FACTORS INFLUENCING HOUSEHOLD ENERGY CONSUMPTION: THE CASE OF BIOMASS FUELS IN KIKUYU DISTRICT OF KIAMBU COUNTY, KENYA

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DECLARATION

This Research Project Report is my own work and has not been submitted for a degree at any other university.

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DEDICATION

I dedicate this Research Project to God Almighty for His grace, mercy and blessings that have seen me through this programme. To my beloved family for their love, support and encouragement throughout this programme. To my loving parents, who have been a source of inspiration and have demonstrated to me how to live a life of humility, sacrifice and hard work. To my sisters and brother who have always been there for me.

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ABSTRACT

Biomass dominates energy consumption in Sub- Saharan Africa even in relatively well-off countries such as Botswana and prominent oil producing countries such as Nigeria. The main consuming sectors are residential, transport, industry and commercial. In the residential sector, households require energy primarily for cooking, lighting and space conditioning. In Africa, cooking often accounts between 90 -100% of household energy consumption due to limited space conditioning loads. The amount and type of energy that a household consumes depends on age, education, number of cooking times, household size and costs of energy. The main objective of this study was to establish factors affecting household consumption of biomass fuels in Kikuyu District, located in Kiambu County, Kenya. Specifically the study set out to investigate how age, education level of the household head, daily cooking frequency, household size and energy cost affects household's biomass energy consumption; The study was based on the null hypothesis that there was no significant relationship between age of household heads, education level of household head, daily cooking frequency, household size and cost of energy and the amount of biomass energy consumed by households. The study applied a survey design and was based on a stratified random sample of 198 households drawn disproportionately from the six wards in the district. The study used questionnaires to collect data from the sample. Simple regression analysis method is used to analyze the data with the use of SPSS as a platform to analyze the data collected from the field.

Data analyses revealed that the most significant factors that affected household biomass energy consumption is the cost of energy at 73.4% followed by household size at 63.8% then daily cooking frequency with 59.8% and age with 54.6%. The education level of the household head was not a significant factor as revealed by the analysis. Majority of the respondents (32.8%) indicated that their households spent between Kshs. 1000 to Kshs. 1500 per month for the purchase of biomass energy for household use while majority of households comprised of household ranging from four to five members. Majority of households cooked thrice a day and the majority age group was the age bracket of 40-49 years.

The study concluded that energy cost, household size, daily cooking frequency and age determine biomass energy consumption in Kikuyu District. This accounts a total average of 50.5% of the factors that affect biomass energy consumption with the leading factor being energy cost. The study recommends further studies that account for 49.5% of other factors influencing household biomass energy consumption. The study also recommended that energy price regulatory policies be set up to ensure that households can have access to biomass energy

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ACRONYMS/ABBREVIATIONS

AFREPREN/FWD	Africa Energy Policy Research Network
CBOs	Community Based Organizations
CO_2	Carbon Dioxide
ECOWAS	Economic Community of West African States
EU	European Union
FAO	Food and Agricultural Organization
GOK	Government of Kenya
HAP	Household air pollution
HH	Household head
IAP	Indoor Air Pollution
IBTs	Improved Biomass Technologies
IEA,	International Energy Authority
KIPPRA	Kenya Institute of Public Policy Research and Analysis
LPG	Liquidified Petroleum Gas
MoE	Ministry of Energy
MW	Mega watts
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
UK	United Kingdom
UNDP	United Nations Development Programme
UNGACC	UN Foundation Global Alliance for Clean Cook stoves
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Biomass refers to biological material derived from living, or recently living organisms. In the context of biomass for energy this is often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material. Thus biomass Energy is defined as any organic materials that can be burned and used as a source of fuel. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into: thermal, chemical, and biochemical methods (Kunkes, et al, 2008).

Wood remains the largest biomass energy source to date; examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. In the second sense, biomass includes plant or animal matter that can be converted into fibers or other industrial chemicals, including biofuels (Kunkes, et al, 2008).

Ensuring access to clean and efficient household energy is arguably one of the major challenges that developing countries face today. Around three billion people across the world rely on solid fuels and traditional, inefficient stove technologies to meet their basic energy needs, including cooking, heating and lighting. Some countries and localities have very successful experiences with the development and diffusion of renewable energy technologies, whereas similar projects have become highly controversial in given countries (Rehfuess et al, 2006). These differences are not fully explicable in terms of natural endowments, as evidenced by the uptake of solar energy in Austria, Germany and Greece, (Tsoutsos 2005), or the emergence of local opposition to biomass energy projects more visibly in the UK, France, the Netherlands and Greece than, for example, in Denmark or Germany (Predace 2003; Szarka 2006; Breukers and Wolsink 2007). Solid fuel use includes biomass fuels (e.g. wood, dung, crop residues, charcoal) and coal while cleaner fuel use includes various liquids (e.g. LPG, ethanol, plant oils) and gaseous fuels (e.g. producer gas, biogas) as well as electricity. Kerosene and paraffin occupy a separate category as

they are relatively efficient liquid/solid fuels which are cheap and easily available but should not be actively promoted as cleaner fuel options given the mounting evidence on health hazards that include: increased risks for tuberculosis (Pokhrel et al, 2010), burns, poisonings and other unintentional injuries as well air pollution which lowers the quality of the environment.

