This is a limited liability company with its main business being processing of imported crude oil to refined oil products. The Kenyan refinery has an operation capacity of 4 million tons per year (Saoke et.al, 2018)

j) National Oil Corporation of Kenya Limited (NOCK)

It's mandated to stabilize the petroleum supply market by participating in all aspects of the petroleum industry namely upstream, mid-stream and downstream activities.

k) Kenya Nuclear Electricity Board (KNEB) KNEB

Is charged with the mandate of spearheading and fast-tracking development of nuclear electricity generation in order to enhance the production of affordable and reliable electricity.

l) Centre for Energy Efficiency and Conservation (CEEC)

Was formed in 2006 by the Kenya Association of Manufacturers- (KMA) and the ministry of energy and petroleum. It champions energy efficiency and conservation efforts in Kenya for commercial, industrial and institutional energy consumers. It does capacity building through training on energy related programs and undertake energy audits (Saoke et.al, 2018)

m) Oil Marketing Companies (OMCs)

OMCs are local and international companies licensed to undertake the importation, storage, wholesale, export and retail of petroleum products.

n) Petroleum Institute of East Africa (PIEA)

It plays a key role in capacity building and awareness creation in the petroleum sub-sector.

o) Oil Exploration and Production Companies (OIEPs) These are local and international companies licensed to undertake exploration and production of petroleum products.

Other key players in the energy sector include National Environmental Management Authority (NEMA), Kenya Revenue Authority (KRA), Kenya Railways Corporation (KR), Kenya Truckers Association (KTA), Kenya Association of Manufacturers (KAM), Kenya Maritime Authority (KMA) and Consumers (The Government of Kenya, 2006).

This policy has developed framework which forms the basis for sharing of the benefits. One of the benefits to be equitably shared is the government share of profits accruing from energy natural resources to be implemented between the years 2014 to 2018. These shall be shared as follows: National government (75%), County government (20%) and Local communities (5%).

Some planning documents include:

Least Cost Power Development Plans (LCPDP)

The Least Cost Power Development Plans (LCPDP) have been overarching power implementation plan used for delivery of energy sector targets in realization of vision 2030 (Government of Kenya, 2008). The plan entails demand forecast scenarios for electricity, energy resource assessment for the country, generation and transmission expansion plans for the respective study periods. The Least Cost Power Development Plan (2013-2033) sets ambitious target of generating an installed capacity of 22.7GW of which 50% of Kenya's energy from renewable resources primarily; wind, hydro, and geothermal (Owuor & Kageni , 2018). Therefore, the policy promotes development of big grid tied renewable and non- renewable energy projects.

Other programmes encouraging renewable energy development include the Rural Electrification Master Plan, the National Climate Change Response Strategy, and the Investment Plan for Scaling-up Renewable Energy Programme (SREP) (Saoke et.al , 2018). In 2016, following the rise in the number of investments in renewable energy, particularly in wind and solar projects, the ERC also revised the Electricity Grid Code to enhance the country's capacity to absorb renewable electricity. Other regulatory frameworks such as the standardized PPA for small scale renewable energy (up to 10MW) (2012), the Energy (Complaints and Dispute Resolution) Regulation (2012), and the Mini-Grid Regulation (2016) are already in place.

Kisumu County Energy Development Sector

The Ministry of Trade and Energy through the Green energy department of Kisumu County envisages itself as a center of excellence to other counties in Kenya in the utilization of electricity, lead in sustainable energy transition to alternative and renewable sources of energy and be a repository for policy, technology and financial knowledge on renewable energy and climate change (The County Government of Kisumu, 2018).

To improve energy access to most households, Kisumu County will embrace renewable energy strategies. The County government shall put in place deliberate measures to ensure conservation and protection of the water catchment areas. There will be sensitization campaigns in the county pertaining to the importance of conserving the environment.

The use of renewable energy and energy efficiency projects will be implemented and Kenya Power will expand power connectivity in the County.

Objectives for Kisumu County energy department

i. Enhance rural electrification in conjunction with Rural Electrification Authority (REA) and Kenya Power
ii. Increase access to alternative energy sources to households and institutions within the County
iii. Identification of renewable energy sites for development.
iv. Formulation and review of County specific policies on renewable energy.

v. Developing and enacting legislations and regulatory framework for County specific policies on renewable energy.

vi. Implementation of county policies and legislations related to renewable energy.

vii. Enforcement of the energy policies, regulations, laws and compliance with management measures within the county.

viii. Facilitate research, adoption and capacity building on sustainability and utilization of renewable energy.

ix. Promote partnerships to support distribution and provision of affordable rural electrification and sustainable secure renewable energy.

Stakeholders

The following are the key stakeholders the department seeks to work with in realizing their strategic vision; The national government, National Environmental Management Agency (NEMA), Sustainable energy fund (SEF), Private sector. Leading academic and research institutions like universities and polytechnics

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature relevant to this study. The review covers the renewable energy policy environment in Kenya, adoption of renewables among households, barriers to adoption of renewables among households, problem statement, study relevance and limitations, theoretical framework and a conceptual framework

2.2 The Renewable Energy Policy Environment in Kenya

Creation of devolved governments in Kenya for purposes of governance and development through the new constitutions promulgated in 2010 has had many implications for policy development across all sectors. One of these sectors is energy. Energy needs and the energy profiles vary from county to county hence a common policy environment would not suffice for the specific needs of each county. An effort is underway to support county governments to develop county specific policies termed, Sub national energy policies (Valladares, 2016). These efforts will supplement various policies at the national level aiming at increasing access to energy across the county. Busia County enacted an energy bill that prioritized renewable energy in the light of locally available resources in a bid to build a sustainable economy (Busia County, 2014). This bill is an example of trends within county governments to provide policy environment to support the development of renewable energy resources at county specific levels.

According to the Energy Regulatory Commission in Kenya (ERC), one of the key challenges affecting renewable energy adoption in Kenya is lack of data on renewable energy availability, potential and utilization (Osawa, 2011). While much efforts and research are ongoing to fill these gaps, the market conditions for renewable energy adoption are constantly in flux, just like changes in renewable energy technologies. This means that research efforts ought to be in tandem with the changes for sustainable development of stable market conditions and responsive policy environment

Lack of resources and knowledge by municipal authorities in regards to the development of adequate renewable energy policies is not a problem unique to developing countries but can also be seen at play in Dutch Municipalities (de Heer , 2017). Dutch municipalities carry the most responsibility in regards to the adoption of renewable energy in line with European Union targets. The lack of capacity is hampering progress by the Dutch Government towards meeting their national renewable energy adoption goals.

Another factor identified as helpful to the adoption of renewables by households is the presence of policy advocacy groups (Boampong & Phillips, 2016). It is well understood that advocacy has an impact on policy development and as such policy advocacy groups can help shape policy so that there is good adoption of renewables by households. Legislators and other policy development personnel at the municipal level are not necessarily renewable energy experts and hence they can benefit from the work of policy advocacy groups.

Two policy directions that can help improve the adoption of renewables include clear legislation on the renewables at the county level to govern access, trade and usage, as well as registration and regulation of vendors to protect end users from substandard products and unscrupulous traders (Maina & Rotich, 2016).

The energy Act of 2006 which established the Energy Regulatory Commission (ERC) was the first major policy effort aimed at addressing the needs of the renewable energy sector (Boampong & Phillips, 2016). The ERC was set up to set energy prices such as during the development of Power Purchase Agreements (PPAs). This role seemed to have more to do with large scale renewables distributed through the national grid and had large solar and wind plants in mind. On the other hand, it did not do much for the adoption of the renewables at a domestic level.

The act also offered some tax reliefs for equipment acquired to be used for renewable energy generation, and also abolished the need for a license when producing renewable energy at levels lower than 4MW (Boampong & Phillips, 2016). These incentives, while welcome, still had their sights on industrial level renewable energy systems and hence may not have benefitted the domestic adoptions of renewables.

2.3 Adoption of renewables among households

Urbanization has led to increases in energy demand over time, but supply has often remained constant or growing at rates that do not keep pace with additional demand thereby, affecting provision of energy services to a sizable urban population (Boampong & Phillips, 2016). The largest growth areas in urban areas in developing countries tend to be low income areas. Sustainability of cities requires their growth and expansion to be in sync with the incremental increase in demand of critical resources for urban systems sustenance. The urban energy supply needs to meet the current demands while at the same time have capacity to meet additional demand on short notice without compromising the ability of its systems and other support services.

At a time of rising concerns about climate change and resource constraints, the energy access agenda is gaining traction around the globe. Availing modern energy to people who lack it will likely benefit the globe without harming the environment or unduly stretching finite resources (Halff, Sovacool, & Roxhon, 2014). The world has come to realize the central role of energy in human, economic and sustainable development. Energy is critical enabler at addressing a number of global challenges, including poverty, inequality, climate change, food security, health and education. According to the International Energy Agency (2017), energy is integral in the provision of clean and safe water, sanitation and healthcare, and additional benefits of modern energy services like efficient lighting, space heating and mechanical power, transport and information telecommunication. The link between energy access and achievement of Sustainable Development Goals (SDGs) has been vastly documented in literature over time and energy poverty has been found to undermine progress towards their achievement.

The adoption of renewable energy in developing counties by low income groups may be improved by the introduction of local renewable energy cooperative societies as found in the Netherlands. In the Netherlands, Local Renewable Energy Cooperatives (LRECs) play an important role in increasing the adoption of renewables towards the achievement of EU targets for member states (de Heer , 2017). Since the concept of cooperatives is already well accepted in Kenya, the probability of success is promising in cases where cooperatives are created to encourage members to adopt and use renewable energy.

Any study looking at the adoption of renewable energy choices must look at each of the sources that may be adopted in context, with cooking and lighting being the two major applications for domestic use in low income households (Maina & Rotich, 2016). Water heating plays a larger role in high income households especially for bathing. Failure to contextualize the energy source can lead to unusable results because local factors play a central role in the cooking and lighting fuel choice. Access to these options is one such factor. Some areas may have more wood fuel compared to others, while others may have more sunshine compared to others. In this regard, it is important to consider the effect of the locality on the fuel choice.

2.4 Barriers to adoption of renewables among households

A study conducted in Kitui found that high taxes levied on renewable energy systems were responsible for low uptake of solar energy in the county (Maina & Rotich, 2016). This finding indicates that while some policies may be made in regards to a category of products, say imports, or electronics, they need to be assessed from their respective end use for the purposes of creating an enabling environment. A case is point is the difference between car batteries and solar batteries, which can end up in the same tax pool despite significant differences in their uses.

The cost of renewable energy is a huge factor affecting adoption (Maina & Rotich, 2016). The two main costs that affect adoption, especially of solar PV systems are the cost of equipment, and the cost of installation. Solar power equipment is often priced too highly and is not seen to be an effective investment when compared against the cost of grid power. While incentives can be offered to consumers who may have access to credit to access the systems, the same is not true for those who lack the means or the ability to service large loans. Therefore, low income groups are particularly affected by high costs as compared to those with higher disposable incomes.

Pundo and Fraser (2006) that investigated the factors that influenced household energy choice between firewood, charcoal and kerosene found that level of education of wife, the level of education of husband, type of food mostly cooked, whether or not the household owns the dwelling unit, and whether or not the dwelling unit is traditional or modern type were the important factors)..

It is however worthy to note that the study did not include adoption of solar, biogas, wind or other types of renewables.

