

ASSESSMENT OF FACTORS AFFECTING GREEN ENERGY ADOPTION FOR
HOUSEHOLD USE AMONG THE URBAN AND PERI-URBAN POOR IN KENYA: A CASE
STUDY OF KIBERA -LAINI SABA, NAIROBI.

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Partial Fulfilment of The Requirements for A Bachelor's Degree in Environmental Resource
Management of The Technical University of Kenya.

JULY 2020.

DECLARATION

This research project is my original work and has not been presented for a degree in any other university or any other award.

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Date

SPGI/00567/2016

This research project has been submitted for examination with my approval as university supervisor.

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Date

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DEDICATION

I would like to devote this research project to the Creator of our Universe, the Almighty God, for enabling me to accomplish this work by His grace and mercy. To my beloved parents and siblings whose financial and moral support has been of paramount importance to the success of this project.

ACKNOWLEDGEMENT

I highly appreciate God for His unending support throughout my education. I am profoundly indebted to my supervisor, Dr. Vincent Owanda, for his merited supervision, timely and broad review of my project. Also, I extend my hearty gratitude to all my colleagues and friends who took their time to review my work and provide me with valuable comments that helped in enhancing the success of this project.

May the Almighty God bless all of you!

ACRONYMS/ABBREVIATIONS

SDGs	__Sustainable Development Goals
WHO	__World Health Organization
NGOs	__Non-Governmental Organizations
AMREF	__The African Medical and Research Foundation
UNEP	__United Nations Environmental Programme
KWh	__Kilowatt hour
LPG	__Liquefied Petroleum Gas
CSP	__Concentrated Solar Power
PV	__Photovoltaic
GHGs	__Greenhouse Gases.
GoK	__Government of Kenya.
CoK	__Constitution of Kenya 2010

ABSTRACT

Energy is of paramount importance in economic development and meeting daily household needs. Green energy is a type of energy generated from natural sources that are environmental friendly and whose usage is not depleted. Specific household basic needs that require use of energy include cooking, lighting and heating. Examples of clean sources of energy include biogas, electricity, and liquid petroleum gas. Others such as wind, geothermal and hydro power are also clean though there exists several challenges in harnessing them, more especially financial challenges. Consumption of clean energy has several benefits to the general environment (reduced pollution and depletion of natural resources) and human health (respiratory diseases among others). The use of unclean energy sources such as charcoal and kerosene often lead to indoor air pollution which results in respiratory difficulties and increased mortalities. This study was guided by its main objective - to assess the factors affecting adoption of green energy in Laini-Saba, Kibra. Laini Saba is one of the thirteen villages making Kibera slums and the most populated hence a good target area of study. Knowing the types of clean energies used by households, benefits and awareness of using them, helped in obtaining the main objective of this research. A total of 99 households were selected through systematic random sampling technique for the study. This was done by administration of questionnaires, conducting thoughtful interviews (especially with several key informants), and through observation. As revealed by this study, ethanol, biogas, LPG, and electricity were the most used forms of clean energy in Laini Saba. On the other hand, it was revealed that charcoal and kerosene were the most used form of unclean energy. Charcoal was the most used form of unclean energy because the residents argued that it is very cheap, can be accessed easily, and it is quick in cooking, lighting and warming. The use of clean energy for cooking was mainly influenced by cost, education level, gender, and household income. Moreover, the study revealed that the key

importance of using clean energy include cost reduction, time used for cooking is reduced, enhanced education and good health conditions. Other respondents observed that clean energy provides some form of employment and helps in conserving the environment since charcoal burning is reduced. The knowledge and related findings obtained from this study could play a fundamental role in informing, advising (or even challenging), and bringing wise guidelines and policies to the relevant stakeholders involved in the management, conservation, and planning of environment, with a special attention to energy.

Contents

DECLARATION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
ACRONYMS/ABBREVIATIONS.....	v
ABSTRACT.....	vi
CHAPTER ONE: INTRODUCTION	3
Background to the study.....	3
Statement of the Research Problem.....	5
Justification and significance	6
Research Objectives.....	7
Research Questions	7
Scope and Limitations of the Study	7
CHAPTER TWO: LITERATURE REVIEW	9
Types of Clean Energies used by Households in the world.....	9
Solar energy	9
Wind Energy.....	10
Geothermal power.....	10
Hydroelectric energy.....	10
Household Energy sources used in Kenya.	11
Factors determining the type of green energy used by households.	12
Energy Cost and price.	12
Level of education among the households.....	13
Age and gender of households	13
The size of households.....	13
Government policies.....	14
Impacts of clean energy use on households.....	14
Conceptual Framework.....	15
CHAPTER THREE: RESEARCH METHODOLOGY.....	18
The study area.....	18
Location of the study area.	18

Employment and Economic activities	19
Drainage	19
Housing	19
The study methodology	20
Sampling Procedure and sample size.....	20
Sources and Methods of data collection	20
Data Analysis and Techniques.....	20
CHAPTER FOUR: RESULTS AND DISCUSSION	22
Social and Economic Background	22
Main types of cooking energy	25
Factors influencing the use of clean energy in Laini Saba	26
Cost of energy	26
Education level and energy awareness among household heads	27
Gender of Household head	29
Benefits of using clean sources of energy for cooking	30
CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS	32
Summary of findings	32
Conclusion	33
Recommendations	33
To policy makers;	33
To the Laini Saba residents;	34
To future researchers.....	34
REFERENCES	35
APPENDICES	40
Appendix 1: Research Questionnaire.....	40
Part One: General Information	40
Part two: information on energy used for cooking.....	41
Part three: Factors influencing type of energy use.....	43
Awareness level	43
Part Four: Information on benefits (either for LPG, Biogas or Hydropower)	44
Appendix 2: interview guide for Laini Saba area administrator	44
Appendix 3: Interview guide for administrator of Laini Saba Biogas plant	45

CHAPTER ONE: INTRODUCTION

Background to the study

Energy is very critical for day to day activities such as cooking and other household needs as well as for economic development. The availability of energy, especially clean energy, helps in reducing health risk due to unclean energy and subsequent elimination of the potential disease-causing elements. Energy is defined as the power acquired from the utilization of resources especially physical and chemical resources. This power is specifically used to give light and heat, and can also be utilized to run machines. Green energy refers to energy that is acquired from inexhaustible natural sources which are free of pollution hence cannot emit pollutants.

Energy is mainly categorized into two major groups, that is, renewable and non-renewable. On the other hand, energy can be regarded as either clean or dirty and all these classifications are put into use depending on the level of development, economic and social status of countries and individuals in particular. However, it is critical to note that the major sources of energy used for cooking are classified into traditional, intermediate or modern sources. For instance, traditional sources include fuel wood, animal waste and agricultural residues. Charcoal and kerosene are the main examples of intermediate sources, whereas, modern sources of household energy encompasses electricity, biogas, ethane, and liquid petroleum gas. While a good number of developed nations have, to a large extent, adopted modern types of energy for household needs, most people in the developing countries are still using traditional and intermediate types of energy which, widely conducted studies, have revealed to be harmful or otherwise life-threatening (Martin II et. al. 2013)

Renewable energies, though not all of them, are considered clean sources of energy and their effects to the environment and the lives of households are not as harmful (in fact are considered

harmless) as the unclean sources of energy are. In this regard, institutions dealing with the conservation of environment, energy use and distribution are keen on advocating for the adoption of green types of energy like biogas, LPG, solar power, wind energy, and hydroelectricity; among others (Lambe et al. 2015).

Unclean types of energy have been widely used for household needs especially for cooking. Typical examples of unclean conventional energies used in most households include charcoal, firewood, and kerosene (stoves) among others. Unclean sources of energy are not only leading to unsustainable energy use practices which have led to negative environmental impacts like land degradation, deforestation, and air pollution, but are also leading to direct loss of lives of millions of people. For instance, yearly reports by World Health Organization (WHO) indicate that about 1.5 million people die prematurely from indoor air pollution mainly caused by unclean solid fuels (WHO 2013). In addition, global trees coverage has been greatly undermined (especially forests in Africa) as millions of people are still cutting down trees, without necessarily planting others, to meet their energy needs in form of charcoal and fuel wood (Pearson et. al. 2017).