In the short to medium-term, biomass fuels are likely to remain predominant among poor households in developing countries, and improved cooking stoves will therefore be a critical means of achieving greater fuel efficiency and improved health. Among middle-income households in developing countries and in most middle income countries, gas and in particular, LPG has already replaced all or selected cooking tasks and increasingly represents a predominant alternative fuel for poorer households. In selected settings, ethanol, biogas or other alternative fuels can provide an efficient and clean source of household energy but are less likely to be scaled up worldwide. In view of availability, acceptability and feasibility considerations, this systematic review therefore focuses primarily on LPG and improved solid fuel cooking stoves as the two interventions with the greatest potential for large-scale uptake globally. Brief consideration of other cleaner fuel options will however be included in this research.

Decisions to change practices and adopt, pay for, use and maintain cleaner and more efficient household energy technologies take place at the household level, embedded in the community, but also include influences from international and national economic factors, for example oil prices and fuel subsidies, respectively. This systematic review therefore applies a household/community perspective in its search for factors that enable or limit household uptake. These factors impacting or modifying household and community decisions can be located at different levels (e.g. programmes, policies and regulations at sub-national and national levels)
Unless rapid and effective action is taken, their number will increase over the coming decades (IEA 2004), especially in view of greater vulnerability brought about by climate change, the global financial crisis and volatile energy prices (UNDP & WHO 2009).Traditional household energy practices have dramatic consequences on health, the environment and socio-economic development leading to unsustainable development. Household air pollution (HAP) (also referred to as indoor air pollution or IAP) from burning solid fuels is a major risk factor for pneumonia, chronic respiratory diseases and several other health outcomes, resulting in more than 1.5 million annual deaths, primarily among children and women (Pokhrel et al, 2010). The

inefficient burning of biomass fuels also represents an unsustainable use of natural resources, aggravating deforestation in areas where wood is scarce. It also contributes to climate change, as much of the fuel energy is lost as so-called products of incomplete combustion, including the potent climate warming pollutants methane and black carbon (Tsoutsos, 2005). Finally, much time spent on fuel collection and cooking and/or a disproportionate amount of income spent on securing lower-quality fuels undermines opportunities for education and development among societies. Lack of access to modern energy services therefore contributes to trapping poor households in a cycle of ill-health and poverty. Several regional and global initiatives, consisting of the Economic Community of West African States (ECOWAS 2006), the World Energy Outlook 2010 (IEA 2010) and the United Nation Secretary General's Advisory Group on Energy and Climate Change (AGECC 2010), have emphasized the need to address cooking energy crisis and to achieve universal access to modern energy. In view of this growing recognition and substantial untapped financial resources in development aid, private sector investment and official/voluntary carbon offset schemes; the large-scale promotion of modern household energy technologies seems more realistic today than ever before.

In working towards this goal, one critical consideration is the effectiveness of interventions in achieving desired benefits for health, the environment and socioeconomic development. An ongoing systematic review of the impacts of household energy interventions on IAP and health outcomes, funded by the WHO in the context of work on developing indoor air quality guidelines for household fuel combustion (WHO effectiveness review), is addressing one major question regarding effectiveness. An equally important consideration is how we can achieve the "quantum leap" (WHO 2006) required to result in the sustainable adoption of modern household energy practices by hundreds of millions of households.

According to KIPPRA (2010) as Kenya aspires to be a middle income economy as envisaged in Vision 2030, it faces an enormous task of meeting energy needs due to the high expectations in growth to power the economy. The country therefore needs to come up with strategies and investment plans to secure sustainable supply of energy to meet the growing demands. The energy sector is considered a key enabler to achieving vision 2030. Electricity, petroleum and renewable energy are the most potential sub-sectors. Even though wood fuels are the most consumed fuels in Kenya, petroleum and electricity are the most dominating fuels in the

commercial sector. Other major energy consumption sectors apart from commercial sector, include: transport, manufacturing and residential sectors.

1.2 Statement of the Problem

The research in essence is meant to contribute to the ongoing endeavors in Kenya to bring about change in the management and use of biomass fuels. It will contribute to the ongoing activities in Kenya by addressing energy challenges and inefficiency as well as develop appropriate environmental sound management practices for energy management and appropriate policy packages for sustainable energy management.

Kikuyu District has been experiencing various challenges in sourcing the energy for domestic use of which majority of the households rely on biomass energy and there has been no study conducted to determine the various factors that affect biomass energy consumption. Despite the great use of biomass fuels for home use few studies have been done on factors that influence consumption of household energy in Kikuyu.

This study examined the various types and factors influencing the use of biomass energy that are commonly used by households in Kikuyu District and how the government and other agencies that are involved in the formulation of policies and regulations dealing with energy would come up with comprehensive and effective policy measures that would be used to regulate consumption of biomass fuels in the country.