Ngaira & Omwayi, 2012 conducted a study in the lake basin looked at Kisumu and all the counties that form part of the lake basin with the goal of identifying renewable energy potential with a bias on clean energy. The study found that 80% of the energy used in the region for cooking and lighting is from biomass, and that improved cook stove and charcoal briquette technologies had the potential of improving the yield of renewables. The study also omitted technologies that would harness solar and wind. It concluded that inhibiting factors to adoption of the listed technologies included; unavailability of technologies, lack of technical knowledge in operation and maintenance of technologies and inadequate finances to buy a desired technology and also procure services of technicians. challenges that were cited in this study as impediments to the adoption of renewable energy included inaccessibility of the resources, lack of technical knowledge, and lack of finances.

A study undertaken in rural Kisumu North to determine factors influencing adoption of improved energy saving cook stoves concluded that even though majority of the household adopted the technology owing to its ability to conserve biomass, the families still used three stone fires for cooking especially during functions or where the family size is big. This study further revealed that most women headed households adopted the use of the technology including Kenya Ceramic Jikos (KCJ) than male headed household as women were the ones tasked by gender roles to fetch firewood or other forms of biomass for cooking. From the same study however, education did not seem to influence adoption as most of those that adopted had informal education but rather improve the user experience with the technology. Awareness of the technology informed more than 90% of household's decision to adopt, and they mostly confirmed they adopted from hearing about the technology from a friend (Adhola, 2014)

Abdullah (2009) found out the willingness of consumers to pay for renewable energy sources in Kisumu was to pay more for a grid connection as opposed to buying a solar PV system. In addition, there was a higher likelihood of adopting renewables if the person interviewed were older and had lived in the area for long. This study also showed that those who had home based businesses, were

of a higher socio-economic profile and had lived for shorter periods in the area had a preference for grid power and were willing to connect to it.

A comparative study was carried out in Embu, Meru and Muhoroni to assess biomass usage patterns in three rural villages (Wamukoya, 1995). Among the findings made was that 15%-35% of household income was spent on energy, without accounting for the time spent in gathering the energy source (Wamukoya, 1995). This indicates that time spent gathering an energy resource can possibly have an effect on its adoption potential by users. The study however only focused on biomass to the exclusion of other forms of renewables, and it only concerned itself with rural households.

Olang et.al (2018) undertook a study in Kisumu to compare renewable energy adoption and usage determinants in the context of energy poverty and found that there is a preference for kerosene and pico- solar products for lighting and cooking as interchangeable energy sources. Respondents using pico-solar products used kerosene for backup and maintained it as an alternative. The study by Olang et al (2018) found that factors influencing energy types used in households included appliance types acquired, access concerns, and cost of usage. The methodology of the study (purposive and snowball sampling) did not allow for generalization of the results, but rather verified the significance of the variables and identified the presence of key relationships.

The key concept arising from the studies reviewed are as follows. First a pattern emerges that links socio-economic status of respondents to their energy source options. This comes from realities such as cost of acquisition of the energy source, and operational costs. It is also clear that grid power is a key player when it comes to energy adoption options in the study area. Factors such as power quality come into play but seem not to play a major role in the adoption decision. This can mean that the renewable energy options may not offer clear benefits in terms of reliability and availability of energy, as compared to grid power. Awareness also comes out as a factor in the adoption of renewable energy. Higher awareness levels indicated by higher education levels and a corresponding higher socioeconomic status have an effect on energy adoption decisions. The other aspect that the studies reviewed bring out is the variability in the choice of study methods and the choice of study in the study regions. While all the studies cited were carried out in Kisumu, the

scope varied in three ways. Some studies included Kisumu as part of the lake basin, some studies looked at the rural parts of Kisumu, while other looked at the urban areas.

Another key issue that emerges from the review are perspectives regarding what constitutes renewable energy, and the implicit choice of what can be considered widely used sources. Renewables in the studies reviewed include solar, biomass (bagasse, wood fuel, and charcoal). There was no mention of biogas and wind power in any other studies. This may be because of low potential or their non-existence in the area of study. Kerosene was featured as an energy source, and grid power was also listed as a formidable energy source. These studies also show that it is necessary to identify specific renewable energy sources for study based on the difference in their profiles of use

2.5 Research Problem

According to Kenya National Bureau for Statistics report - KNBS (2013), Kisumu central households utilize the following energy choices for lighting; electricity stands at 57%, 42% from various forms of kerosene lamp and 0.2%. solar. Charcoal dominates the preferred source of cooking at 63.5% followed by paraffin at 15.4% then LPG at 11.15%. These figures indicate there is continual use of conventional fuels like biomass and paraffin for cooking and lighting. These fuels when used in poorly aerated households result to major health burdens for the household owing to indoor air pollution (Karekezi , Kimani, & Onguru, 2008).

Due to the high cost of connection ($150) to the grid and resultant unaffordability if connection is done under current tenure of the last mile program most of the urban poor continue to live without access to critical energy services which underpins the socio-economic gains of utilizing energy, as their productive options are diminished. Likewise, the cost of conventional fuels biomass and kerosene for both cooking and lighting is expensive and comprise a bigger share of households' budgets. Renewable energy offers these households an opportunity to reduce energy related expenditures and leverage on a number of options that can transform their economic profiles. These problems exist inspite of the area having a large potential for development of wind, bioenergy, solar and even biogas from municipal solid waste and the current status implies low

levels of adoption. The area for example has a potential of receiving approximately 5kWh/m^2/day all year round (Oloo et als, 2016) and 6.44kWh/m^2/day acording to RETScreen Data as well an an annual average wind speed of 2.5ms^{-1}.

Finally, the development initiatives stipulated in the County Integrated Development Plan 2017 are likely to increase demand for electricity with intensification of urbanization of which renewables will be integral in meeting household demand. There is need to study factors that affect renewable energy adoption process namely; policy framework and regulatory environment, knowledge and awareness and availability of alternative technologies for urban areas in Kisumu central sub county of Kisumu city.

2.6 Relevance of the study

Kisumu in Kenya is the perfect choice for this study owing to its peculiarities of possessing a huge potential for development of renewable energy while low levels of energy access still remain endemic among its urban population. This means that resources haven't been sufficiently harnessed or if so mechanisms of distribution for improved access hasn't been sufficiently achieved. Urban areas of Kenya are experiencing fast growth especially since the promulgation of the 2010 constitution that created devolved units of governance to improve on service delivery. All the county government headquarters serve as urban centers witnessing increased rates of urbanization occasioned with competing economic opportunities. The study is relevant because:

i. This study will be relevant to policy makers, as it is likely to shed light on what drives and what impedes the adoption of renewable energy. This will make it possible to propose policy options that regional players can make to improve the uptake of renewables. The increasing interest in renewables at the global level, the improvement in the cost economics of renewables and the urgency to eliminate extreme poverty while driving growth in the developing world makes such a study critical
ii. Utility company, industry and to and users in general. The analysis of the policy environment provides the policy makers at the county level with insights into how existing policies affect the adoption of renewables in the county. Secondly it enables them better

understand the adoption process, consequently formulating future policies that are responsive to alleviating inhibiting factors for renewable energy adoption. This will steer green-energy transition for urban households and enable utility companies plan for and install resilient power systems backed by renewable energy such as solar and wind. The study identifies institutional inefficiencies that when remedied will positively influence adoption process

iii. To industry business owners interested in undertaking commercial projects geared towards the adoption of renewable energy in Kisumu City. Potential investors in the domains of renewable energy technology will understand better the preferred technology among residents and seek to invest in sales and marketing of the identified product for greater profits. The study is important for utility companies in that they are capable of equally investing in promotion of adoption of specific technologies so that demand for electricity within the city is maintained at optimum without resulting to load shedding and power outages

iv. To general users of renewable energy technologies, the study findings make a case for potentials that adoption gives households. This is not only limited to socio- economic benefits but also environmental benefits. Households will have a wider variety of clean energy sources to choose from for either cooking or lighting

v. Finally, the study's relevance to academia will be that it will help to fill the knowledge gap on the effect of policy environment on adoption of renewables. It shall offer a basis for future research endeavors into the topic especially adoption in other cities or rural areas thus validating this study findings or proposing a raft of other recommendations or purposes of positively impacting the adoption process. offer.

2.7 Objectives of the Study

The general objective of the study was to assess factors influencing renewable energy adoption process among households in urban Kenya, a case study of Kisumu Central sub- county of Kisumu city.

The specific objectives for the study

i. Assess factors that promote adoption of renewable energy
ii. Assess the factors that inhibit adoption of renewable energy
iii. Assess the renewable energy policy environment for Kisumu
iv. Assess impacts of existing policy framework on adoption process in Kisumu city

2.8.1 Research questions

i. What factors promote adoption of renewable energy in Kisumu city
ii. What are the existing energy policies on renewable energy
iii. What is the existing institutional framework for Kisumu city in regards to renewable energy
iv. What are the national policies that affect county adoption process with regards to renewable energy
v. Which renewable energy technologies do residents use for cooking and lighting

2.8.2 Working hypothesis

i. Kisumu city policy environment on renewable energy positively influences the adoption process
ii. National policies on energy have a great influence on county level policies

2.9 Study Limitations

The allotted time and resources for purposes of the study did not allow for a comprehensive determination of variables for purposes of generalizing patterns within the population under study. The process of application for ethics permit for purposes of the research was bureaucratic and it took more than 2 months to obtain the authorization for purposes of carrying on with the field work

2.10 Theoretical Framework

The innovations diffusion theory developed by Rogers (2003). The diffusions of innovation Theory is predicated on the postulation that people adopt innovations at various points, and there are differences between those who adopt innovations early versus those who adopt innovations later one. The theory was developed in the context of technological innovations. Renewable energy technologies are best seen as technological innovations, and their adoption can therefore be mapped effectively using the innovations diffusion theory.

The innovations diffusions theory identifies five stages within which an innovation passes at it gains acceptance and eventual adoption within social groups. The first stage is knowledge. Knowledge refers to gaining awareness regarding the nature of the innovation and having some idea on how it works. This makes awareness a key element in the adoption of an innovation. A community that is not aware of an innovation and how it works is ill placed to adopt it.

After awareness, the second stage is persuasion. This refers to the formation of an opinion regarding whether or not the innovation is useful and acceptable for ones needs. The question in this case would be whether the respondents to this study were persuaded as to the relevance or irrelevance of the technology to them. The third stage in the adoption process is decision. At this point, an individual who is presented with the opportunity to adopt or reject the innovation, in this case renewable energy technology, makes a choice. The choice is either to accept or reject the innovation on the basis of the facts considered and personal preferences.

The fourth and fifth elements of diffusion innovation are implementation and confirmation. Implementation refers to putting the technology into use, having accepted and acquired it. This phase is critical because the adoption of a technology preceding long term use depends much on the initial experience a person has with it. Confirmation refers to an evaluation by the users whether or not the technology has been useful to them. When confirmed, the adopter becomes a satisfied user and hence a powerful advocate for the technology.

The innovations diffusion theory also classifies users into five groups depending on how early or late they chose to accept an innovation. The stages arise from the risk appetite of each of the

groups. These five sequential groups are innovators, early adopters, early majority, late majority and laggards. Innovators take one new technologies early and their satisfaction is on being the first ones to enjoy the new technology. Early adopters then follow this groups, and usually base their decision in the experiences of the innovators. The next two groups are early majority and late majority who adopt the technology in masses, making it mainstream. Laggards tend to join the bandwagon after the technology begins to decline and may be motivated by its proven aspects, or reduction in cost as shops seek to offload old stock. This theory provides sufficient support to the aims of this study as it examines the profile of respondents in the context of policy initiatives by the Kisumu County Government.