Kenya is among the developing states and for good reasons, one of the African countries boasting of modest economic progresses and many advancements in technological fields (Amankwah-Amoah 2019). However, many of her people, particularly those based in remote/rural destinations, are up to this day struggling with the usage of traditional or otherwise unclean sources of energy. Kibera, a slum in Kenya and among the biggest slums in Africa, holds thousands of people whose background is mainly characterized by abject poverty, with some lacking the ability to afford the very basic human needs (Chege & Waweru 2014). Daily experiences in this slum are collectively miserable and it is crystal clear that their access to important services such as energy (clean and sustainable energy in this case) is limited to a number of factors. Frequent environmental concerns

in this area such as pollution due to unclean sources of energy have attracted several stakeholders, mostly Non-Governmental Organizations (NGOs) such as AMREF Health Africa and Asante Africa Foundation in the region and their efforts have seen a substantial adoption of clean energies. With full knowledge of the many challenges in Kibera slum, this study sought to understand if the residents in this biggest slum, particularly Laini Saba village have access to clean energy for their consumption and the factors affecting the uptake of such energy for household use.

Statement of the Research Problem

Energy uses are diverse and contribute directly to the growth and development of social, economic, and even political endeavors. More specifically, energy is a vital household need as it is used for cooking, lighting, heating and boiling of water as desired by individuals. When used sustainably, energy (especially clean energy) contributes significantly to good health as the miscellaneous dangerous effects such indoor pollution and general implications to the environment are increasingly mitigated upon.

Many residents in Laini Saba are predominant users of unclean energies sources such as charcoal whose effects are far reaching. It is believed that women and children spend most of their time at homes doing house chores, and as they do so, they are exposed to these dangers more than men. Charcoal usage, for instance, is known to cause a wide range of complications through smoke inhalation which is a known cause of acute respiratory disorders, tuberculosis, and sometimes can cause untimely deaths (Lambe & Senyagwa 2015). Despite these evidently seen hazardous effects, the rate at which green energy types are embraced in Laini Saba is worrying and this calls for urgent, proactive and thoughtful measures to mitigate the current conditions. Thus, this was a very timely research whose knowledge and related findings aims at informing, advising (or even

challenging), and bringing wise guidelines and policies to the relevant authorities involved in the management, conservation, and planning of environment, with a special attention to energy.

Justification and significance

As Kenya aims to achieve her ambitious vision 2030 and the sustainable development goals (SDGs), there is need for expansion of the energy sector (with the goal of ensuring clean energy) in order to enhance sufficient energy distribution. Whereas most regions are by far benefiting from the government's electrification initiative which has increased electrical energy coverage, the urban and peri urban poor locations are still using the health-hazardous sources of energy to meet their household needs. Even though there are outstanding strides made to improve access to clean sources of energy in these poor areas, there are still many residents who depend on unclean energy and this has been reported to cause myriad health complications.

With this knowledge, this research was timely and largely needed as its findings would help in developing a knowledge base from which key stakeholders in the sector of energy can use to enhance the adoption of green and clean sources of energy in urban and peri urban poor areas. Laini Saba is a suitable area of study since it represents one of the villages in Kibera known for endless cases of power outage and inadequacy which force residents to opt for unlawful and otherwise dangerous sources of energy. The results from this area were a representative of the majority of many other areas that are believed to face similar obstacles and this could largely help in calling for speedy implementation of important and useful environmental policies and guidelines.

Research Objectives

This study was guided by the main objective which was to evaluate the factors that affect the adoption of green energy for household use in Laini Saba households in Kibera. The study was also guided with specific objectives which include:

1. To find out accessibility to green energy resources in Laini Saba, Kibra.
2. To evaluate the factors that determines the use of green energies by households in Laini Saba, Kibra.
3. To examine awareness on the benefits of using green energy by households in Laini Saba, Kibra.

Research Questions

This research exclusively answered the following questions:

1. What sorts of green energies are accessible and used by households in Laini Saba, Kibra?
2. What are the factorss that influence the use of green energies by households in Laini Saba, Kibra?
3. What is the level of awareness on the benefits of using green energies in Laini Saba, Kibra?

Scope and Limitations of the Study

This research was conducted in Laini Saba area of Kibera, one of the populous villages in the slum. According to the 2019 Kenya population census, Laini Saba has about 50,000 residents and about 10,000 households. Generally, Kibera represents the majority poor living in horrible conditions, with many residents lacking clear avenues of generating income. Small businesses like kiosks,

eating points majorly called “vibanda,” and hawking practices are very many in Kibera. Majority of the youths are unemployed in Kibera (though a national problem) and have ventured in alcoholism and misuse of drugs. As a result of abject poverty, instances of HIV/AIDS infections are many since a number of women, including school-going girls, opt for prostitution as a way of sustaining themselves and their families. In addition, Kibera has poor power connections and often experiencing power outage most of the time and this has given some residents rare opportunities of doing illegal power installations to other households. Nonetheless, the region is widely known as a talent hub since most musicians and creative personnel have their roots in Kibera. Historical indications undeniably implicate this area to be prone to many insecurity issues, poor structures which made it slightly difficult to access the households.

CHAPTER TWO: LITERATURE REVIEW

This section gives a detailed account of green energy use in different parts of the world by providing a number of reviews based on the existing literature. The review is tailored to feed into the research objective, and as such, it is subdivided into several focus areas of interest.

Types of Clean Energies used by Households in the world.

Clean energy has become a prerequisite requirement in many parameters of daily life and this has been enhanced by modern developments and needs. Setiartiti (2018) argues that clean energy has clear and well understood benefits since its effective use and utilization contributes to a lot of dependable gains such as better health care, education services, and improved sanitation systems. Proper exploitation of electricity, for instance, can be a reliable way of easing transportation and telecommunications which drive economic endeavors such as industrial growth, businesses, among others (ESMAP 2015). The different types of clean energies are discussed below:

Solar energy

Solar Energy is power obtained from the sun and turned into energy. Solar energy is increasingly becoming popular all over the world as it can be harnessed in large amounts and used to generate electricity for many household demands. In Kenya, this type of energy has had a vibrant market for many years and it is used for both domestic and commercial developments especially to homes and institutions located far from the national grid. Kenya has about 140,000 solar water heaters (Kariuki & Sato, 2018). Solar energy is usually generated in two major ways, photovoltaics (PV) and concentrated solar power (CSP) (Alrikabi, 2014). It is a clean renewable source of energy because it does not pollute the environment in terms of noise. Germany has become a leading user of solar energy for ages and now. Health institutions in Germany have reported an increased decline in deaths resulting from use of biomass resources since the introduction of solar energy (Duić, 2015).

Wind Energy

Wind power is another type of clean energy driven by atmospheric air. Its working mechanisms depend on the speed of wind to turn the turbines, and this means that the areas they are located are carefully selected (Bandoc et al. 2018). Such areas are very few in the African continent and that explains why it has been least adopted. Despite this, wind energy requires technical skills and a great deal of financial needs. However, wind energy use has no lethal contents, is free from air and water pollution, and usually poses no threat to the consumers (Kazimierczuk, 2019). With the increase of wind power installation in China, there have been enormous benefits such as reduced air pollution, employment opportunities and increased rural electrification (Feng et al. 2015).

Geothermal power

This is another type of clean energy which can help reduce greenhouse gas emissions by greater heights. It is basically a kind of energy obtained from the mantle of earth and it is often utilized directly. Africa has the potential to produce geothermal power, with Kenya particularly becoming the first sub-Saharan Africa country to use this energy in greater ways. Its sustainable use will help in addressing the environmental concerns especially greenhouse gas emissions (Huenges et. al. 2013).