1.3: Objectives of the study and research questions

1.3.1 Overall objective

The overall objective of the study is to determine the factors influencing biomass energy use among rural households in Kikuyu District of Kiambu County in Kenya.

1.3.2: Specific Objectives

The specific objectives of the study were:

a) To investigate how age of the household head affects household energy consumption
b) To determine how the education of the household heads affects household's energy consumption

c) To assess how the number of cooking times affects the amount of energy consumed by households
d) To establish the relationship between household sizes and the amount of energy a household consumes
e) To determine how cost of energy affects the amount of energy consumed by the households.

1.3.3: Research Questions

a) How does age of the household head affect household energy consumption?
b) How does the education of the household heads affect household energy consumption?
c) How does the number of times of cooking affect the amount of energy consumed by households?
d) How does the household size affect the amount of energy a household consumes?
e) How does the cost of energy affect the amount of energy consumed by households?

1.4: Research hypotheses

This study was based on:

a) H0: There is no significant relationship between age of the household head and the energy consumption by the household.
   H1: There is a significant relationship between age of the household head and the amount of energy consumed by a household.
b) H0: There is no significant relationship between education of the household head and the energy consumption by the household.
   H1: There is a significant relationship between education of the household head and the energy consumption by the household
c) H0: There is no significant relationship between the number of times of cooking and the energy consumption by the household.
   H1: There is a significant relationship between the number of times of cooking and the energy consumption by the household.
d) H0: There is no significant relationship between the household size and the energy consumption by the household.

H1: There is a significant relationship between the household size and the energy consumption by the household.

e) H0: There is no significant relationship between the cost of energy and the energy consumption by the household.

H1: There is a significant relationship between the cost of energy and the energy consumption by the household.

1.5: Significance of the Study

In the past two decades numerous studies (examples like S. Paul & R. Bhattacharya 2004 and Woh, & K Lee 2004) have examined the causal relationships between energy consumption and economic growth as measured by either income or employment. The direction of the causality between energy consumption and income is an important issue for energy economics, economic growth, and policies towards energy use. Understanding the relations between income and energy consumption assists in the implementation of various policies that are entailed in the conservation of energy and the reduction of pollution posed by energy use. Other studies (like Heltberg 2003, Mekonnen & Kohlin, 2008; ESMAP, 2003; Jingchao & Kotani, 2010), have been done on the subject of household energy consumption, very little is done on factors that influence household energy consumption in Kenya

Kenya aspires to be a middle income economy as envisaged in Vision 2030, it faces an enormous task of meeting energy needs due to the high expectations in growth to power the economy. The country therefore needs to come up with strategies and investment plans to secure sustainable supply of energy to meet the growing demands. The energy sector is considered a key enabler to achieving vision 2030. In order for Kenya to draft this strategies and investment plans on sustainable energy supply which will lead to achievement of vision 2030 information on factors that influence household energy consumption is important

Thus, this study aims to fill this research gap on factors influencing the consumption of biomass energy by households among the rural households in Kikuyu District of Kiambu County in Kenya

1.6: Scope of the study

The study focuses on household energy consumption, taking the case of biomass energy use in Kikuyu District of Kiambu County, Kenya. The study focuses on three types of biomass fuel

these are firewood, charcoal and kerosene. The study uses household energy data to examine factors that influence the use of various biomass fuels at household level.

1.7 Summary

Chapter one of the study introduced the intention of the proposed research, giving a background of the study while putting the topic of study in perspective. It gave the statement of the problem, defined the problem and the purpose of the study. This chapter further outlined the objectives and the scope of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviewed previous research studies as wells as theories related to the study topic. There are many studies on competition, distribution, advertising and positioning which relate to sustainability of biomass energy consumption in Kenya's Kikuyu District.

2.2 Factors that influence human- energy interactions:

According to the KIPPRA (2010) two major approaches to energy demand analysis are macro and sectoral demand analysis. Macro demand analysis considers demand as a function of population, income and prices. Sectoral demand examines the structure of sector and sub-sectors and their energy consuming activities, including equipment. Many attempts have been made to model the effect of price changes and other factors on domestic demand both for total of all forms of energy and for specific types of fuel.

The reviewed studies reveal that in the residential sector, there is an extensive empirical literature on household energy demand with most papers using micro data and econometric single equation models for household demands on electricity, gasoline and car fuels. Baker *et al*. (1989), for example, uses a quadratic model to estimate gas and electricity expenditure in the United Kingdom, including several energy prices as regresors in each single equation. The study however pays relatively little attention to the estimation of household energy demand through multiple equations modeling (Greene, William H. 2002). The studies reveal that there are two main models that are widely used to explain household energy consumption or choice behavior. These are the fuel stacking and fuel ladder models. The fuel stacking model suggests that as people become richer, they may be expected to move from traditional biomass fuels to more advanced and less polluting or cleaner fuels (e.g. From wood to charcoal, kerosene, and then to gas). The fuel ladder model on the other hand postulates that fuel switching is mainly observed when there is significant increase in income (KIPPRA 2010).