2.11 Conceptual Framework

The study hypothesized the below conceptual framework figure 2.1 as a model for purposes of augmenting the study. The independent variables encompass those within the renewable energy policy regime, promoting and inhibiting factors for renewable energy adoption. The adoption process is the dependent variable which is influenced by other facts such as promotion and inhibiting factors

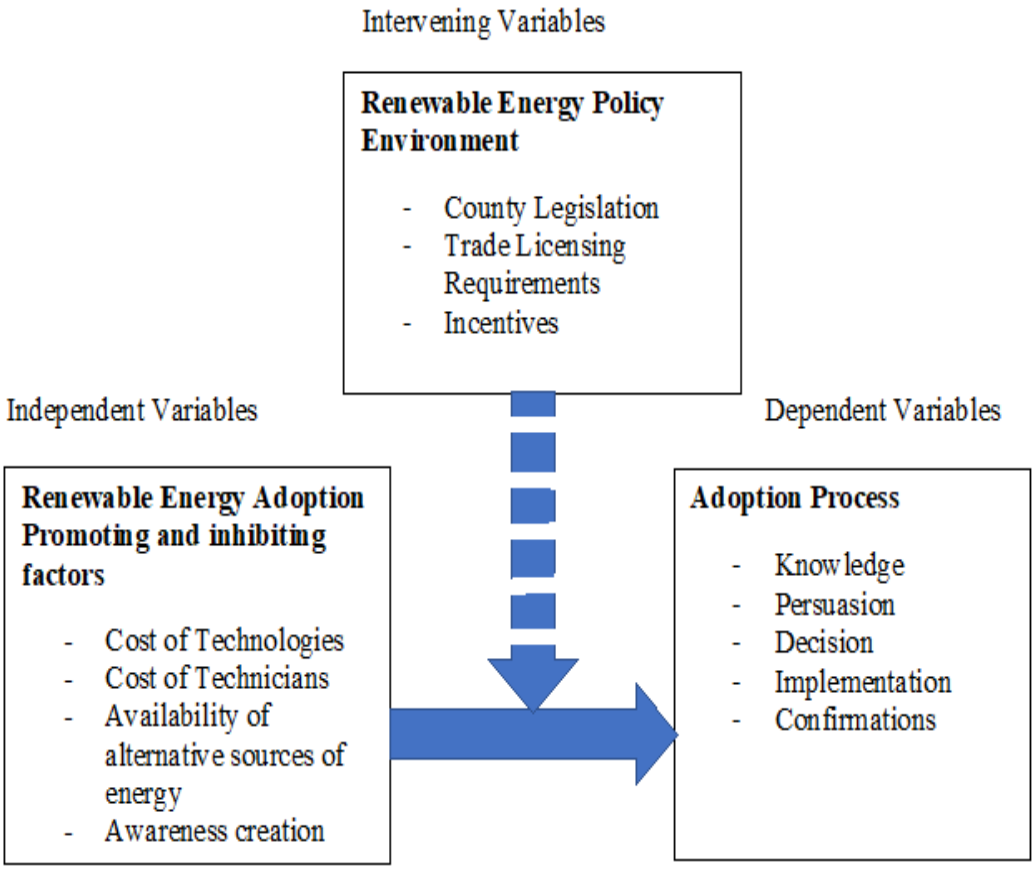


Figure 2.1: Conceptual Framework

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter discussed the research methodology applied in the study. The chapter presents the research design, target population, sample size determination, sampling methods, data collection procedure and data analysis.

3.2 Target Population

The target population for the study was Kisumu Central Sub- County in Kisumu city. The projected population for Kisumu county for 2017 was 1145747 persons, composed of 561351 males and 584396 females across all the age brackets (County Government of Kisumu , 2013). Based on this projection the county population has increased by 13.4% from the last population census conducted in 2009. According to Kisumu County Integrated Development Plan 2013-2017 the population projections for Kisumu town in 2017 was 491893; 248666 males and 243228 females. Kisumu Central constituency however had a population of 168892 and thus the figure adopted as the study population. The estimated population of Kisumu central from the Kisumu County Government data indicates that sixty percent of the population are poor, compared to a national average of 46% (County Government of Kisumu, 2015).

3.3 Sample Size Determination

Kisumu County is made up of nine constituencies (also called sub-county units) The County is further subdivided into 35 electoral wards as shown in Table 3.1.

Table 3.1: Constituency delimitations in Kisumu County

Constituency	No of Wards	Wards
Kisumu East	5	Kajulu, Kolwa East, Manyatta 'B', Nyalenda 'A', Kolwa Central
Kisumu West	5	South West Kisumu, Central Kisumu, Kisumu North, West Kisumu, North West Kisumu
Kisumu Central	6	Railways, Migosi, Shaurimoyo Kaloleni, Market Milimani, Kondele, Nyalenda B
Seme	4	West Seme, Central Seme, East Seme, North Seme
Nyando	5	East Kano/Waidhi, Awasi/Onjiko, Ahero, Kabonyo/Kanyag Wal, Kobura
Muhoroni	5	Miwani, Ombeyi, Masogo/Nyag'oma, Chemelil/ Muhoroni/Koru
Nyakach	5	South East Nyakach, West Nyakach, North Nyakach, Central Nyakach, South West Nyakach

Source: The County Government of Kisumu, 2018

Kisumu Central sub county was chosen among the nine sub counties since it's the most urbanized part of Kisumu as other section of the city straddle in Kisumu east and Kisumu west yet they are equally made up of rural areas. Additionally, Kisumu Central is socioeconomically homogenous and located at the heart of Kisumu County making it fit the criteria for purposes of the study and samples drawn were concluded to represent patterns in of the whole city.

In addition, Kisumu central sub county has the highest population density in the county at 5162 persons per square kilometer, and the smallest area with a total land area of 32.7 square kilometers (County Government of Kisumu , 2013). In addition, it is located at the heart of Kisumu County, making it the most urbanized section of the county, hence conclusions on urban households can be drawn.

The following sample size calculation formula proposed by Fisher *et al.* (1998) was used to determine the ideal sample size

$$n = \frac{z^2 pq}{d^2}$$

Where:

N is the desired sample size

Z is the normal standard deviation, set at 1.96 which corresponds to 95% confidence level

P is the proportion estimated to have characteristics being measured. The characteristic of interest which is recommended by Fisher *et al* (1998) is 50% (the study adopted 0.50)

Q =1- p

d is the level of statistical significance set and the degree of accuracy which is usually 5%

$$n = \frac{(1.96)^2 * 0.5 * (1 - 0.5)}{(0.05)^2} = 384.16$$

The actual sample size was 331 in view of resources and logistical limitations

3.4 Sampling Method

The study used a simple random sample. The survey was conducted across all the wards that make up Kisumu central sub county with respondents being selected at household level. Each ward was allocated a proportionate number of questionnaires as shown in the table 3.2 Since some wards equally make up a location while some have two locations, the type of dwelling was used to further segment the ward and come with a more representative sample. From observation, most of the households are either homes, apartments or slum dwelling. The study apportioned data to be distributed proportionately depending on the characteristics of dwellings in every ward. For

example, Nyalenda B is solely a slum dwelling thus all the interviewers targeted all households randomly. In Kondele where a sample of 109 was obtained, the area was segmented into three and three interviewers administered the structured questionnaire on the Open Data Kit (ODK) leveraged on android phones, proportionately to slums, home owners and apartment dwellers respectively.

The study anticipated 384 questionnaires from the household. The study employed 6 interviewers 4 days and the expected return rate was to be 96 questionnaires filled per day. This translated to an individual interviewer managing to fill in 16 questionnaires per day. With 8 hours of work from 8.30am- 5.30 pm daily, it was expected that each questionnaire filling rate was 30minutes. However, a return rate of 86% was attained with 331 fully filled questionnaires translating to around 83 questionnaires filled per day. Interviewers working at 6 hours a day were able to fill 14 questionnaires each per day at filling rate of around 26 minutes per questionnaire.

Table 3.2: Sample size determination for Study

KISUMU CENTRAL SUB COUNTY STATISTICS			
County Assembly Ward	**Population**	**Percentage Weight (%)**	**Sample Size**
Railways	34924	20.68	79
Migosi	19826	11.74	45
Shauri Moyo/ Kaloleni	14806	8.77	34
Market Milimani	18902	11.19	43
Nyalenda B	32430	19.2	74
Kondele	48004	28.42	109
Total	**168892**	**100**	**384**

Source: The County Government of Kisumu and Author 2018

3.5 Data Collection Procedures

The data was collected using a structured questionnaire. Since the variables to be studied had already been identified and most of their motivations understood from previous research. The questionnaire was divided into four sections. The first section captured background information of the respondents. The second section enquired on renewable energy policy environment in Kisumu, the third section enquired on adoption promoting factors for renewables among households while the last section enquired on inhibitors to adoption of renewables among households as per appendix 1

For the key informant interview, an interview guide was used to gather information regarding the policy environment in the city and factors influencing adoption of renewable energy technologies by residents in the city. Secondary data was also used in the study by reviewing the county laws and regulations relating to energy

3.6 Data Analysis

The data collected was analyzed using SPSS to locate patterns in the responses. This included measures of central tendency and correlation analysis. For the Key Informant interviews and for secondary data collected from county sources, content analysis was used to find out the policy implications on renewable energy adoption.

3.8 Ethical Issues

Confidentiality: The participants were guaranteed that the information they give will remain confidential for purposes of the study only

Permission: The researcher sought permission for purposes of conducting the study first from The National Commission for Science, Technology and Innovation for ethical permit as well as Kisumu County Education offices and the County Department of Green Energy

Informed consent: The prospective research participants were fully informed about the procedures involved in the research and their consent to participate before inclusion into the study.

Anonymity: The participants retained anonymity throughout the study and even to the researchers themselves to guarantee privacy.

CHAPTER FOUR: RESULTS, DATA ANALYSIS, PRESENTATION AND DISCUSSSION

4.1 Introduction

This chapter focuses on the results, data analysis and discussions. The study was keen to investigate factors affecting adoption of renewable energy among the households in the urban Kisumu central and the sections covered include demographic information, the policy regime for adoption of the renewable energy process, the policy interventions and lastly the promoters and inhibitors of renewable energy adoption

4.2 Questionnaire Return Rate

The study realized 86 percent questionnaire return rate, being 331 out of the expected 384. According to Mugenda (2010), a response rate of 60% is good and 70% very good for analysis of surveys. This was enough to enable the study to derive findings and conclusion based on the objectives and research questions.

4.2 Demographic information

The study established the demographic information of the respondents which included; gender, age distribution, marital status, household dependents and lastly education level. The results of the findings are presented in figure 4.1.

4.2.1 Gender

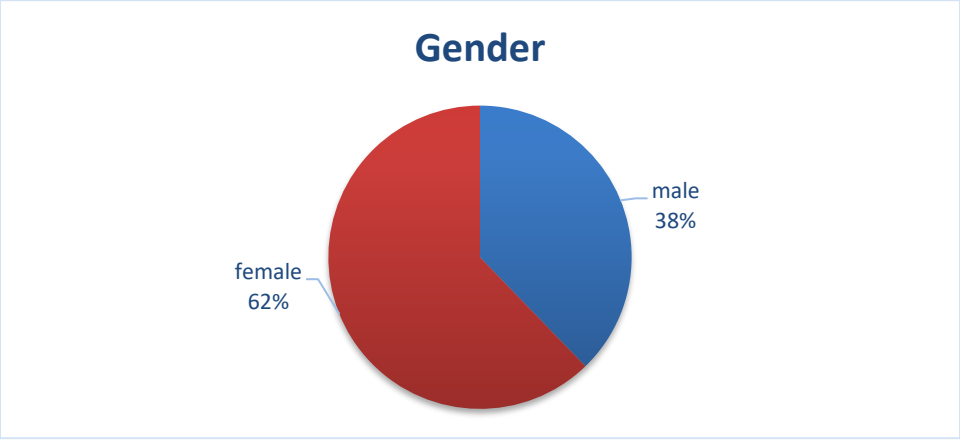


Figure 4.1: Gender distribution of respondents

From the results above majority of the respondents were of female gender accounting for 62 percent of the total sample population. 38 percent of the remaining sample were male respondents. These figures deviate from the population parity between males and females as given by the county government and the KNBS for the study area. The high number of the female respondent can be attributed to the fact that at the time of the study females are the one who were in charge of the households. Consequently, the numbers can an indication of rise in female headed households according to national household surveys conducted in most urban areas by the Kenya National Bureau of Statistics

4.2.2 Age

The study found the age distribution of the respondents and presented the results in Figure 4.2 below.