Hydroelectric energy

This refers to a type of clean energy generated by converting kinetic energy into electrical energy. This energy is used in homes for various purposes such as lightning, cooking and powering electrical appliances. Hydropower is widely being used all over the world, with Kenya having installed over 761 MW (Rose et al. 2016). The resilience of hydropower is based on the fact that its generation is fueled by water, which means that there are hardly any form of environmental pollution. However, despite the many benefits –clean, reliable, safe, and flexible source of energy- the potential of hydropower can be limited to such factors as unending drought in some regions.

Africa has a great potential of hydroelectric power but this has not been properly developed –only 7% is being exploited (Antonelli et al. 2017).

Household Energy sources used in Kenya.

A great percentage of Kenyans are using charcoal, wood fuel, dung and agricultural residues mainly for cooking. Most rural and peri-urban settlements embrace use of kerosene for lighting in homes. According to Yonemitsu (2014) the dominant fuel source in Kenya is taken from direct combustion of biomass mainly from wood sources, such as charcoal and wood fuel. Wood fuel plays a vital role as an important source of energy which is widely used for rural households and majority of small-scale rural industries. Woody biomass charcoal has for a long time served as source of energy used for cooking by households in informal settlements. Nevertheless, kerosene is used in combination with other energy sources that are carbon intensive including candles, paraffin, and biomass for lighting. Biomass is greatly used in rural Kenya –about 90 percent of energy in rural areas is biomass (Yonemitsu et al, 2014).

Solar energy is also used by the Kenyans. In the past few years, solar PV lighting and lantern programs have been introduced in Kenya. Yet, kerosene is still a widely source of energy used for lighting at the household level mainly for illumination. Recent measures taken by the Kenyan government to install electricity throughout the country through rural electrification program have not fully ensured reliable and adequate energy. Most households still use significant portions of their income to buy kerosene fuel. Use of kerosene is adversely affecting the environment and human health since kerosene contributes directly to greenhouse gas emissions which further contribute to household air pollution. Solar lanterns have therefore become a choice of the government, regulators, and agencies advocating for a stop in the use of kerosene lamps (Lesirma, 2016).

A number of Kenyans especially the middle class use Liquefied Petroleum Gas (LPG) for cooking in order to supplement charcoal, hydroelectricity and kerosene. LPG is relatively expensive and only used by a few who can afford it. It is available in different sizes of gas cylinders ranging from 3-15 kilograms. It is mainly used by the urban majority and often has to be refilled when used up, thus leading to additional costs. Its effects to the environment (if any) are very few but there have been a number of reported cases where the gas cylinders explode and lead to bodily harm, property destruction, and at times cause deaths.

The harnessing of wind energy is also going on in Kenya on a small scale, and just like other sources of energy it is used to meet household needs. The exploitation of wind energy has been limited to several factors especially high capital cost and lack of sufficient regime data (Nordman & Mutinda, 2016). There are limited installations of wind turbines used to generate electrical energy, with stations in Ngong Hills and Marsabit managed by Kenya Electricity Generation Company (KENGEN). Consecutively, geothermal energy is used to provide electricity, though to a least extent, and it has so far proven to be the most successful in Kenya (Zhou et al. 2013).

Factors determining the type of green energy used by households.

The type and use of clean sources of energy depend on various factors within which residents make decisions. Some of the leading factors influencing clean energy use include:

Energy Cost and price.

Different sources of energy have different costs which influence their use. Clean sources of energy are often considered expensive than unclean sources and this explains why the majority poor opt for unclean energies such as charcoal and fossil fuels. The cost of energy is the main factor influencing access to clean energy among the poor urban (George & Gicheru 2016). When energy

cost increases, the amount of energy demand decreases and this makes it easy to gain access to cheaper fossil fuels that are otherwise harmful to human and the environment.

Level of education among the households.

The more people are educated, the more they become aware of the importance of clean sources of energy. A majority of people are exposed to unclean energy use due to ignorance and lack of well-coordinated and structured trainings meant to provide education on the usefulness of clean energy. According to UNEP (2017), households with a high level of education heads tend to use more clean sources of energy in cooking, lighting, heating compared to the uneducated households who mainly adopt fossil fuels, especially wood fuel. Thus said, it implies that the government needs to create legislative frameworks to enhance knowledge acquisition through substantive trainings on the benefits of using clean energy (Lambe et al. 2015).

Age and gender of households

Many old people grew up using traditional sources of energy for their household needs. It therefore becomes hard for them to embrace change. On the other hand, the younger population tend to use modern clean sources of energy and this is mainly based on the convenience of such forms of energy and somewhat understanding of the potential problems of unclean sources of energy. Gender preferences also play part in access to clean energy in that both men and women have varying behavioral traits (Brounen et al. 2018). For instance, Taking time to light up a “jiko” is perceived by men as being feminine.

The size of households.

Large households undoubtedly use unclean energy due to cheaper prices in contradiction to small-sized families (Antonelli et al. 2017). In order to meet every need for a largely-sized family, it will mean cutting off other needs and in most cases this leads to consumption of what is cheap. Although government initiatives such family planning and regulations may help in bringing order,

of paramount concern is the prices of clean energy sources which need to be constantly checked and regulated (Martin II 2013).

Government policies

The government of Kenya is keen to enhance a sustainable environment as it aims to achieve envisioned vision 2030. Unclean sources of energy cause instability to the environment leading to greenhouse gas emissions, air pollution, indoor air pollution, and global warming (when large amounts of trees are cut for charcoal burn and fuel wood) (Zhou et al. 2013). Thus, the government has put in place policies affecting energy use which have regulations and restrictions on the preferred energy types to be used.

Impacts of clean energy use on households

Use of clean energy has tremendous benefits to the households and helps them improve their social, economic, and environmental development. The adverse effects of unclean energies are overcome to a large extent when clean energy is used. For instance, environmental pollution in terms of air pollution, noise, greenhouse gas emissions can be mitigated by consumption of clean energy (Danlami et al. 2015). According to Martin II (2013) when residents use clean energy, chronic respiratory diseases as a result of indoor air pollution are reduced. Cases of suffocation mainly due to charcoal use are many among the poor population thus, a stop to its use will prevent such occurrences henceforth.

Clean energy types release small and often controlled amounts of solid wastes that does not adversely affect the environment too much (Ahmed & Cameron 2014). For example, biogas is usually converted into valuable resources whose use can be realized further. In addition, they do not pollute the land they occupy and often use advanced technologies that are environmental friendly (Kozarac et al. 2014).

Subsequently, in many African homes women and children are usually tasked with the responsibility of fuel wood collection for use at home. This practice greatly undermines their social life with some of these children calling off their studies in some cases. Also, it becomes hard for women involved in the daily collection of firewood to be included from developmental matters affecting the society (Wanyonyi, 2019). A timely adoption of effective clean energy will mean well to this population and consequently improve their social status.

Consecutively, clean energy leads to direct employment opportunities to many households. This becomes possible through clean energy projects which in turn add economic values. Businesses also flourish as such projects usually require a great deal of installation materials, among other valuable resources (Huenges et al. 2013). From the inspection of these projects to the time they finally get connected to the national grid, as it is for solar, wind, or hydropower for example, many jobs are created and this contribute towards poverty reduction. The knowledge base also expands and these people, especially those directly involved in those projects, learn the importance of adopting use of clean energy for their household use (Shayegh, 2017).