Household fuel choice has often been conceptualized using the "energy ladder" model (Heltberg 2003). This model places heavy emphasis on income in explaining fuel choice and fuel

switching. The energy ladder model envisions a three-stage fuel switching process. The first stage is marked by universal reliance on biomass. In the second stage households move to "transition" fuels such as kerosene, coal and charcoal in response to higher incomes and factors such as deforestation and urbanization. In the third phase households switch to LPG, natural gas, or electricity. The main driver affecting the movement up the energy ladder is hypothesized to be income and relative fuel prices (Heltberg R, 2005).

Geographic location (urban or rural) is a way to approach the diversity of institutional, historical and cultural issues influencing the sustainability of household energy. There are four broad categories of contextual factors that influenced the societal acceptance of new energy projects at the national and local levels: political and policy issues, socio-economic factors, cultural factors and geographic factors (Nicol, 2003). In terms of political and policy issues, factors such as the presence of specific supportive (or restrictive) policy instruments are fairly obvious, but also the stability of policy instruments may have influence on public confidence in the new technology projects. Moreover, national and local policy cultures and administrative procedures provided variable conditions for projects to seek alignment among different interests, and differences in the distribution of power provided projects, their supporters and opponents' variable access to centers of power.

While the availability of natural resources is an 'objective factor', perceptions of the abundance of different energy sources could be quite different, and could influence public confidence in the projects. Socio-economic issues, such as regional economic or social development needs are important in promoting a number of projects, but the case studies also indicated that issues of development were often subjects of controversies in which projects could become embroiled. In a similar vein, different regions welcomed investments from other countries or economic centers differently: at some sites, foreign investment was a sign of progress, whereas at others it was viewed with suspicion. (J. C. Rogers et al, 2008) Moreover, the importance attributed to energy independence at the national and regional levels could significantly boost the societal acceptance of some projects, whereas low energy prices, high production factor costs and competing technologies and industries were challenges that many projects have had to grapple with. Cultural factors relate to historically shaped traditions and beliefs that the project needs to deal with. These include the level of trust in different institutions involved in the project, such as large

corporations, local business or local government. Moreover, different local traditions influence the ability of projects to mobilize bottom-up initiatives or to introduce top-down plans which are acceptable amongst societies. Levels of environmental awareness influenced the relevance of environmental arguments (such as combating climate change) in justifying the projects. Furthermore, different technologies have variable track-records in terms of positive or negative historical experiences among the local populations. Overall attitudes to new technologies can also influence the acceptability of a project: novelty can be a bonus in some regions, but a cause for concern in others. Finally, geographic factors such as climate naturally influence the types of projects that are acceptable in different locations. A very important geographic factor, both at the national and the local levels, pertains to the availability of suitable locations: for example, the possibility to utilize existing industrial sites, or to locate facilities where they can support local development. (J. C. Rogers 2008)

2.2 Energy Policy Interventions

Most countries favor public policies that promote access to cheap energy, although this may often be balanced with concerns related to negative externalities of energy production and use. For this reason, various policy interventions and strategies across the world have been used to improve accessibility, ensure security in supplying affordable energy and to achieve efficiency and conservation of energy. These have been implemented by individual countries or unions such as the European Union and within economic blocks (Karekezi et al, 2009) from other countries that have been implemented with success. Many policy analysts stress the need for aggressive dissemination of improved biomass technologies (IBTs) in Sub-Saharan Africa in order to mitigate negative effects of traditional biomass energy use; particularly indoor air pollution that is linked to respiratory diseases which is one of the main causes of death of children under the age of five. Sub-Saharan African governments have inadequate policies that could support the development and dissemination of IBTs (Karekezi et al, 2009). Private sectors, NGOs, CBOs and donor organizations implement projects aimed at ensuring the rapid dissemination of these IBTs. In particular, efforts to reduce the cost of widely used IBTs such as improved cooking stoves should be accelerated so that they are within the reach of even the poorest of the poor in Sub-Saharan Africa (Smith, 1991; Kammen and Ezatti, 2001). Improved rural and urban biofuel stoves, which are designed to reduce heat loss, increase combustion efficiency and attain a higher heat transfer, would be an appropriate response option. These

stoves could ensure efficient utilization of fuel wood and could significantly reduce indoor air pollution thus mitigating respiratory health problems associated with smoke emissions from stoves (Karekezi and Kithyoma, 2002; Kammen and Ezzati, 2001; Akarakiri, 2002).

With regard to Kenya's National Energy Matrix, total final energy consumption in Kenya in 2009 was 14,353.80 thousand tonnes of oil equivalent while the total primary energy supply was 18,215.99 thousand tonnes of oil equivalent (Karekezi et al, 2009). In 2009, petroleum fuels accounted for about 28.57% of the total national energy consumption while electricity and combustible renewables accounted for about 3.11% and 67.65% of the total national energy consumption (Karekezi et al, 2009). The energy sector contributes about 9.49 % to GDP with the petroleum sector, electricity and fuel wood sector contributing 8.4%, 0.6 % and 0.4% respectively (Karekezi et al, 2009). The GDP per unit of oil equivalent is PPP US$ 2.98 compared to that of Botswana of US$ 12 and Tanzania US$ 2.53 (Karekezi and Kithyoma, 2002)

2.3 Biomass Consumption

This section focuses on contributions by the various scholars and researchers in the area of biomass fuels and the various factors that affect household energy consumption.