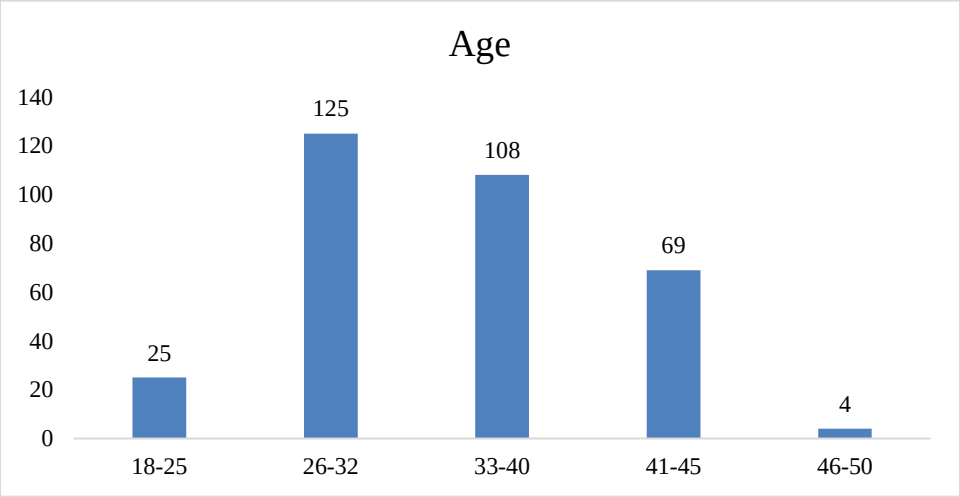


Figure 4.2: Age distribution of respondents

The results above show that 125 of the respondents were of the age between 26-32 years, this account for 37 percent of the total sample in the study. The second group with high number of respondents were of the age group of 33-40 having 108 respondents which account for 32 percent of the total valid sample. Respondents within the age group of 46-50 had the least representation of 4 respondents which represent 1 percent. The second least group were respondents between 18-25 years with 25 respondents only. From the findings, majority of those below 25 years are either

at school or involved in work out of the household thus underrepresented in the findings. However, those between 26- 40 years are over represented corresponding to majority of women respondents as it validates the existing data on population structure for most urban areas. Those of ages between 41- 50 were cumulatively 22% meaning most are out working in employment or businesses and ages above 50 are likely to have moved to the village. The data above also validates the state of youth unemployment since a majority of those interviewed were in their prime ages of employment but were found in the household during a normal working day.

4.2.3 Marital status

The study also enquired on the marital status of the respondents and presented the findings as shown in Figure 4.3 below

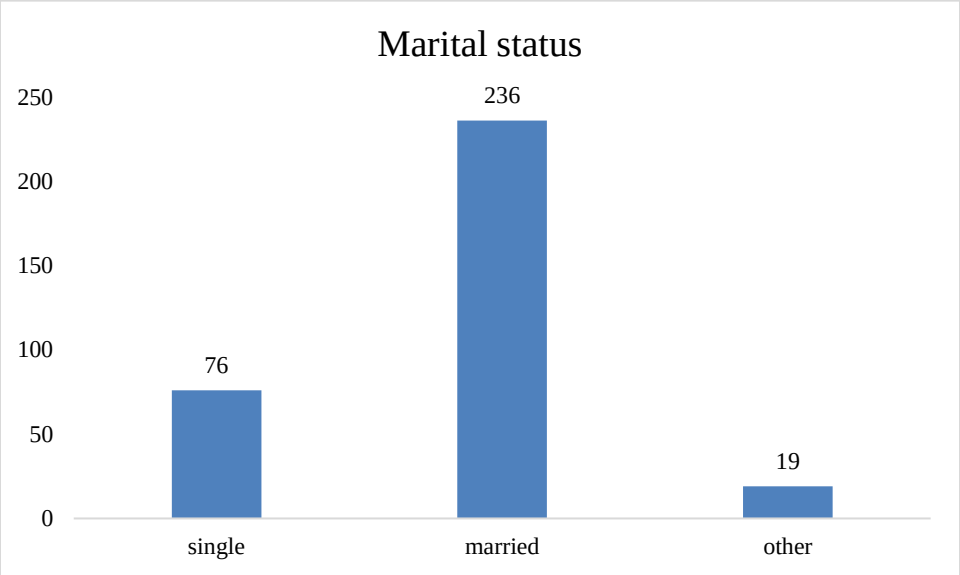


Figure 4.3: Distribution of respondents according to marital status

The study established that most of the respondents were married. This was noted in a total of 236 respondents, with 76 noting that they were single while 19 were either divorced, separated or widowed.

4.2.4 Household dependents

The study probed the number of dependents within each of the households visited and the results of this enquiry are presented in figure 4.4 below.

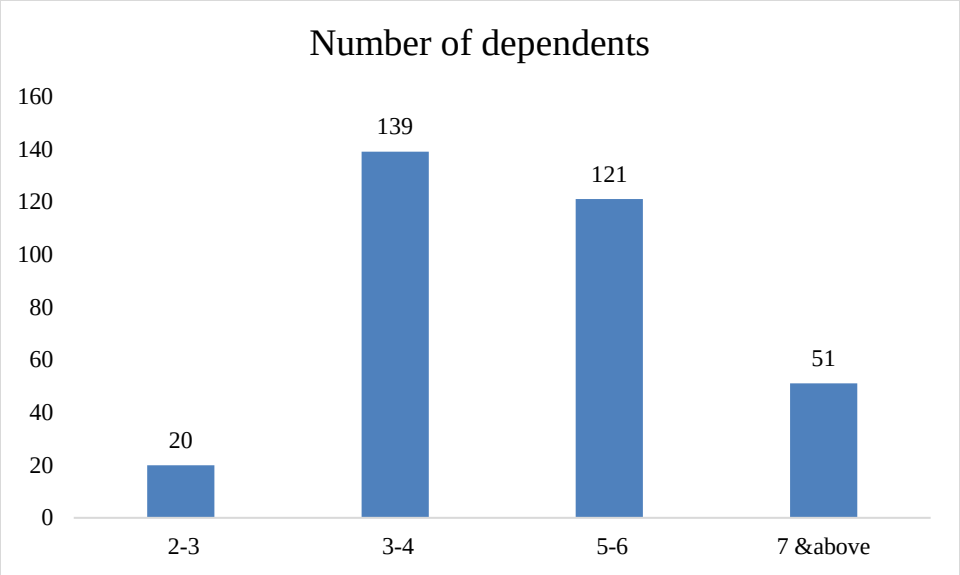


Figure 4.4: Number of dependents in the household

The study found out that most of the households had between 3and 4 dependents. This was noted among 139 respondents. Households with between 5 and 6 dependents were 121, those with between2 and 3 dependents were 20 while those with 7 or more dependents were 51. The study observed that in general, the number of dependents ranged between 3 and 6 dependents.

4.2.5 Education level

The study inquired the level of education of respondents in the study as it was thought that education influences choice of energy sources. The results of this enquiry are presented in figure 4.5 below.

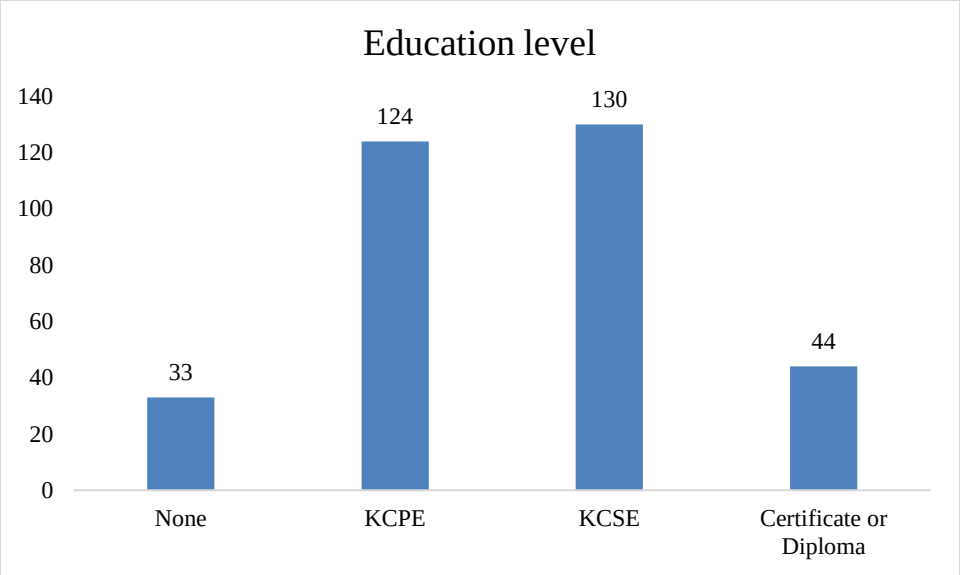


Figure 4.5: Highest education level of respondents

The study established that most of the respondents had achieved secondary level of education. This was realized among 130 respondents. Those who had no formal education were 33, those with primary level of education were 124 while those who had attained diplomas and certificates above secondary level were 44. Generally, across the study sample, the study noted that respondents had achieved a considerable level of knowledge and literacy despite cases of those who had no formal education. This conforms with previous Kenya national Bureau of Statistics report (2013) indicating that more than 45% of Kisumu central residents had secondary education and above, with a paltry 12.2% having no formal education. It can thus be concluded the lower number of non-educated respondents 33 with no formal education is a characteristic of urban areas where majority of the educated seek employment opportunities to improve their economic well-being.

4.3 Adoption Process

The study aimed at finding out whether respondents had adopted certain forms of energy in their households. This helped the researcher get a clear picture of the extent to which respondents had adopted different energy forms.

4.3.1 Knowledge on the use of different forms of energy

The study enquired from the respondents whether they had knowledge on different forms of energy and their responses were recorded in figure 4.6 below.