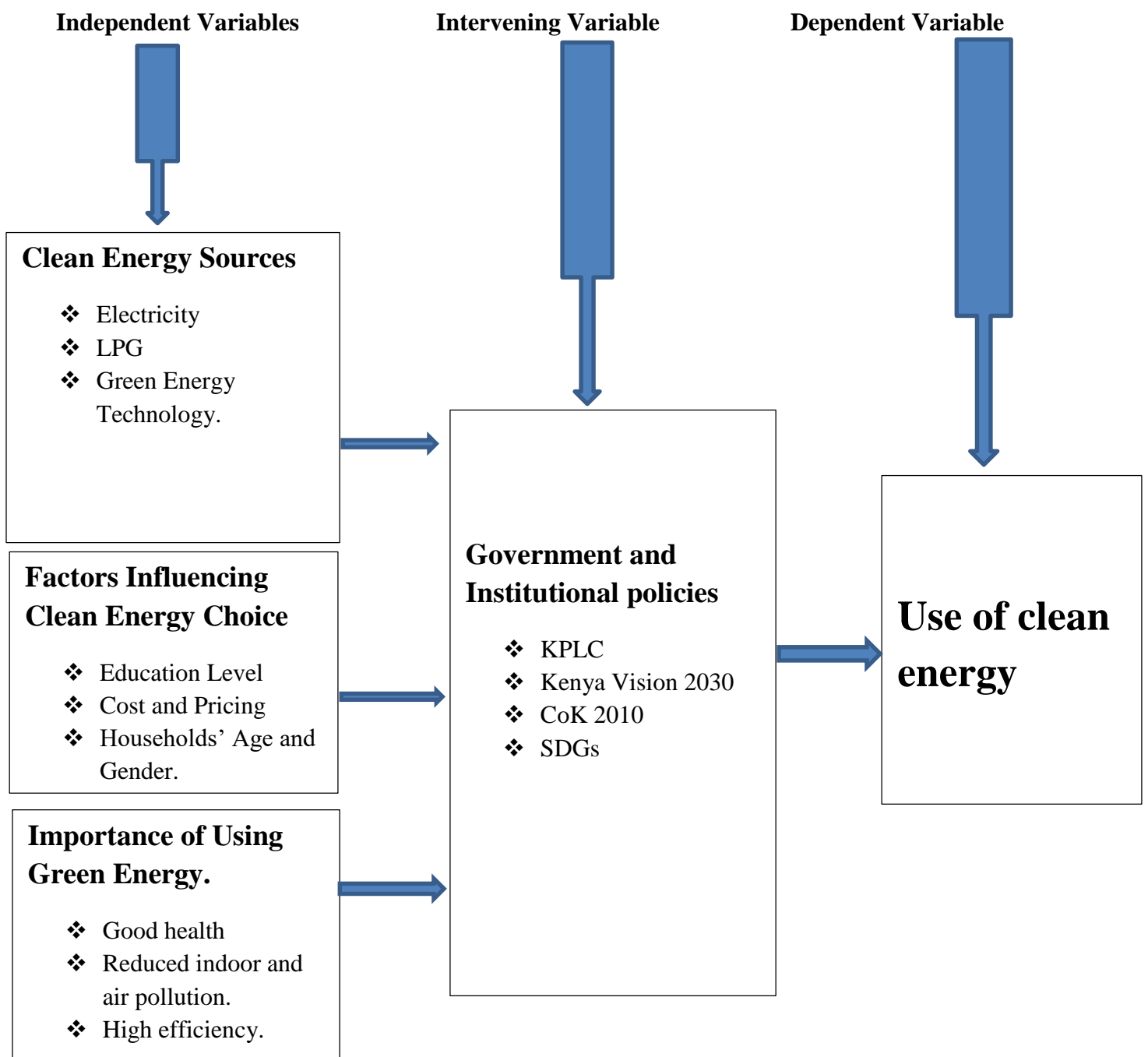
Conceptual Framework

The concept of sustainable development has become the prime goal of every nation in the world today. According to UNEP, sustainable development has been defined as, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” It is therefore a kind of development that calls for concerted efforts that enhance wise use of resources in way that guarantees a resilient future (UNEP 2010).

Use of clean energy promotes sustainability of the three pillars of sustainable development, that is, social, economic, and the environment. It is critical to note that when unclean sources of energy such as charcoal and firewood are used, they contribute heavily to global warming which brings

problems of climate change on the environment. Clean energy can enhance effective and sustainable economic opportunities. This is mainly because in the long run unclean energy is linked with high costs in terms of mitigating the effects (Van Den Hazel, 2018). On the other hand, the social aspect sustainable development depends on good health of the people. Human existence is heavily influenced by the type of energy used. Unclean energies lead, without doubt, to a number of health complications including respiratory diseases. This is even worse to the younger and women population as they are mainly involved in household chores such as cooking. As established from a 2017 research conducted by Gall and others, women and children below the age of 15 years were more vulnerable to indoor air pollution than their male counterparts. Their research also noted that most rural girls are often dropping out of school due to their direct involvement in the collection of firewood for energy use at home. This is a rising problem in developing countries (Gall et al. 2017).

Figure 1: Conceptual Framework



CHAPTER THREE: RESEARCH METHODOLOGY.

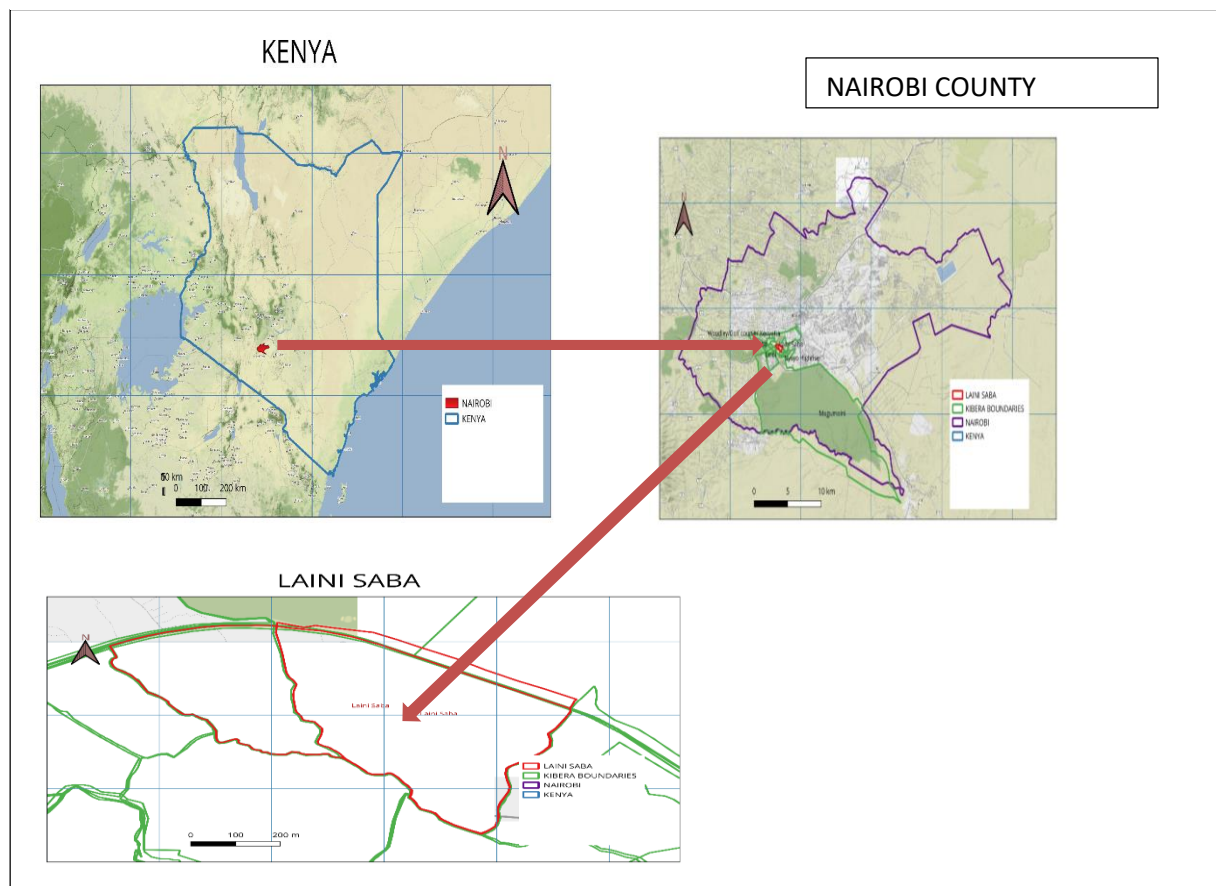
The study area.