2.3.1 Trends on biomass energy consumption in the world

According to FAO's Unified Bioenergy Terminology (FAO, 2004), bio-energy can be defined as energy obtained from biological and renewable sources (biomass). Bio-energy may be derived in the form of heat or transformed into electricity for distribution. Biomass also can be transformed into biofuels, which are portable feedstock for use in the generation of bio-energy. Biofuels are defined as feedstock intended for the production of bio-energy, produced directly or indirectly from biomass (Karekezi and Kithyoma, 2002). Biofuels can be in solid form (fuel wood, charcoal, wood pellets, briquettes etc.) or liquid (bioethanol, biodiesel).

From 1990 to 2008, IEA estimated that the average use of energy per person increased by 10% while the world population increased by 27% (IEA, 2004). In the same period, regional energy use grew tremendously: the Middle-East 170%; China, 146%; India, 91%; Africa, 70%;Latin America, 66%; the USA, 20%; the EU-27 block, 7%; while the world overall grew by 39%. In 2008, total worldwide energy consumption was 474 exajoules (474×10^{18} J=132,000 TWh). This is equivalent to an average power use of 15 terawatts (1.504×10^{13} W). The global potential for

renewable energy is: solar energy 1600 EJ (444,000 TWh), wind power 600 EJ (167,000 TWh), geothermal energy 500 EJ (139,000 TWh), biomass 250 EJ (70,000 TWh), hydropower 50 EJ (14,000 TWh) and ocean energy 1 EJ (280 TWh).

2.3.2 Trends on biomass energy consumption in Africa with a focus on some selected countries

According to UN-DESA report (2004) households require energy primarily for heating, cooking and lighting. In Africa, cooking often accounts for between 90 and 100% of household energy consumption due to limited space conditioning loads (Karekezi and Kithyoma, 2002). Household energy consumption levels and the types of energy used depends on a variety of factors but mainly on availability and cost of energy resources (Karekezi and Kithyoma, 2002). The table below shows that as incomes increase, the use of modern cleaner energy resources becomes more prevalent in rural households. For instance, while low income rural households rely mainly on biomass fuels for cooking; high income households use modern fuels such as kerosene, LPG and electricity (Karekezi and Kithyoma, 2002). Also, among the poor, biomass resources are used in unsustainable and inefficient ways due to lack of access to information, financial resources and technology (Kammen and Ezzati, 2001).

Table 2.1: Rural Household Income with relation to type of energy used

	Rural Household Income		
	Low	**Medium**	**High**
Cooking	Wood, residues dung	Wood residues dung ,kerosene biogas and LPG	Wood kerosene electricity LPG biogas
Lighting	Candles, kerosene wood	Candles kerosene LPG and electricity	kerosene electricity
Space conditioning	Wood, residues dung	Wood , residues dung and LPG	Wood , residues dung LPG electricity and coal
Other appliances	Often none	Grid or genset-based electricity and batteries	Grid or genset-based electricity and batteries

Source: AFREPREN, 1999

Biomass dominates energy consumption in sub-Saharan Africa even in relatively well-off countries such as Botswana and prominent oil producers such as Nigeria (Mathangwane *et al*, 2001). Botswana's energy sector, for example, is characterized by both traditional and commercial energy sources, with fuel wood being the principal energy source whereby the main consuming sectors are residential, transport, industry and commercial, (Mathangwane *et al*, 2001).

2.3.2.1 Biomass energy consumption in Nigeria

In 1994, Nigeria was the highest consumer for fuel wood in the West African sub-region (Mathangwane *et al*, 2001). In this country, fuel wood became scarce and expensive over the years and households walked increasingly longer distances to collect fuel wood (Mathangwane *et al*, 2001). Nigeria's rapid population growth has led to forest land being converted to agricultural land in order to provide food and export crops (Akarakiri, 2002). Rubber, coffee, cocoa and palm oil plantations have replaced natural forests. Also, increased demand for fuelwood has caused its price to rise relatively more than the price of other fuels in the country (Akarakiri, 2002). Sources of energy for rural use in Nigeria include fuel wood, oil, gas, and coal. Petrol is used for transportation while kerosene is used for lighting and cooking. Gas is mainly used for electricity generation and fuelling electric power stations. As at 2002, gas had no significant impact on the development of the rural areas (Akarakiri, 2002). The percent of coal consumption in the energy mix within the country was less than 0.5% (Akarakiri, 2002).

2.3.2.2 Biomass energy consumption in Tanzania

The major energy resources consumed in Tanzania (in percent) are biomass fuels (91.6%), petroleum products (6.8%) and electricity and coal (1.6%) (IEA, 2003; Kaale, 1999). In 2001, Tanzania's final energy consumption was estimated at 2.4 million TOES - equivalent to a per capita consumption of 246 kgoe (IEA, 2003; World Bank, 2003a).