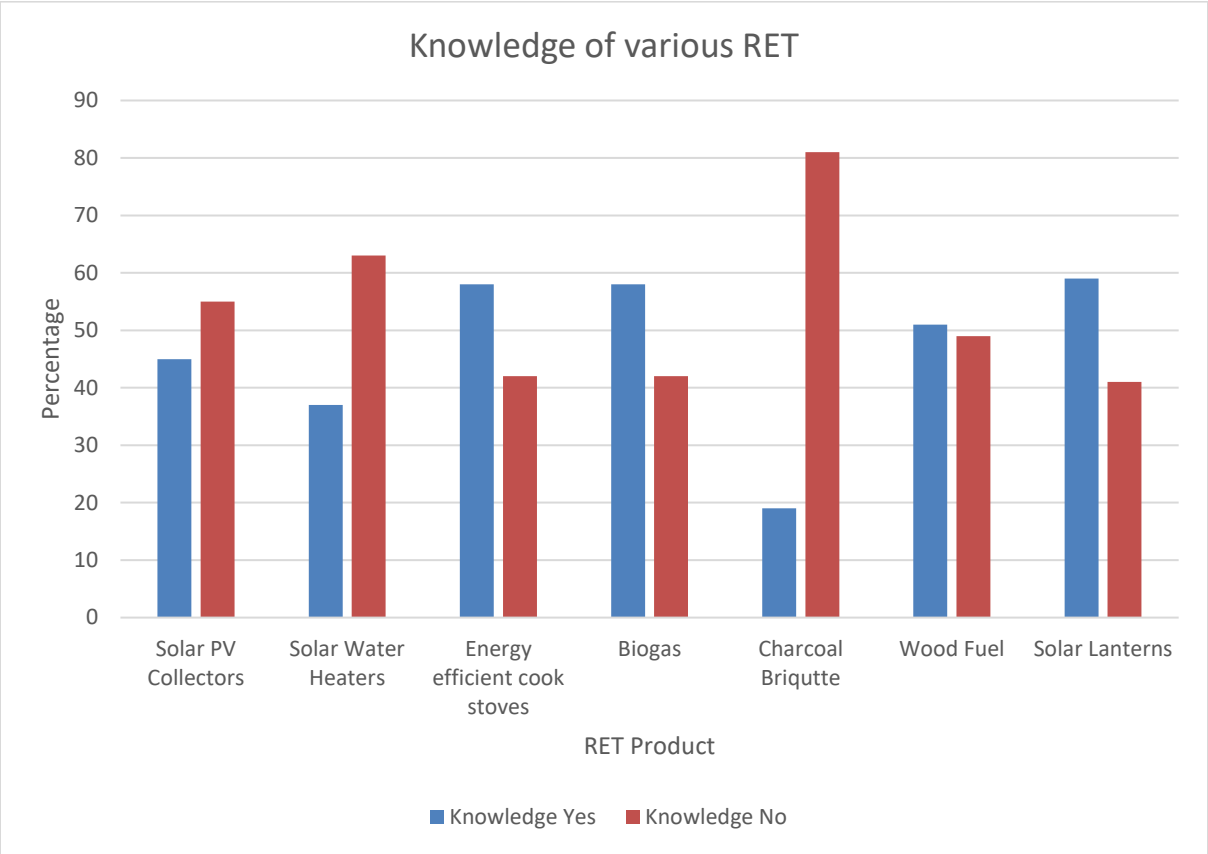


Figure 4.6: Knowledge of different energy products

From the data collected, the study established that a total of 45% of respondents had knowledge about solar PV collectors for electricity generation while 55% did not. Those who had knowledge about solar water heaters were 37% with 63% not knowing about solar water heaters. 58% had knowledge about energy efficient cooking stoves and biogas compared with 42% who lacked such knowledge. Those who had knowledge about charcoal briquettes were 21% against 79% who lacked knowledge about charcoal briquettes. There was almost parity for those who knew wood fuel at those who did not, at 51% and 49% respectively. Those who knew about solar lanterns were

59% compared with 41% having no knowledge about lanterns. The study therefore established that most of the respondents had knowledge about solar lanterns than any other products listed for them while the least number of respondents had knowledge about charcoal briquettes (Figure 4.6).

Pictures (a) showing use of energy saving cook stove and (b) drying of charcoal briquettes

Source: Field Visits

Most households had knowledge of solar lanterns owing to their versatility of being portable, easily re- chargeable due to enough irradiation in the area and less costly compared to installing a solar PV for lighting. The lanterns could be easily used as alternative in-case of power outage which occasion most of the grid connected households. Most of them equally indicated they knew of the lantern through their friends and visits in rural areas where a number of products are sold through awareness programmes for rural lighting. This conforms to the conclusion of a similar study by Adhola (2014) which concluded that awareness of products and willingness to adopt are factors influenced by friends, relatives or the environment.

The study equally established biogas and energy cooking stoves as pretty well-known renewables to the respondents. This can be attributed to a number of efforts by the county government to install biogas digestors for institutions within the county, as well as efforts of energy related NGOs to install small biogas systems as a means of cooking in slums settlements within the city.

Only about 21% of the respondents indicated they know about charcoal briquettes, implying the rate of awareness of the energy option for cooking is still minimal. This compares unfavorably with 51% who have knowledge of firewood. It is imperative that sensitization needs to be made for more households, especially low- incomed ones to know about charcoal briquettes, a convenient and least costly option for cooking.

4.3.2 Having serious thoughts of buying certain energy products

The study further sought to establish whether the respondents had seriously thought of buying any of the energy products they had known and presented the results in figure 4.7 below.

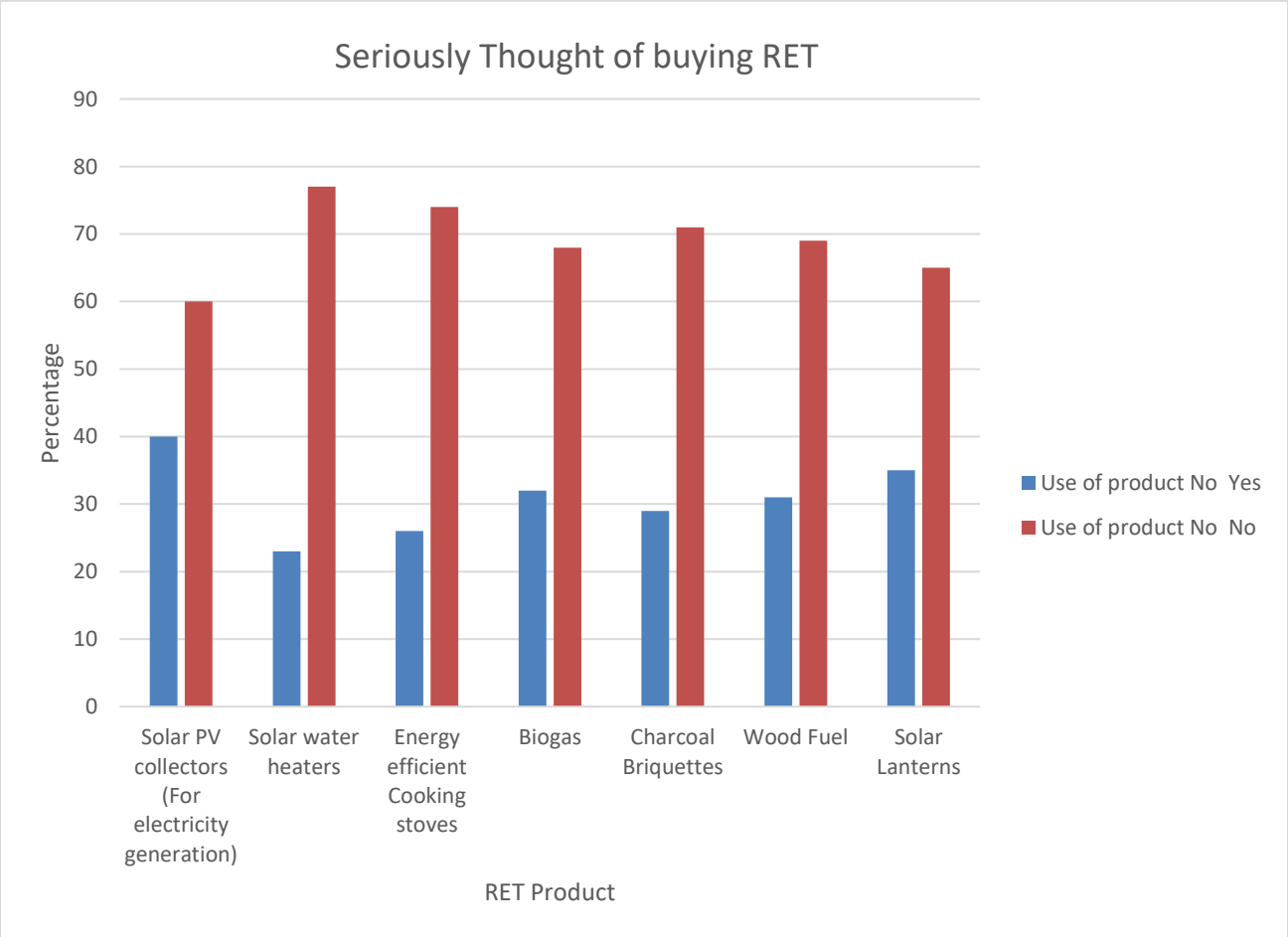


Figure 4.7: Respondents having serious thoughts of buying certain energy products

From the data collected, the study established that 40% of respondents had serious thoughts of buying solar PV collectors for electricity generation while 60% did not. 23% had serious thoughts of buying solar water heaters against 77% who did not. 26% of respondents had serious thoughts of buying energy efficient cooking stoves compared to 74% having no such thoughts. Those who had serious thoughts of buying biogas were 32% with 68% having no serious thoughts of buying biogas. 29% of respondents had serious thoughts of buying charcoal briquettes against 71% who had no serious thoughts of buying charcoal briquettes. Those who had serious thoughts of buying wood fuel were 31% while those who did not have such thoughts were 69%. Those who had serious thoughts of buying solar lanterns were 35% with 65% having no serious thoughts of buying lanterns.

The study therefore observed that most of the respondents had serious thoughts of buying solar PV collectors for electricity generation with solar water heaters being the least thought of energy product. (Figure 4.7). This was despite most of the respondents having knowledge of other renewable energy products as compared to solar PV collectors.

It can be argued that the solar market in Kisumu alike the whole of Kenya is stable, and more households prefer PV for electricity generation for for lighting, as well as infotainment, informed by the need to use electrical appliances like televisions, radios and even charge their mobile phones over other energy products. The solar market equally has a number of vendors offering affordable payment options e.g. “pay as you go schemes,” – (PAYG), whereby clients of solar products are expected to buy product on hire purchase like schemes and make payments in flexible installments from a little as less than $1 a day. Companies like Safaricom M- KOPA and Mobisol offer such customer friendly schemes. Additionally, apart from acquiring the solar panel, households can own digital television, radio, and re- chargeable torch all being powered by the solar panel procured under such business models.

Solar PV water heating was the least thought out technology for households as it is expensive to install them. Since most respondents indicated lack of ownership of their buildings, they would not install the technologies unless their landlords do so. The cost of technicians is equally high since installation costs are higher than that of other technologies. Kisumu city being close to Lake

Victoria experiences warm to high temperatures in the day and nights throughout the year, with an average annual temperature of 23.6^{o}C (KMD data, 2017), thus most residents preferred not to take a bathe with warm water.

4.3.3 Having decided to buy certain energy products

The study sought to find out whether the respondents had made the decision to buy any of the energy products listed following their serious thoughts of buying these products. The results are presented in figure 4.8 below.