Location of the study area.

Laini Saba is one of the 13 villages of Kibera slum, in Nairobi County, Kenya. Laini Saba is the most densely populated and predominantly consisting of the lowest income group in Kibera slums with an approximate population of 50,000 people with 10, 000 households. The majority of the people live under a dollar, with an average income of Kshs.45 per day out of which 55 per cent of these being women (Kenya population census, 2019).

□

Figure 2; Location of Laini Saba in Kibera



Source: GIS tools

Employment and Economic activities

Kibera is one large slum with high levels of unemployment despite a booming population –with unemployment rate of over 60%, a few of the residents serving temporary employment. Most youths are usually seen roaming in the streets, with no known records of employment. This has been a major cause of the unending chaos in the area making the slum unsafe during the day and night. The area has wide range of small scale businesses believed to generate substantial amount of income for day-to-day living needs (Basu 2018).

Drainage

Laini Saba has no well-established drainage systems, and this can be ascertained from the large amounts of sewerages due to widespread disposal of wastes. Garbage collection services are also not effective in the area. The water drainage systems are also not well established since a number of cases in past reportedly indicate how moving water, which often cause more stagnant water, in the area carry along the poorly erected building structures. Cases of poor and impassable roads are very common and the region's leadership, both the past and the current, has done little to improve this status (Kozarac et al. 2014)

Housing

Like other villages in Kibera, Laini Saba has poor housing structures which make the area vulnerable to several problems such as health complications, pollution (water, soil, air). These housing structures are uncontrolled and some of them are located in unsuitable lands. Possible disasters such as fire outbreak or electric fires are likely to cause a lot of intolerable losses if they ever occur. While the current government of Kenya aims to achieve affordable housing to all Kenyans as part of its big four agenda, the people of Kibra (specifically Kibera slums) are far from such hopes since there are no noticeable progresses to this far (Rose et al. 2016).

The study methodology

Sampling Procedure and sample size

The study targeted the whole village of Laini Saba. In order to get the required household size, a systematic random sampling technique was used. The study determined a central location using geographical direction so as to identify a sampling transect. The study targeted a population of 10,000 households. Nassiuma's (2002) formula was then used to determine the sample size of the population -99 households as given:-

$$\text{Sample size (n)} = (NCV^2) / [CV^2 + (N-1)] e^2$$

Where;

N = Target population

CV = Coefficient of Variation (0.5)

e = Tolerance at desired level of confidence (0.05) at 95% confidence level.

Therefore, $n = 10,000(0.5)^2 / [0.5^2 + (9,999)0.05^2] = 99.02 \sim 99$ households

Sources and Methods of data collection

This was split into two, that is, primary and secondary methods of data collection. Primary sources included interviewing key informants, Laini Saba ward administrator and biogas plant administrator in the area, use of questionnaires and through observations in order to determine clean energies used in Laini Saba village. The study was also supported by a review of the past literature.

Data Analysis and Techniques.

The analysis was done on the data obtained from questionnaires. Only data from 85 questionnaires was used since the other fourteen questionnaires did not have adequate information as required.

The useful data was carefully cleaned through extensive editing and error correction before the actual analysis. Calculation was done by use of relevant mathematical formulas, based on the researcher's skills and no software was applied. This was then followed by generating frequency distributions in order to describe sample data.

CHAPTER FOUR: RESULTS AND DISCUSSION

This study pursued to evaluate the factors that determine the adoption of green energy for household use in Laini Saba households in Kibera, Nairobi County, Kenya. Therefore, the information presented herein is based on the objectives of the study, that is, 1.) To find out accessibility to green energy resources in Laini Saba, Kibra; 2.) To assess the aspects that determines the use of green energies by households in Laini Saba, Kibra; and 3.) To examine awareness on the benefits of using green energy by households in Laini Saba, Kibra. It therefore suitable to start by giving a brief background of the socio-economic status of the respondents.

Social and Economic Background

From the study, the sample size composed of (61.3%) females and (38.7%) males. Females usually spend most of their time at home doing domestic chores while men are normally outgoing to look for casual jobs in order to earn a living. The study revealed that half of the respondents had gone through primary education. Also, 45.1% of the respondents had attained secondary level education and above while only 4.9% had not received any formal education. As studied by Danlami et al. (2015), the level of education among the people usually determine their use and understanding of clean energy. This means that the more people are educated, the more they are likely to adopt use of clean energy sources.

The period of stay in Laini Saba varied considerably among the respondents. 48.2% of the respondents have lived in Laini Saba village for more than 10 years, 16.5% for 6 to 10 years, 21.2% for 1 to 5 years, and 14.1% for less than a year. According to Amankwah-Amoah (2019), the length of stay in a place is usually determined by the attachment to that place. The table below shows the length of stay in Laini Saba.

Table 4.1. Period of stay in Laini Saba

	(N)	(%)
Less than 1 year	12	14.1
1 – 5 years	18	21.2
6 – 10 years	14	16.5
More than 10 years	41	48.2
Total	85	100.0

Source: Field Data (2019)

The household heads involved in this study were all 18 years and above. Nonetheless, those in the age bracket of 18-25 and 36-45 largely dominated the household heads as illustrated below.

Age has a tendency to influence use of green energy in a positive way.

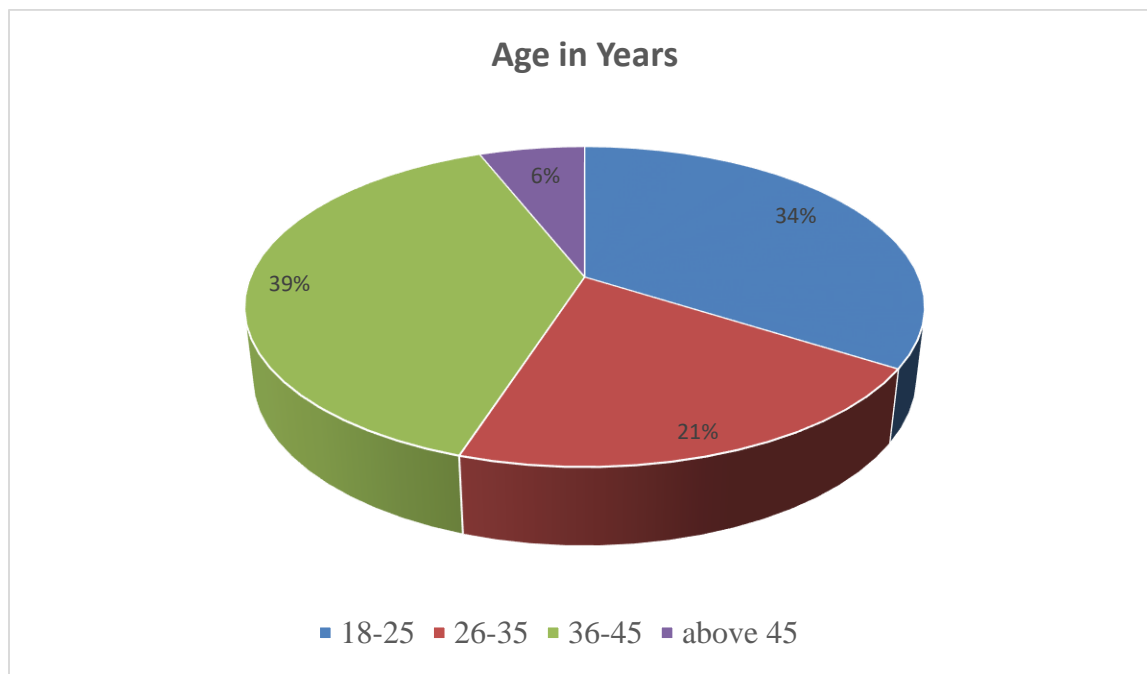


Figure 4.1. Pie chart of ages of household heads

The probability of households to afford use of clean energy also depends on their financial status. As shown in the table below, 45.9% of the households earn approximately kshs 15,000; 23.5% of the sample population earn between kshs 10,001 and kshs 15,000; 11.8% of the sample population earn between kshs 5,001 and kshs 10,000 while 18.8% earn between kshs 1000 and kshs 5,000 every month.