2.3.2.3 Biomass energy consumption in Ghana

Biomass is the dominant source of energy in Ghana accounting for 65% of the total energy consumed in 2001 (IEA, 2003). Biomass energy resources in Ghana include fuel wood (firewood and charcoal), wood residues, crop residues and human/animal waste. Fuel wood is mainly used in the household sector for cooking and heat applications (Edjekumhene and Brew -Hammond, 2001). The sub-Saharan African country mainly focuses on the importance of biomass and the

household sector which largely relies on biofuels. Consequently, the Ghanaian case illustrates how biomass and the household sector should be important foci for sustainable energy consumption initiatives in Sub - Saharan Africa. Coal and electricity provides three quarters of total energy consumed by the industrial sector in Ghana (UN, 2004). Comparison of sectoral energy consumption in South Africa between 1992 and 2000 shows transport and industry energy use rising by 27% and 22%, respectively; mining and quarrying, agriculture, and commerce and public service shares falling by 15%, 18% and 25%, respectively ; and, residential energy consumption remaining almost constant (Akarakiri, 2002). Although in the past, coal and electricity use in industry were perceived as the principal targets for sustainable energy consumption initiatives, the rapid growing consumption of energy in the transport sector justifies the evaluation of this strategic focus.

2.4 Energy sources used by Kenyan households

According to the Energy Environment and Development Network for Africa (AFREPREN/FWD, 2008) the key available energy supply options in Kenya include biomass (wood fuel and charcoal), petroleum, electricity (hydropower, wind, geothermal) and to a small extent, coal. Like most sub-Saharan African countries, biomass dominates the country's energy supply. The next sections discuss the available energy resources, consumption as well as access to modern energy resources in Kenya.

2.4.1 Biomass

Biomass is the most dominant and principal source of primary energy for majority of the population in Kenya (70%) (AFREPREN, 2009) . According to the 2004 statistics from the Government printers, sustainable biomass energy supply was estimated at 15.4 million tonnes annually against a demand estimated by the National Environment Management Authority (NEMA) to be over 38.1 million tons (AFREPREN, 2009). Therefore, the supply/demand deficit of biomass energy supply in the country is about 60% (Ibid).

2.4.2 Electricity

Grid electricity in Kenya, is generated mainly from hydropower in large and small scale, thermal (oil) and renewable energy sources such as geothermal energy, wind energy, solar energy and cogeneration. The Ministry of Energy estimates the effective power generation capacity in the country as 1,177.1MW, against a peak demand of 930 MW, which is projected to rise by 14%

per annum to 1,370 MW by July 2008 (MoE, 2009). The demand for electricity in the past, outstripped supply, precipitating a significant level of unserved demand, which in 2004 was estimated to be 413 GWh (CAN, 2004). However, the situation has improved and the generation currently boasts of a modest and rapidly shrinking reserve margin of about 14% (AFREPREN/FWD 2008).

2.4.3 Petroleum Products in Kenya

Petroleum provides about 22% of the country's energy requirements whereby most of the petroleum used in the country is imported (GOK, 2002b). At the national level, the transport sector consumes about half of the petroleum used in the country while other sectors consume the remaining 50% (Ibid). The high dependence on petroleum in the country cannot be overemphasized in terms of foreign exchange drain. For example, crude oil and imported refined petroleum products are among Kenya's main imports accounting for 47% and 52% of total exports in the years 2005 and 2006, respectively(GOK, 2007). However, a significant proportion of the imported oil is re-exported to the neighboring countries. Petroleum is the major driving force of modern sector of the economy and its importation in 2006 rose by 6.8%. However, the unusual high oil prices experienced in 2006 led to a decline in crude oil importation by an average of 7.4%. Nonetheless, the demand for petroleum products at the national level increased by 12%, up from 2,797,200 tonnes in 2005 to 3,131,500 tonnes in 2006 (GoK, 2007). This could be attributed to the country's growing economy as well as the increased number of motor vehicles registered in the country i.e. monthly registration of new vehicles totaling about 5,000 units. (GoK, 2007). Kerosene is a refined petroleum product that is mainly used for lighting, cooking and heating at the domestic level. (GoK, 2007). In Kenya, about 83% of the urban residents use kerosene mainly for cooking (76% of the respondents) and for lighting (61% of respondents) (GoK, 2007). At the local market, kerosene is supplied and distributed by multi-national oil companies as well as smaller oil companies. Kerosene has a very extensive and effective distribution chain involving retailers and middlemen who ensure the commodity reaches the most remote places within the country (AFREPREN/FWD 2008). However, due to the high number of "middlemen" included in kerosene distribution as well as taking into account the transportation and distribution costs, kerosene ends up being a high cost fuel (Ibid).