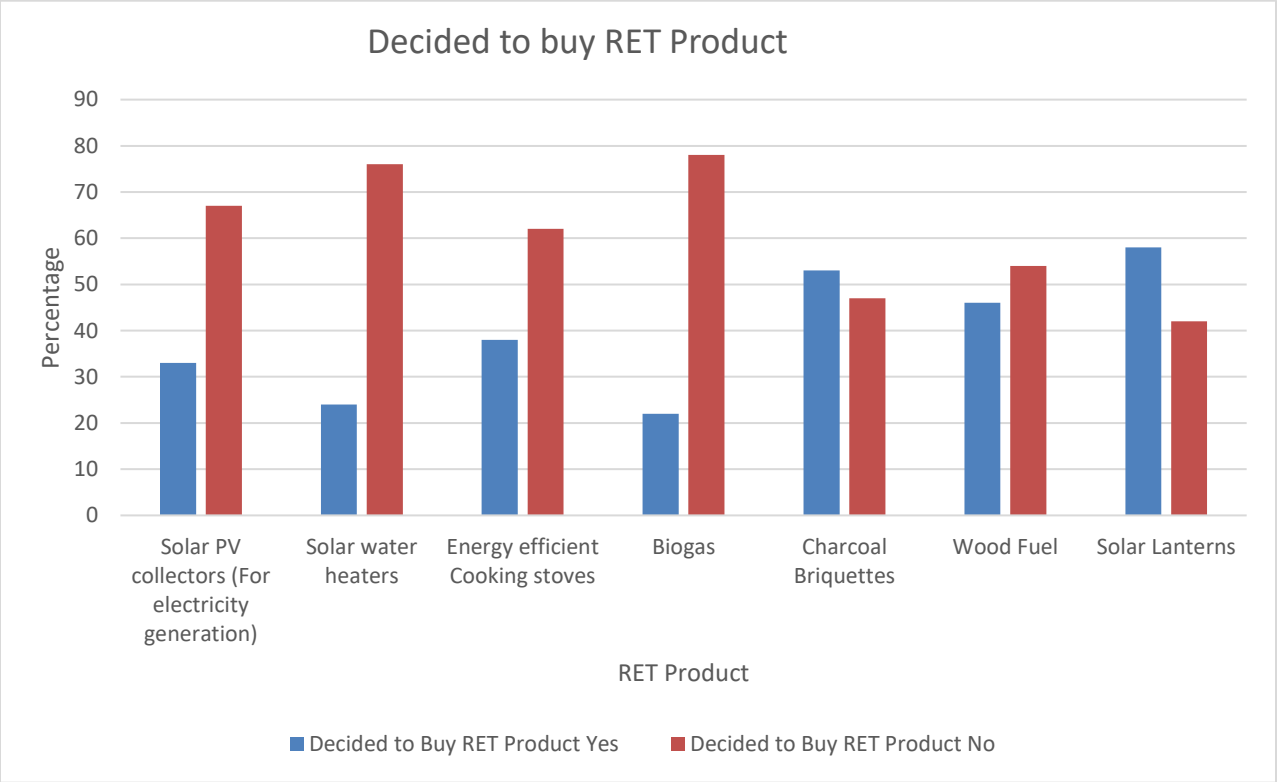


Figure 4.8: Respondents having decided to buy certain energy products

From the data analyzed, the study established that 33% of respondents had decided to buy solar PV collectors for electricity generation while 67% did not. 24% decided to buy solar water heaters compared to 76% who decided not to. 38 of respondents had decided to buy energy efficient cooking stoves, with 62% having not made such decisions. Those who had decided to buy biogas were 22% while 78% having not made such decisions on biogas. Those who had decided to buy

charcoal briquettes were 53% while 47% had not decided to buy charcoal briquettes. Those who had decided to buy wood fuel were 46% while those with a contrary opinion were 54%. Those who decided to buy solar lanterns were 58% with 42% having not decided to buy solar lanterns. The study therefore observed that decisions to buy solar lanterns were made among most of the respondents corresponding to a higher number bearing knowledge on product as well as serious thoughts of buying the product. Likewise, Biogas was the product least preferred to be bought owing to technicalities of installation and cost of installation and resource availability of feedstock for digestor.

4.3.4 Having installed certain energy products

The study also sought to establish whether respondents had actually installed any of the listed energy products and presented the results in figure 4.9 below.

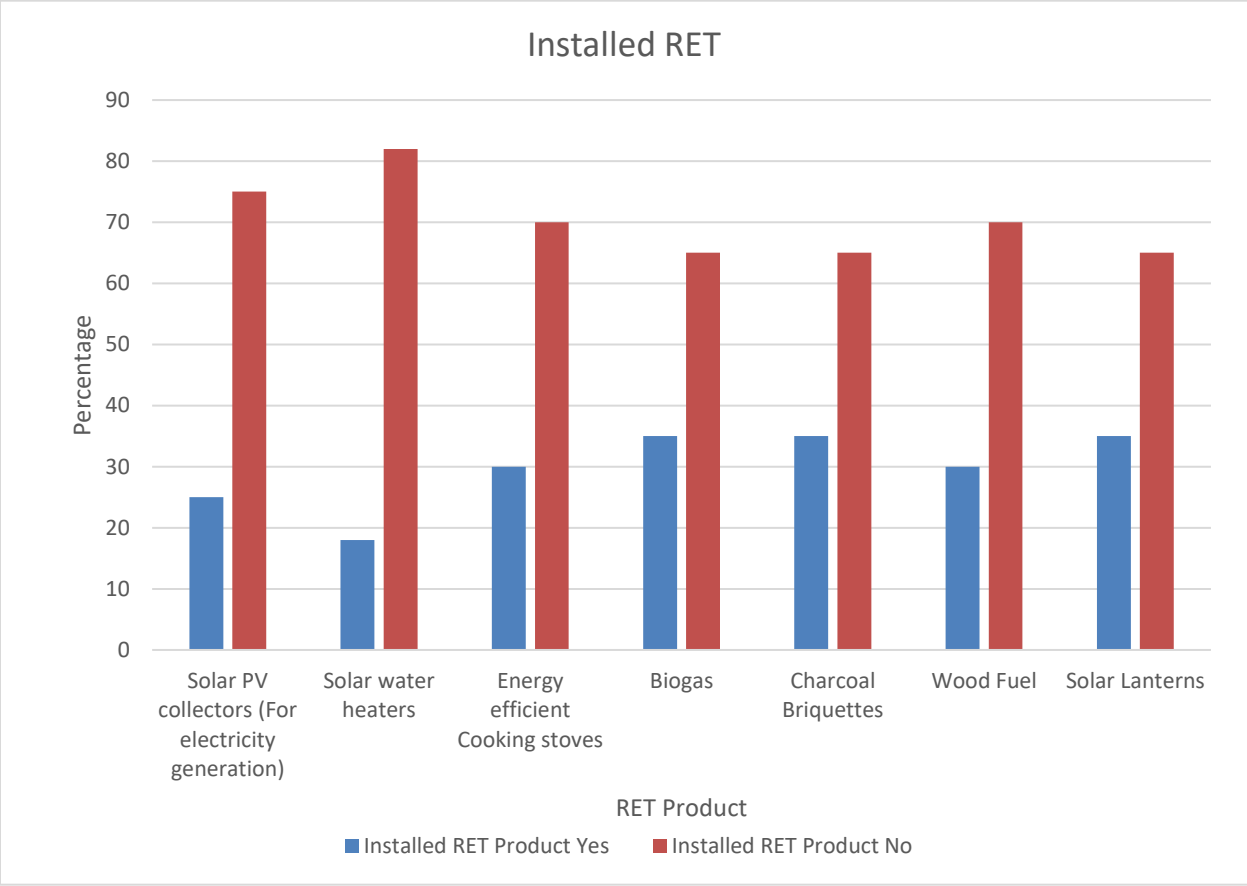
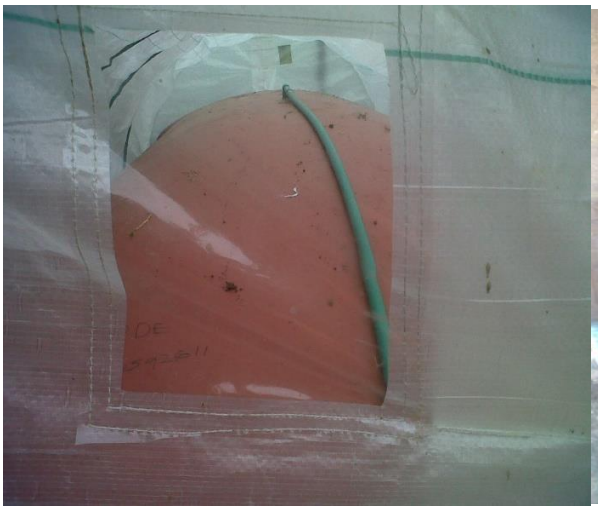


Figure 4.9: Respondents with installed energy product

From the data collected, the study established that a total of 25% of respondents had installed solar PV collectors for electricity generation while 75% had not. Those who had installed solar water heaters were 18% with 82% not having installed solar water heaters. A total of 30% respondents had installed energy efficient cooking stoves, with 70% having not installed such stoves. Those who had installed biogas were 35% with 65% having not installed biogas. Those who had installed charcoal briquettes were 35% while 65% had not installed charcoal briquettes. Those who had installed wood fuel were 30% while those who did not were 70%. Those who installed solar lanterns were 35% with 65% having not installed solar lanterns.

The study therefore noted that across the study sample, most of the respondents had installed energy cookstoves and charcoal briquettes for cooking with the least number of respondents having installed solar water heaters. Interviews conducted with representatives of CGK green energy department informed the study that the movement green champion provided knowledge and expertise in the adoption and use of the renewable energy products

Picture c and d showing components of a small-scale biogas system and burner



Picture e and f: Open fire place using firewood and polyethene biogas digestor

Source: Field Visits

The results of the study show that across the study sample, most of the respondents had installed energy and charcoal briquettes with the least number of respondents having installed solar water heaters (Figure 4.9). There seems to be parity in the number of households having installed or utilizing firewood, charcoal or briquettes with energy cooking stoves. This can partly explain the concept of fuel stacking characterizing most urban households; them installing various alternatives but use them sparingly depending on occasion or kind of meal cooked. This could have been motivated by the fact that the two energy products (biogas and charcoal briquettes) could be easily made as raw materials were readily available and affordable. Access to these options is one such factor. Some areas may have more wood fuel compared to others, while others may have more sunshine compared to others. In this regard, it is important to consider the effect of the locality on the fuel choice (Maina & Rotich, 2016).

A more comprehensive study for the study area involving 43062 households done by KNBS determined that for cooking 1.8% used electricity, 18.1 paraffin, 10.9% LPG, 2.6 biogas, 4.0% firewood, 61.7% charcoal, 0.0 solar cookers whole other options 0.8% (Kenya National Bureau of Statistics, 2013). These figures deviate substantially with those of the study as they include more alternatives which are not renewable in nature. The sample size was equally big, thus a more comprehensive findings were drawn.

4.4 Policy intervention

Policies regarding any subject matter are very important in influencing the success of any discipline. The study sought to investigate the policy interventions that come in to play with regard to adoption of renewable energy. The researcher made us of a Likert scale to obtain respondents' rating of various statements regarding policy interventions in the renewable energy adoption process. The results of this enquiry are presented in table 4.1 below.

Table 4.1: Policy interventions in the renewable energy adoption process

Statement	SA	A	N	D	SD
The Kisumu County Government is involved in helping me understand how to acquire and use	1.5%	16%	21.5%	40.5%	20.5%
The Kisumu County Government works hard to persuade me to use renewable energy	2.4%	20.5%	15.4%	47.1%	14.5%
I feel supported by the CGK when deciding to use Renewable energy	1.5%	16%	21.5%	40.5%	20.5%
The CGK supports residents to install renewable energy systems	0.3%	25.7%	22.1%	39.6%	12.4%
The CGK receives my evaluation of how the renewable energy systems we have adopted are	0%	24.5%	21.5%	40.8%	13.3%

Where SA=strongly agree, A= agree, N=neutral, D=disagree, SD=strongly disagree

The study established that a cumulative 17.5% of the respondents were in agreement that the Kisumu County Government was involved in helping them understand how to acquire and use renewable energy with 21.5% being neutral and a cumulative 61% being in disagreement. A cumulative 22.9% of the respondents were in agreement that the Kisumu County Government works hard to persuade them to use renewable energy with 15.4% expressing neutral opinion while a cumulative 61.6% being in disagreement. A cumulative 17.5% of the respondents were in agreement that they feel supported by the CGK when deciding to use renewable energy with 21.5% being neutral while a cumulative 61% disagreeing. A cumulative 26% of the respondents were in agreement that the CGK supports residents to install renewable energy systems with 22.1% being neutral and a cumulative 52% disagreeing. Finally, a cumulative 24.5% of the respondents were

in agreement that the CGK receives their evaluation of how the renewable energy systems they have adopted are performing with 21.5% remaining neutral while 54.1% disagreed.