Table 4.2. Household Monthly Income

Kshs.	(N)	(%)
1000 – 5000	16	18.8
50001 -10000	10	11.8
10001 -15000	20	23.5
Over 15000	39	45.9
Total	85	100

Source: Field Data (2019)

Household Size

55.3% of the households had more between four to six members. In another household, 10.6% had two members; 12.9% had three members and 21.2% had more than six members. This is shown in figure 4.2 below;

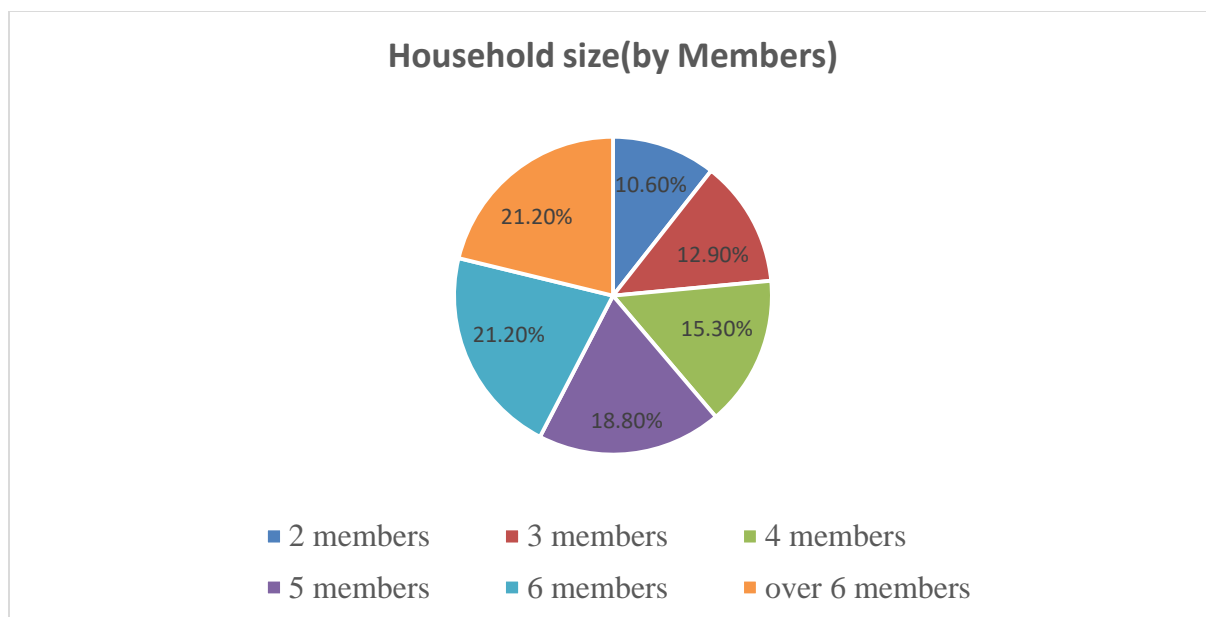


Figure 2: Pie chart showing household size

Main types of cooking energy

It was established that households in Laini Saba use clean and unclean sources of energy. The types of clean energies used for cooking in Laini Saba were biogas, LPG, hydropower and ethanol mainly acquired from the biogas plant in the area. This ethanol is then used through Safi cookers. Charcoal was the most used type of unclean energy with 32.9% of the households embracing its use. The table below shows energy use, clean and unclean, in percentage.

Table 4.3: the types of energy used in Laini Saba

Energy type	(N)	(%)
Biogas	13	15.3
LPG	19	22.4
Electricity	9	10.6
Ethanol	6	7.1

Charcoal	28	32.9
Kerosene	10	11.7
Total	85	100.0

Source: Field Data (2019)

The use of ethanol in the area is limited to the ability of the households to afford the Safi cookers. The Biogas plant administrator who was a key informant to the study revealed that the cost of Safi cookers is expensive, going for approximately kshs. 4,000 and this is unaffordable to a large population.

Many households who use charcoal (32.9%) claimed that the product is easily accessible and cheap hence making its use dominant. Apart from cooking, they said that charcoal provides warmth and lighting for a long time and at a good purchase price.

Factors influencing the use of clean energy in Laini Saba

Cost of energy

Many respondents to this study ‘agreed’ and ‘strongly agreed’ (67%) that the use of energy is reliant on the cost of energy. Another section of the respondents (21.2%) did not know if clean energy use is determined by the cost of energy or not.

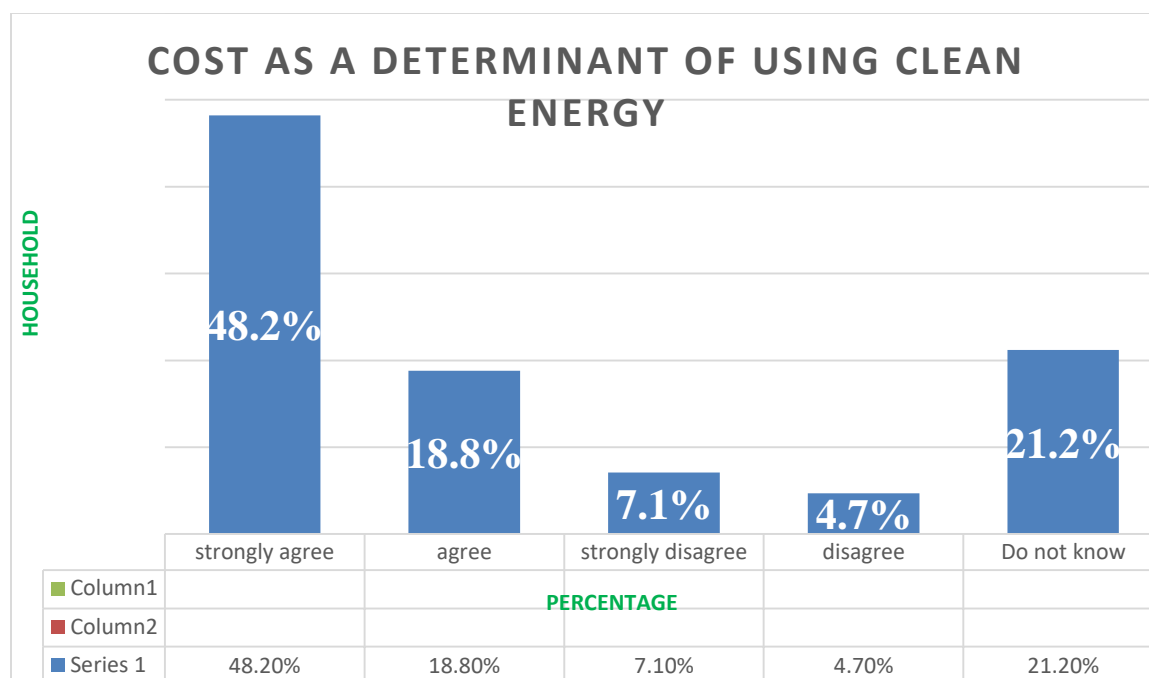


Figure 3: Bar chart showing cost as a factor affecting clean energy use

Education level and energy awareness among household heads

The study discovered that the majority of household heads using charcoal and kerosene for cooking are those with no education and those who studies up to primary only. However, those with secondary education level and above have adopted wide uses of clean energy types –LPG as their major cooking form of energy. As found out by Danlami et al. (2015), use of clean energy is very dependent on the level of education among the people. People who have high education level will always tend to use clean energy unlike those with low or no formal education –main users of unclean energy types. The table below shows how the choice of cooking energy is influenced by the level of education.