2.5 Biomass energy consumption in Kenya

Biomass (firewood, charcoal and agricultural waste) contributes to 78% of Kenya's energy demand (IEA, 2003). Next in significance is petroleum which accounts for about 19% of national energy demand (Ibid). Kenya's manufacturing and commercial sectors depend on petroleum while most rural households, services and small businesses depend on biomass energy (Ibid).

Table 2.2: Lists the fuel types consumed in the urban and rural households in Kenya.

Fuel Type	Rural (%)	Urban (%)
Firewood	50	6.2
Charcoal	26.9	85.4
Kerosene	14.92	5.1
Agricultural residues (plant residues)	8.11	0.2

Source: UN-DESA REPORT (2004)

According to Table 2.2, about 85% of all rural households and 92% of all urban households use biomass as their primary source of energy. Kerosene is the only other energy source that serves the energy requirements for a significant proportion Kenyan household.

According to Nyang (1999), the most common rural household fuel mixes in Kenya are kerosene and firewood (50%), and kerosene, charcoal and firewood (38.8%). In the urban areas, the most common fuel mixes are:

Kerosene and charcoal (29.6%), Kerosene, charcoal and firewood (13.6%).On average, rural households consume 5.2 liters of kerosene per month, while urban households consume 8.7 liters per month.

2.6 Factors influencing energy consumption at household level

2.6.1 Age of household heads

Age of the household heads is said to have influence on the likelihood of consuming a particular fuel type (Nyang 1999). Households with older heads are most likely to consume wood fuel than non-wood fuels. Mekonnen and Kohlin (2009) found that households with older heads in major Ethiopian cities were much more likely to use wood and kerosene than electricity and charcoal while demand of wood increased with age. This finding was attributed to certain habits of older

people that favor traditional energy sources and resist change so that if they grew up with wood as their main fuel, they would wish to persist with the 'wood tradition' as their source of energy. Limited access to other energy types such as electricity may also discourage their adoption by traditionalists.

2.6.2 Household size

According to FAO (2009), macro factors influence household energy consumption patterns at the aggregate level and indirectly. The direct determinants of household energy consumption patterns are found precisely at the level of households. An examination of household energy consumption surveys shows that energy use and the choice of fuels in the households depends on most or all of the following interrelated variable (Leach and Gowen, 1987): household income; household size; temperature and precipitation (for space heating and drying needs). Household size has been observed to be sometimes a more important determinant of household energy consumption than income. High income has been associated with more family members (more people contributing to household income), thus increasing total household consumption. High energy consumption is associated with higher income. High income countries consume more modern than traditional fuels (Ibid).

2.6.3 Education level of household heads

Education level of household heads is postulated to have an inversely proportional relationship with consumption and demand of less clean fuels. In other words, the higher the level of education of household heads the higher the probability of consuming/using clean fuels. Mekonnen and Kohlin (2009) in their attempts to find the determinants of household fuel choice in major cities of Ethiopia estimated that higher education (secondary and post-secondary) promoted households to use electricity and kerosene more than wood and charcoal as cooking energy. This finding was also confirmed by Ouedraogo (2005) in his study of household preferences for cooking in urban areas in Ouagadougou of Burkina Faso. He found that households with a head that had higher education level had lower firewood adoption probability than households with a head with lower education level. Another study by Heltberg (2003) in Guatemala also found that education level of the household head had a very significant negative impact on wood consumption while at the same time encouraging demand for LPG (clean fuel). Women and children are the most primarily involved in fuel wood collection particularly in the

poorest rural households; in this case, women's and children's time and labor could partly explain the energy consumption patterns of households (Pacudan, 1997). The availability or excess of women labor and time in areas of low literacy and high unemployment in some developing countries is precisely the reason why energy transition is not happening in these countries (Ibid). For example in rural Pakistan, the poorest could afford to switch from biofuels to kerosene, but the shift was not happening because of the availability of unpaid women's labor that may have resulted from lack of formal employment due to low literacy levels (FAO, 2009).

2.6.4 Energy costs

According to Heltberg (2003), there is a large variation across countries in the composition of households' energy expenditures. In the poorest countries, biomass and kerosene often feature heavily. In Ghana, for example, kerosene and charcoal are the two largest energy expenditure items. In Nepal, it is kerosene and market wood (Ibid). In wealthier countries, electricity is the energy source on which much money is spent. Among the cooking fuels, hydrocarbons (LPG and kerosene) tend to be where most of the fuel budget is spent by income-rich households though such households may spend as much or more on wood and hydrocarbons (Hetberg 2003)