The study therefore noted that with regard to the county government of Kisumu forging and fostering policies that were user friendly to the people, renewable energy policies that promoted adoption of renewable energy among the residents were weak and not implemented. This can be seen from the responses as put forward by the study participants, citing a gap in policy interventions and policy implementation.

The study therefore noted that with regard to the county government of Kisumu forging and fostering policies that were user friendly to the people, renewable energy policies that promoted adoption of renewable energy among the residents were weak and not implemented (Table 4.5). This was despite the existence of efforts to support county governments to develop county specific policies termed, Sub national energy policies (Valladares, 2016). These efforts were thought to supplement various policies at the national level aiming to increase access to energy across the county. As noted by de Heer (2017) lack of resources and knowledge by municipal authorities in regards to the development of adequate renewable energy policies is not a problem unique to developing countries but can also be seen at play in Dutch Municipalities.

It is well understood that advocacy has an impact on policy development and as such policy advocacy groups can help shape policy so that there is good adoption of renewables by households. Legislators and other policy development personnel at the municipal level are not necessarily renewable energy experts and hence they can benefit from the work of policy advocacy groups.

4.5 Promoters and Inhibitors of Renewable energy Adoption

Table 4.2: Promoters and inhibitors of renewable energy adoption

Statement	SA	A	N	D	SD
Traders in Renewable energy products in Kisumu have tried to sell	0%	20.8%	15.7%	44.1%	19.3%
Non-Governmental Organizations and Community Based Organizations in Kisumu have educated me on	0%	25.7%	16%	39.9%	18.4%
I feel that renewable energy products are expensive	0%	28.4%	26.6%	35.3%	9.7%
I cannot afford renewable energy products that my family can use that are marketed in Kisumu	2.4%	27.2%	18.7%	38.7%	13%
It is difficult to get technician who can install and repair renewable energy products	0.9%	26.6%	35.3%	31.7%	5.4%
The technician in Kisumu who deal with renewable energy products are not very good at their job	3.9%	22.7%	28.4%	31.1%	13.9%

Where SA=strongly agree, A= agree, N=neutral, D=disagree, SD=strongly disagree

The study established that a cumulative 20.8% of the respondents were in agreement that traders in renewable energy products in Kisumu have tried to sell with 15.7% being neutral and a cumulative 63.4% disagreeing. This meant that renewable energy products were not being availed or sold to consumers within the region and thus, creating a gap. A cumulative 25.7% of the respondents were in agreement that Non-Governmental Organizations and Community Based Organizations in Kisumu had educated them on the benefits of renewable energy products with 16% being neutral and a cumulative 58.3% disagreeing. This meant that there was lack of public education and awareness concerning renewable energy in general. A cumulative 28.4% of the respondents were in agreement that they felt that renewable energy products are expensive with 26.6% being neutral and a cumulative 45% of the respondents disagreeing. This meant that renewable energy products were affordable to majority of the respondents.

A cumulative 29.6% of the respondents were in agreement that they cannot afford renewable energy products that their family can use that are marketed in Kisumu with 18.7% being neutral while a cumulative 51.7% disagreeing. This point corroborates earlier findings which noted that renewable energy products were affordable to most of the respondents. A cumulative 27.5% of the respondents were in agreement that it was difficult to get technicians who can install and repair renewable energy products with 35.3% being neutral while a cumulative 37.1% disagreeing. A

cumulative 26.6% of the respondents were in agreement that the technicians in Kisumu who deal with renewable energy products were not very good at their job with 28.4% being neutral and a cumulative 45% disagreeing.

The study noted that there were several barriers that limited the adoption of renewable energy at the household level. This included lack of traders who sold renewable energy products as well as limited knowledge and awareness on renewable energy as a result of lack of sensitization by NGO sand CBOs in the region. It can also be said that availability of traders dealing in renewable technology like solar within the city and a host of like-minded NGOs concentrate their activities in promoting adoption among rural households where the impact of renewables is likely to be positively felt than urban households where a majority have access to most modern energy services, and renewables only promoted as an option to reducing cost on energy for cooking and lighting. However, the study noted that affordability, availability and expertise of persons who could repair renewable energy products were some of the factors that motivated the adoption of renewable energy products. The county government has played a huge role in ensuring the adoption of renewable energy products by passing a bill that allow the use of the products. Interviews from the green energy department reiterated this by affirming that

County government of recently proposed a program for promoting use of ethanol stoves in the domestic households, with more focus on low income households. The department official also informed he study that a bill to incentivize manufacture and use of briquette charcoal for industrial applications use was in place. Such moves by the county government goes a long way to ensure the adoption and use of renewable energy products.

Several barriers limited the adoption of renewable energy. These include lack of traders who sold renewable energy products as well as limited knowledge and awareness on renewable energy as a result of lack of sensitization by NGO sand CBOs in the region. However, the study noted that affordability and availability and expertise of persons who could repair renewable energy products were some of the factors that motivated the adoption of renewable energy products.

As noted by Olatorugen (2007) in Kenya, energy prices are high and prohibitive to many households thus if the energy transition is not well managed, increasing taxes on carbon shall have a regressive impact on household further limiting access to only the affluent households. The

findings of this study are in line with those of Maina & Rotich (2016) who noted that the cost of renewable energy is a huge factor affecting adoption.

4.6 Assessment of National and Kisumu City Policy Environment

The national policy and regulations form most of the county reference with regards to renewable energy. The county government has earmarked specific projects that entrench adoption of renewables at the household.

a) The Constitution of Kenya 2010

The national constitution promulgated in 2010 sets the basis for a legal and regulatory framework that promotes management of natural resources, equitable sharing and accrual of benefits, encourages public participation in the management of resources (Osiemo, 2012). The constitution confers to every person the right to have' the environment protected for the benefit of present and future generations through legislative and other measures and to have obligations relating to the environment fulfilled and the right to seek redress in a court of law' (Constitution of Kenya, 2010). It is in the opinion of the researcher that such constitutional provision bequeaths citizens and both tiers of the national and county governments responsibilities to ensure that energy resources are developed in a manner that confers to the provisions. This anchors the need to develop renewables for electrical supply and harnessing of other forms of energy for environmental sustainability.

b) The Energy Act 2006

This legislative provision empowers the cabinet secretary for energy to develop and prudently manage energy conservation programs including research and development in the sector, development of training materials for promotion of energy conservation measures, incentivize projects that promote efficiency and allow for importation of cost effective but efficient technologies (Kiplagat et.al 2011). This Act is further strengthened by the consumer Act which requires consumers be accorded right to information on purchases they make.

The study establishes that these laws promote knowledge and awareness in the domains of adoption for renewable energy technologies. Households have been accorded sole rights to information on quality of technologies they procure for purposes of installing efficient devices for use.

c) National Energy Policy

The national policies on energy overemphasizes the need to encourage additional generation of energy to realize the country development goals by subsidizing of major supply projects at the expense of promoting energy conservation measures that can leverage use of renewable technologies.

d) Renewable Feed in Tariff

The policy does not take into account small producers of power, households who are able to produce more electricity through various renewable technologies such as rooftop solar and sell excess to the grid. Most projects covered under the policy are above 0.5 MW thus locking out most households from the REFiT schemes, as it provides for grid tied technologies (Boampong & Phillips, 2016).

e) Solar Hot Water Heating Regulations of 2012

Implementation of this set of regulations has been hampered by extensions of the deadline for compliance (Energy Regulatory Commission, 2017). This is attributed to lack of enough capacity building on provisions of the regulations as well as capacity of the ERC to monitor compliance owing to funding deficits. From the study findings, only 18% of respondent confirmed they have installed solar hot water heating systems for their use. This figure is small considering Kisumu central is the most urbanized section of Kisumu city, having some of the most affluent neighborhoods where education and awareness is high. The study, therefore assess the regulations as having been poorly implemented and if so then the ERC have prioritized compliance of premises consuming greater hot water for example institutions and hotels than households which was the focus of the study.

f) Energy Bill 2017

The bill is the revised form of the energy bill 2015 that was denied presidential assent due to clauses the executive felt was punitive to state utility companies. The bill seeks among other things to liberalize the power sector by licensing other power distributors to compete Kenya Power thereby reducing its monopoly and form a comprehensive piece of legislation that guides activities in the energy sector, unlike the currently used sectorial policies and regulations (GoK, 2017). This legislation which is supported by most consumers under the auspices of the Confederation of

Kenya Consumers- (Cofek), is facing stiff opposition from state agencies which argue that such conditions can only work after Kenya power has finished their contractual agreements with other entities.

The bill proposes to empower county governments into developing local specific energy conservation building codes and a consolidated fund to cater for volatility in oil and electricity prices thereby protecting consumers.

On assessment of this bill, the study concludes that it is likely to involve household participation in energy citizenry, since introduction of other electricity suppliers will make people involved in making choices of the kind of energy source they would want to use based on price and reliability. Renewable energy investors are likely to capitalize on this prompting competition which is key to building a more sustainable energy market devoid of government subsidies.

Secondly, the bill will accord citizens their rights and promote social equity through the consolidated energy fund especially for the urban poor who are often not beneficiaries of state subsidies targeting both the rural poor and rich by stabilization of energy prices.

Lastly, the bill empowers counties to promote use of indigenous knowledge and resources in developing sustainable buildings (GoK 2017).

The drawback of the bill is that it provides for duplication of roles between national and county governments. In efforts to develop renewable energy project proponents must obtain licenses from both the national and county governments. This may result to delays in project implementation and the bureaucracies mean additional project costs (Osiemo, 2012).

g) Institutional framework for Energy Regulation

The Energy Regulatory Commission proscribes the requirements for one to be a technician for renewable energy systems mainly in the domain of solar. This is the mandated institution offering individual licenses to practice as technicians and equally maintaining a list of those licensed to practice available in their websites for client verification before engagement. The institution maintains the list of solar hot water heater technicians, solar photovoltaics technicians thus it protects households wishing to adopt from engaging services of technicians who lack the technical knowledge to either install or repair technologies. This is in addition to the institution licensing of manufacturers, importers and vendors of solar products. It helps promote adoption by boosting

consumer confidence in that procured solar products as they are of good quality, and hence results in solar market stabilization. The institution also develops and reviews training curriculum for renewable energy technicians thus their mandate positively impacts on adoption but in some instance affect adoption due to proliferation of unlicensed technicians who lack proper skills though take a small fee from households for installation and repairs of technologies

Another institution Kenya Renewable Energy Association- KEREA, is complementing ERC efforts of increasing consumer confidence and reduce market spoilage of solar products by developing and implementing a voluntary accreditation framework for Solar PV businesses in the country (KEREA, 2018).

h) Kisumu County Policy

The Kisumu County bill on Climate Change encompasses provisions for renewable energy. The bill has been presented to the county assembly for the second review after public participation was recently concluded. Therefore, the study sought to assess national policy and regulatory frameworks upon which the policy is expected to be anchored. Currently, the county has no mechanism for incentivizing trade and development of renewables, and instead gives licenses to business operations just like any other business. However, in light to promoting adoption of renewables among households the following programmes have been initiated.

i. Street and security lighting using solar- ongoing
ii. Promotion of ethanol stoves for cooking- Pilot stages
iii. Installation of biogas systems in learning institutions- Ongoing
iv. Installation of hot water systems for hospitals, specifically Kombewa district hospital
v. Upgrading of boreholes to use solar power for pumping- Ongoing, one in Holo Market

i) Kisumu County Climate Change Policy 2018

The preamble of the draft policy document recognizes this policy as the framework that addresses current and future problems facing residents of Kisumu county with regards to climate change. The policy identifies energy as one of the important development promoting components likely to be affected by effects of climate change. It further reiterates energy efficiency and reliability as fundamental for development. It encapsulates the vulnerability of grid power in realizing access and reliability owing to drought events which have reduced energy generation from the county Sondu Miriu hydroelectric- HEP plant. It proposes adoption of renewable as a way of improving on efficiency, extending access to reliable, affordable energy the county, a more resilient option (The County Government of Kisumu, 2018).