Table 4.4: Level of education

Education level	Biogas	LPG	Hydropower	Charcoal	Kerosene	(N)

Primary	2	2	1	26	12	43
Secondary	2	11	4	6	4	27
Diploma/degree	0	9	2	0	0	11
No formal education	0	0	0	2	2	4
Total	4	22	7	34	18	85

Source: Field Data (2019)

From the table, most of the respondents, about three-quarters (63.8%) were aware of clean energies that are used for cooking. The rest did not know about clean cooking energies.

Unfortunately, this data on clean energy used for cooking awareness was quite ambiguous. The study ascertained that even those who were aware of the clean cooking energies had no ability to give any example of such energies.

On the question regarding the level of agreement with the statement on whether the residents in Laini Saba were aware of the clean cooking energy types and their benefits, the study established that the level of awareness and benefits of using clean cooking energies was very low in the area. The responses varied from strongly disagreed (25%), did not know (25%), agreed (22%), strongly agreed (14%) and 14% also disagreed.

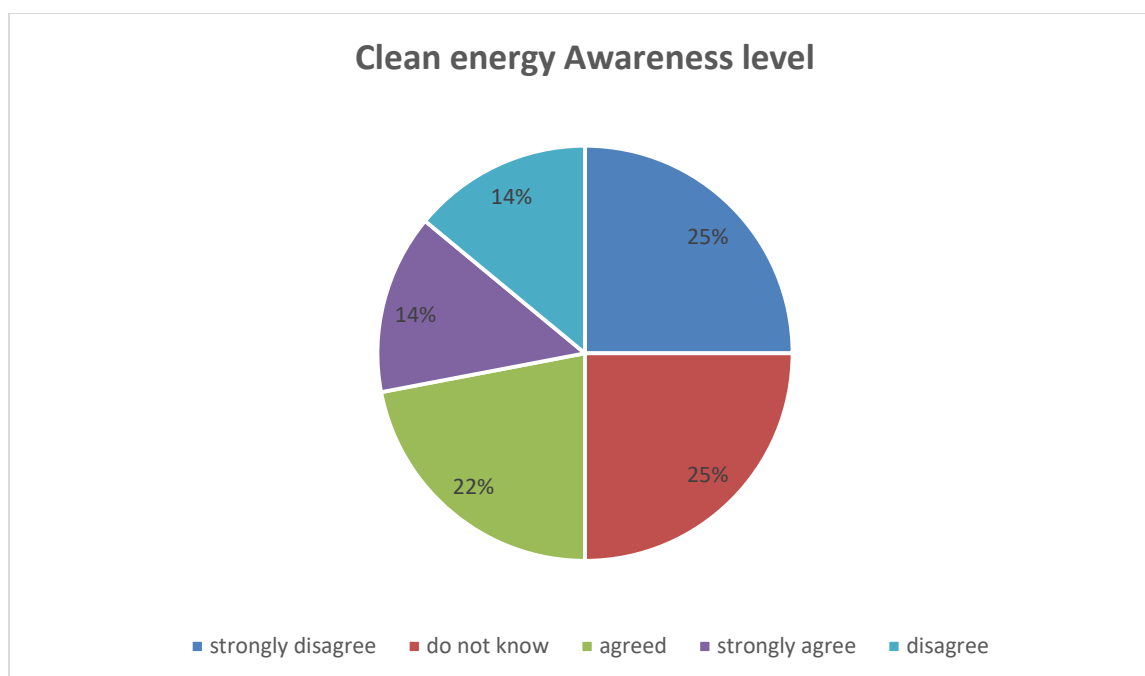


Figure 4.4: Pie chart of awareness of clean energy

Gender of Household head

Different types of cooking energies are used by both men and women in Laini Saba. From the study findings, women seemingly use unclean energy types more than men. They mainly use charcoal and kerosene because of their convenience, cost and availability in the area. Unlike men, women spend most of their time doing domestic chores and this explains why they (women) are the most affected by indoor air pollution.

Table 4.5: Gender and choice of cooking energy

	Biogas	LPG	Hydropower	Charcoal	Kerosene	(N)
Male	2	5	2	12	15	36
Female	0	10	4	21	14	49
Total	2	15	6	33	29	85

Source: Field Data (2019)

Benefits of using clean sources of energy for cooking

According to the World Health Organization (2013), use of clean energy has substantial benefits including the achievement of SDGs related to poverty alleviation, health and education improvements. In this study, 48.2% of the respondents opined that clean energy usage saves on time taken to prepare meals. Some respondents (21.2%) revealed that clean energy improves health by eradicating respiratory and indoor air complications. Moreover, 21.2% of the respondents argued that cost of energy is highly reduced in the long run as a result of using clean energy, while 9.4% had the opinion that clean energy enhances education of children. This data is shown in figure 4.5 below.

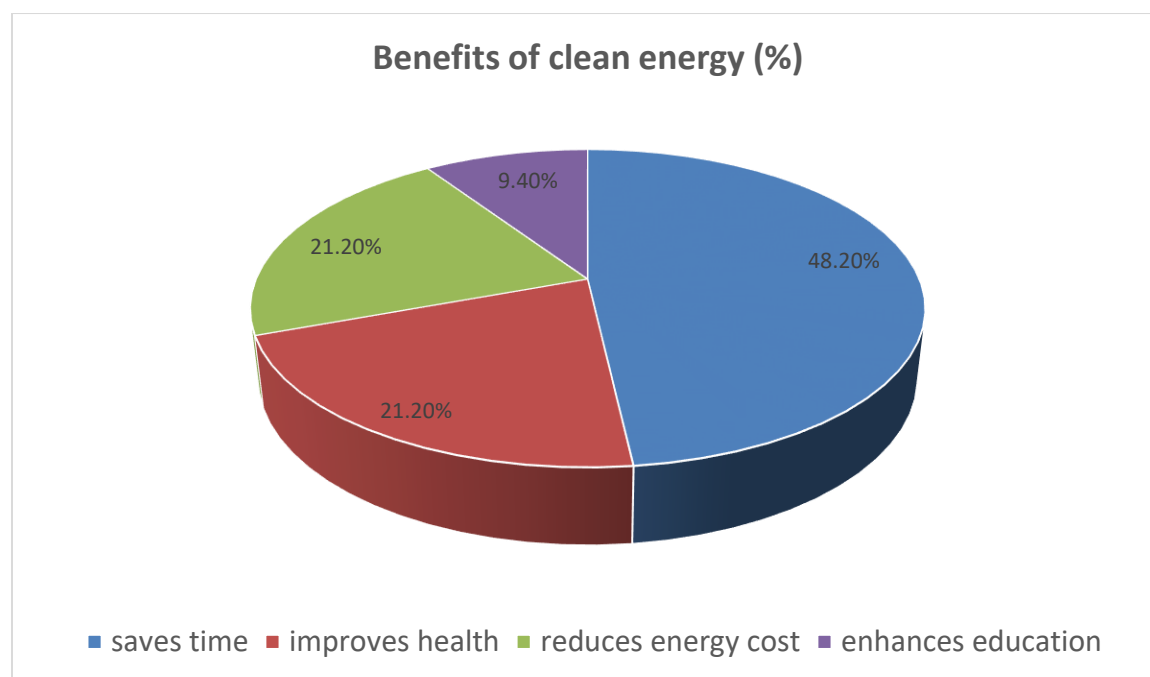


Figure 4.5: Benefits of clean energy for cooking

Yet, a good section of the respondents had the view that clean energy has the potential of employment opportunities as well as reduction of poverty among the people, NGOs and other entities involved in the manufacturing of clean energy. Furthermore, use of clean energy means

good to the environment through preservation of forests. The residents believe that, in the long run, trees are conserved from charcoal burn and fuel wood use. There are many youths in the study area who already benefit from selling of LPG cylinders while others are employed in the Biogas plants in the area.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter briefly gives a summary of findings, conclusion and recommendations as a result of this study, and it focusses on the research objectives, that is, 1). To find out accessibility to green energy resources in Laini Saba, Kibra; 2). To evaluate the factors that determines the use of green energies by households in Laini Saba, Kibra; and 3).To examine awareness on the benefits of using green energy by households in Laini Saba, Kibra.