Under the policy, the following are the intents for promoting energy access;

i. Create awareness on energy efficiency, conservation measures and management
ii. Ensure gradual introduction of renewable energy in different sectors of the economy
iii. Enforce energy conservation measures in all sectors of the economy
iv. Promote adoption of energy efficiency appliances in buildings by standardizing building codes and legislate or incentivize efforts to retrofit buildings with more efficient appliances, encourage daylighting and insulation
v. Carry out energy audits for institutions and facilities
vi. Identify and team up to implement initiatives of the national government

The study establishes that this policy does not expressly state the intents the county administration has to promote adoption for households. It states various action plans in general and doesn't mention renewable energy integration. It can be concluded that the policy environment is not articulate enough with action-oriented policy statements keen to promote adoption of renewables. However, the policy statements are backed up by strategic plans the county has as documented in the second county integrated development plan (2017-2022). The policy lacks coherence with reference to renewables, it informs issues of climate change thus very sectorial in nature.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Renewable energy offers opportunities for households to integrate provisions of sustainability and uplift their living standards. The assessment of this paper concludes that Kisumu County policy, institutional and regulatory framework for renewables is not adequate enough to encourage adoption. This chapter therefore concludes the study by proposing recommendations for policymakers at the Kisumu County Government as well as those in the fields of research; academia or project research.

5.2 Conclusions

The study concludes:

i. That households within the study region have knowledge of various renewable energy products, 58% for energy cooking stoves, had thought of buying them 40% for solar PV modules and as a matter of fact, some of the households had installed their preferred renewable energy products for use by their families 35% of those using briquettes and energy cooking stoves. This can be emphasized by the higher number of households having seriously thought of buying the various technologies for use in either lighting, cooking and complementing existing sources they currently use.
ii. That policy interventions towards adoption of renewable energy is not achieving their intended goals and objectives as envisaged, despite these policies being devolved and further, given the backing of the national government. 61% of the respondents felt that the policies were not convincing enough to promote adoption, the study noted gaps in policy implementation. The study concluded that a weak policy regime and limited awareness among various products was responsible for the slow adoption of various technologies. Inadequate funding for county awareness campaigns is also a hinderance to knowledge dissemination among residents to adopt to renewable technologies

iii. Inadequacy of traders who sell renewable energy products or components, as well as limited knowledge and awareness on renewable energy as a result of lack of sensitization by NGO sand CBOs in the region are the main limiting factors to the adoption of renewable energy. However, the study also concluded that affordability, availability and presence of renewable energy technicians are some of the factors that motivate adoption of renewable energy

5.3 Recommendations

The study recommended the following based on the findings;

5.3.1 For Policy

i. The use of a multi-disciplinary approach to create awareness and public education of not only the benefits of renewable energy but also knowledge on the choice of best-fit renewable energy product, adoption and use. This can be done through the use of NGOs, CBOs, faith-based organizations and local administration to sensitize and create awareness.
ii. The county government through its mandated responsibility of approving physical plans for buildings should implement provisions of the solar hot water heating regulations for buildings utilizing more than 100 litres of hot water per day as directed by the hot water solar heating regulations of 2012 to promote adoption of technology while lessening demand for grid power in the context of heating water thus promoting energy conservation and demand side management initiatives
iii. The county government should fast track implementation of the proposed project for promoting adoption of ethanol stoves among poor households, keen at weaning them from using paraffin and firewood. This will go a long way in increasing adoption levels since technology will be availed with re-filling centers located within settlements at affordable cost.
iv. The national government in conjunction with the county government should re-look at the existing pro-renewable energy policies with an interest on their practicability and find ways and means of implementing these policies, ways that are user-friendly and all-encompassing in terms of consultations and adequate communication. For example, the

policy on promoting biogas is only suitable for the urban setting if the feedstock is either kitchen waste and human waste but not cattle dung' common in rural areas. Thus, plans should be made for personnel to use the right kind of bacteria to ensure maximum gas yields can be obtained

v. The transition needs the development of the right institutions, policy regimes and mobilization of appropriate capital investment of which current actions often overlooks the plight of the urban poor while propagating for electrification and improving access for rural areas. It must be understood that though electricity access as a policy prerequisite is high in Kisumu City, most households have remained poor as the ultimate well-being of the people rests on their ability to consume goods and services that electricity as a carrier facilitates. Institutions should be strengthened by way of financial provision and capacity building to enable them oversee implementation of legal provisions e.g. the solar hot water heating laws
vi. Kisumu county ought to develop a comprehensive policy on renewable energy; highlighting action areas to be prioritized for purposes of increasing adoption. As it currently is the policies are fragmented on sectorial areas as evidenced by the draft climate change bill 2018
vii. Incentivize businesses dealing with renewables by reducing license fees so that cost reductions can be passed on to households who purchase products. This can be seen as a positive political will to enhance adoption.

5.3.2 Recommendations for Further Studies

i. Comparative studies of urban areas within Kisumu County as well as between urban and rural households if more time and resources are availed. Findings to inform specific targeted policies for planning and investment for renewable energy
ii. Since the study was more of descriptive in nature and limited in scope, further studies can incorporate an exploratory study designs for measurement of more variables
iii. Future studies be undertaken to gauge the successes and failures post implementation of the policies and legislation to enhance the green policy agenda within the county

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APPENDICES

Appendix I: Household Questionnaire

Dear Sir/Madam,

Please take a few minutes to answer this questionnaire for gathering information on adoption of renewable energy technologies for households within Kisumu Central Sub- county for my MA Thesis. The answer you provide will go a long way in improving the policy environment within the county for promotion of adoption factors. Feel free to make additional comments even against questions where such spacing is not provided. Answer the questions as honestly as possible. Your responses will be completely confidential.

Where choices are provided, put a tick in the appropriate box. Where there is no suitable option for your response, kindly use the 'other' option and specify. Where there are no choices provided, feel free to respond in your own words using the space provided.

Part 1: Demographic Information

1) Gender

Male ☐ Female ☐

2) Age

18-25 ☐ 26-32 ☐ 33-40 ☐ 41-45 ☐

3) Marital Status

Single ☐ Married ☐ Other _____

4) Number of Dependents

1-2 ☐ 3-4 ☐ 5-6 ☐ 7 & Above ☐

5) Occupation

Employed ☐ Self Employed ☐ Unemployed ☐ Student ☐

6) Highest level of Education attained

None ☐ KCPE ☐ KCSE ☐ Certificate or Diploma ☐ University Degree ☐

Part 2: Adoption Process

Please tick the correct answer to the following questions

7) Do you **know** how to use the following products?

a) Solar PV collectors (For electricity generation) Yes ☐ No ☐

b) Solar water heaters Yes ☐ No ☐

c) Energy efficient Cooking stoves Yes ☐ No ☐

d) Biogas Yes ☐ No ☐

e) Charcoal Briquettes Yes ☐ No ☐

f) Wood Fuel Yes ☐ No ☐

g) Solar Lanterns Yes ☐ No ☐

8) Have you ever **seriously thought** about buying the following products?

a) Solar PV collectors (For electricity generation) Yes ☐ No ☐

b) Solar water heaters Yes ☐ No ☐

c) Energy efficient Cooking stoves Yes ☐ No ☐

d) Biogas Yes ☐ No ☐

e) Charcoal Briquettes Yes ☐ No ☐

f) Wood Fuel Yes ☐ No ☐

g) Solar Lanterns Yes ☐ No ☐

9) Have you ever **decided to buy** the following products?

a) Solar PV collectors (For electricity generation) Yes ☐ No ☐

b) Solar water heaters Yes ☐ No ☐

c) Energy efficient Cooking stoves Yes ☐ No ☐

d) Biogas Yes ☐ No ☐

e) Charcoal Briquettes Yes ☐ No ☐

f) Wood Fuel Yes ☐ No ☐

g) Solar Lanterns Yes ☐ No ☐

10) Have you ever **installed** any of the following products for use by your family?

a) Solar PV collectors (For electricity generation) Yes ☐ No ☐

b) Solar water heaters Yes ☐ No ☐

c) Energy efficient Cooking stoves Yes ☐ No ☐

d) Biogas Yes ☐ No ☐

e) Charcoal Briquettes Yes ☐ No ☐

f) Wood Fuel Yes ☐ No ☐

g) Solar Lanterns Yes ☐ No ☐

Part 3: Policy Interventions

Please indicate your level of agreement with the following statements

13) The Kisumu County Government is involved in helping me understand how to acquire and use renewable energy

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

14) The Kisumu County Government works hard to persuade me to use renewable energy

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

15) I feel supported by the CGK when deciding to use Renewable energy

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

16) The CGK supports residents to install renewable energy systems

☐ Agree ☐ Neutral ☐ Disagree ☐ ☐

Strongly Agree ___ ___ ___ ___ Strongly Disagree ___

17) The CGK is receives my evaluation of how the renewable energy systems we have adopted are performing

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

Part 4: Promoters and Inhibitors of Renewable energy Adoption

Please indicate your level of agreement with the following statements

18) Traders in Renewable energy products in Kisumu have tried to sell

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

19) Non-Governmental Organizations and Community Based Organizations in Kisumu have educated me on the benefits of renewable energy products

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

20) I feel that renewable energy products are expensive

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

21) I cannot afford renewable energy products that my family can use that are marketed in Kisumu

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

22) It is difficult to get fundis who can install and repair renewable energy products

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

23) The fundis in Kisumu who deal with renewable energy products are not very good at their job

Strongly Agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

Thank You for Participating

Appendix II: Interview guide for county government officials

Dear, Sir/Madam, this questionnaire is to help in gathering information on assessments into renewable energy adoption of households in Kisumu central sub county, Kisumu City. The major aim is to identify help review the County government of Kisumu Policies and their contribution to adoption. The answer you will give will go a long way into providing additional insights that can improve the policy environment. Please respond as honestly as you can to all the Questions. Feel free to make further comments you may want to. The answers you give will be treated with utmost confidentiality. You do not have to write your name anywhere in the Questionnaire.

1) Are you aware of any policy advocacy groups in Kisumu County that focus on the adoption of renewables? If yes, what is their contribution so far to the policy development process?

   ……

2) Are there any trade incentives that specifically target traders involved in the development of renewables in Kisumu? ……

3)Are there any policy incentives that specifically target technicians that install and maintain renewable energy solutions in Kisumu County?

……

4) Does the county government have any processes underway relating to the development of policies and bills that will help to promote the adoption of renewables?

……

5) What is the current position of the County Government of Kisumu on adoption of renewables for domestic and industrial uses……

6) Has the county Government of Kisumu implemented any renewable energy projects in its jurisdiction, or on public facilities it controls within the city?

……

7) What are the critical issues that would have an impact on the adoption of renewables in Kisumu County for domestic uses?