Summary of findings

With regard to the first objective, the study ascertained that both clean energy and unclean energy sources are used by households in Laini Saba, Kibra. The use is subjected to a variety of intensities and choices. As such, charcoal, kerosene, LPG, electricity, ethanol and biogas are the most used types of cooking energies in the region. The use of charcoal and kerosene, though unclean, is based on their affordability, accessibility and being faster in cooking as well as providing warmth and lighting to the households.

In response to the second objective, the main factors influencing the use of green energies by the households include cost, employment, household level of education, and gender of household head. The poor conditions of the majority of households mean that they have constrained sources of capital and therefore end up consuming affordable unclean energy sources like charcoal and kerosene. Consecutively, those employed are low income earners and their choice of energy is mainly charcoal and kerosene because of irregular incomes. Households with high education levels are often informed and tend to use clean energies unlike those with low levels of education whose main source of energy is charcoal and kerosene. In most cases, female household heads use charcoal and kerosene for cooking.

The benefits of using green energies among the residents of Laini Saba are reduced time during cooking, mitigating environmental pollution, which improves human health, reduces cost of energy in the long run and ensures the education of children. Another importance include creation of employment opportunities thus checking poverty and conserving the environment.

Conclusion

The study sought to identify the various energy resources used in Laini Saba, the factors determining their use and the benefits of using clean energy sources in Laini Saba, Kibra. The results were that the residents of Laini Saba use both clean and unclean sources of energy in meeting their household needs. To this far, it is clear that most residents will continue to use charcoal and kerosene for a long time unless requisite policy measures are put in place. The cost of clean energies such as electricity and LPG is still high while most residents are very poor. Though efforts to erect biogas plants in the area are a good initiative, the consumption of biogas and ethanol is very low based on the perception by many people that their production from human waste is not efficient. In order to increase the use of clean energy in Laini Saba, there is urgent need to enhance their availability and awareness about their benefits to the households.

Recommendations

To policy makers;

1. There is need to ensure maximum inclusion of all the concerned parties including the government and NGO enhance suitable energy use through provision of financial support.
2. To continue with informed campaigns on the benefits of using clean energy by all households, and making cleaner energies available and affordable.

To the Laini Saba residents;

1. They should realize the need to form supportive groups to help them have a say on the prices of energy as well.
2. Create and enhance platforms for education and awareness so that they become fully aware of the benefits of using clean energies.
3. There is need to educate the residents of Laini Saba on the socio-cultural aspects making it harder to adopt greener energies.

To future researchers

1. The future researchers should carry out studies with larger sample size to see if they will find the same results.
2. Further research is still needed to determine the households' awareness and understanding of health problems brought by the use of unclean energies.

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APPENDICES

Appendix 1: Research Questionnaire

The Technical University of Kenya

Department of Geoscience and the Environment

Name: Marigi Manuel Iresa

Year: 2019

Part One: General Information

Date

Questionnaire Number.....

1. For how long has the household stayed in Kibera?

Less than 1 year ☐ 1 – 5 years ☐ 6 – 10 years ☐ more than 10 years ☐

2. How many members does the household have? (both adults and children)

One ☐ Two ☐ Three ☐ Four ☐ Five ☐ Six ☐

More than Six ☐

3. Fill the table by ticking where appropriate.

	Gender	Age (years)	Level of Education
Household head			
Spouse			
	Male <input type="checkbox"/>	18 – 25 <input type="checkbox"/>	Primary <input type="checkbox"/>
	Female <input type="checkbox"/>	26- 35 <input type="checkbox"/>	Secondary <input type="checkbox"/>
		36 – 45 <input type="checkbox"/>	Diploma/degree <input type="checkbox"/>
		More than 45 <input type="checkbox"/>	Masters <input type="checkbox"/>
			Other(s) specify <input type="checkbox"/>

4. What is your main source of income?

Self-employment ☐ Formal ☐

Casual labor ☐ other (specify) ☐

5. What is your monthly income?

kshs 1,000 and below ☐ between kshs 1,000 – 5,000 ☐

Between Kshs 5,001 – 10,000 ☐ between kshs 10,001 – 15,000 ☐ more than ksh 15,000 ☐

6. What type of dwelling unit do you occupy?

Single room/bedsitter ☐ two rooms ☐

Three rooms ☐ more than three rooms ☐

7. Between breakfast, lunch, and supper, which meals do you take regularly in a day?

One ☐ two ☐ all ☐

8. What is the main reason for not taking the three meals in a day?

Low/lack of income ☐ no time to prepare ☐ by choice ☐

Part two: information on energy used for cooking

9. What type of energies do you use? Tick the main in each category

Category 1

category 2

Biogas ☐

firewood ☐

Solar power	<input type="checkbox"/>	charcoal	<input type="checkbox"/>
Wind power	<input type="checkbox"/>	kerosene	<input type="checkbox"/>
LPG	<input type="checkbox"/>	other (specify)	<input type="checkbox"/>
Geothermal	<input type="checkbox"/>		
Hydropower	<input type="checkbox"/>		
Other (specify)	<input type="checkbox"/>		

10. Which of the above two categories of energy do you use most?

11. Why do you use the energies you selected above more than others?

Affordable	<input type="checkbox"/>	accessibility	<input type="checkbox"/>	pollution free	<input type="checkbox"/>
Cooks faster	<input type="checkbox"/>	recommended by government/NGOs	<input type="checkbox"/>	other (specify)	<input type="checkbox"/>

12. If you were to choose which type of energy to use, which one will you select according to priority?

	Most preferred	Preferred	Least preferred
Charcoal			
Firewood			
Kerosene			
LPG			
Solar			
Biogas			

Hydropower			
Wind			

Part three: Factors influencing type of energy use

13. How much do you agree with this statement “the cost of energy influences the type of energy used”?

Strongly agree ☐ agree ☐ strongly disagree ☐ disagree ☐

Do not know ☐

Awareness level

14. Have you ever heard of “clean energy”?

Yes ☐ No ☐

15. If yes, where did you hear about it first?

16. What is your own understanding of ‘clean energy’?

17. What are some of the clean energies you know? List them down

.....

.....

18. To what extent do you agree with the statement, “Many residents are aware of several types of clean energies and the benefits of using them?”

Strongly agree ☐ agree ☐

Strongly disagree ☐ disagree ☐ do not know ☐

Part Four: Information on benefits (either for LPG, Biogas or Hydropower)

19. For how long have you used any of the above types of energy for cooking?

Less than a year ☐ 1-2 years ☐ 2-3 years ☐ more than 3 years ☐

20. Have you experienced any benefits as a result of using the energy types selected?

Yes ☐ No ☐

21. If yes, tick the main benefit obtained

Improved family education ☐

Saves on energy cost ☐

Improves family health ☐

Saves time ☐

Other (specify) ☐

22. Do you think use of clean energy can contribute to the following? Tick appropriately.

Poverty reduction ☐

Employment creation ☐

Forest preservation ☐

Appendix 2: interview guide for Laini Saba area administrator

1. What are the types of energies used in this area for cooking?

2. What is the most used type of energy in this area?

3. In your view, what are some of the factors you think influence the choice of energy type used for cooking in this area?
4. How do you define clean energy in your understanding?
5. What are some of the benefits of using clean energy for cooking according to you?
6. What efforts have the government taken to increase the use of clean energy for cooking in this area?

Appendix 3: Interview guide for administrator of Laini Saba Biogas plant

1. What do you know about clean energy?
2. What other clean energies do you know apart from biogas?
3. Why were the biogas plants established in this area?
4. Do these biogas plants have any benefits to Laini Saba households?
5. What are some of the challenges faced as a result of using these biogas plants in this area?
6. Do you have any measures to encourage the use of clean energies in this area?