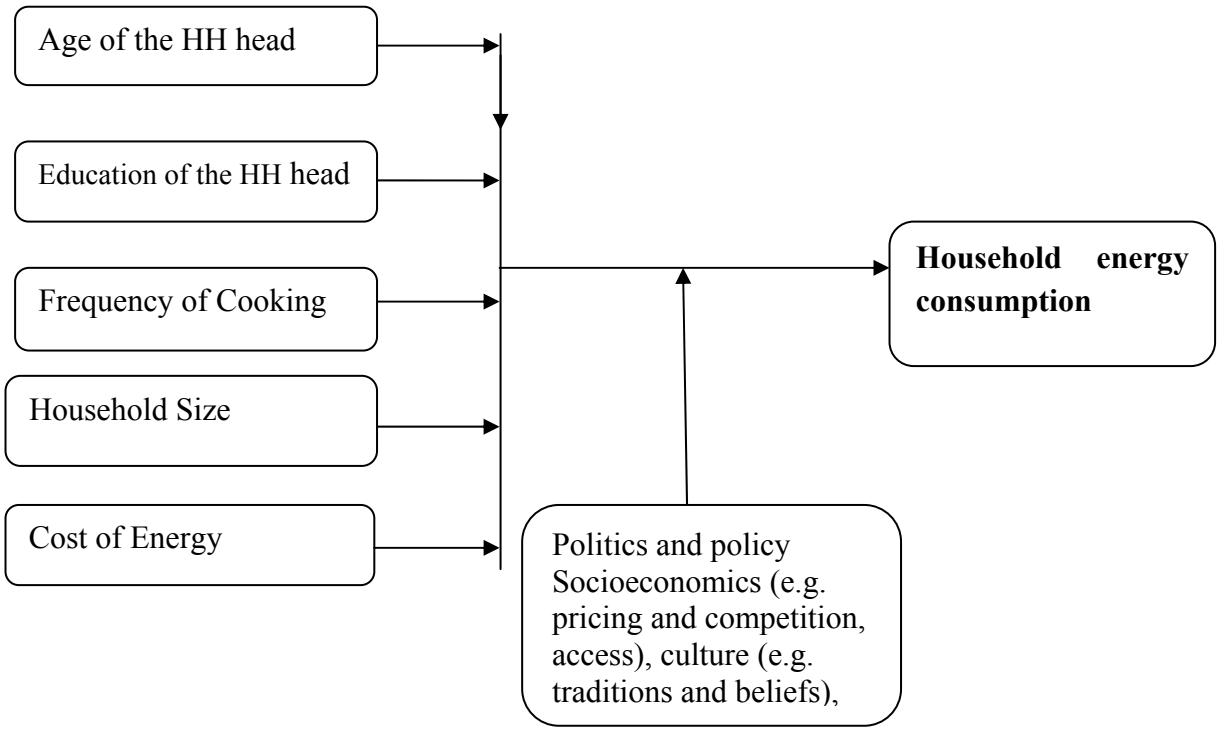
Electricity tends to weigh much heavier on the urban budgets (Hetberg 2003). Rural households spend a smaller proportion of their expenditures on electricity. Among all of the energy sources considered, firewood has the highest budget share among its users especially in the rural areas. Price of energy also influences the household energy choice and the amount of energy consumed by both rural and urban households. The general observation is that price has a negative effect on the quantity of energy consumed. As price increases, the amount of energy consumed decreases. In Guatemala, Hetberg (2003) found that price of wood had a significant negative impact on firewood demand on both rural and urban sectors.

2.6.5 Number of cooking times

The number of times a household cooks as well as the time taken to prepare a single meal determines the amount of energy a household uses. A household that cooks more often in a single day tends to use more energy as compared to households that cook for much lesser time in a single day.

2.7 Conceptual Framework

Figure2.1: Conceptual Framework Analysis Model



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

Age of the household head is also said to have influence on the likelihood of consuming a particular type of fuel. The households with older heads are more likely to consume wood fuel than non-wood fuels. Households headed by females have been observed to cook more often as compared to households headed by males. Household size has been observed to be a more important determinant of household energy consumption than income. High income has been associated with more family members that is; more people contributing to household income, thus increasing total household consumption bringing to a conclusion that high energy consumption is associated with higher income.

Education level of the head of the household is postulated to have a negative relationship with rate of usage and demand of less cleaner fuels. The higher the level of education of the household head the higher is the probability of consuming/using cleaner fuels.

Price of energy also influences the household energy choice and the amount of energy consumed by both rural and urban households. The general observation is that price has a negative effect on the quantity of energy consumed. The number of times a household cooks as well as the time taken to prepare a single meal determines the amount of energy a household uses. A household that cooks more times in a single day tends to use more energy than households that cook less often and this has a direct relationship with the number of members that a household has. Income of the household head has been observed to be important as it determines the purchasing ability and determines the choice of fuel

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter briefly describes the study area then proceeds on to present a detailed research design, describes the target population, sample design, methods of data collection, methods of data analysis and presentations and lastly methods for dissemination of the study findings.

3.2 The Study Area- Kikuyu District

Kikuyu District is a cosmopolitan administrative region in Kenya's Kiambu County. It lies within the Nairobi metropolitan area with its administrative headquarters at Kikuyu town, approximately 25 km from Nairobi's city Centre. The District has 4 administrative divisions, 14 administrative locations and 30 administrative sub-locations. The divisions are; Kikuyu which has 3 locations and 6 sub-locations; Kabete which has 4 locations and 8 sub-locations; Karai which has 4 locations and 8 sub-locations; and Kinoo which has 3 locations and 6 sub-locations (Nguyai L. 2012)

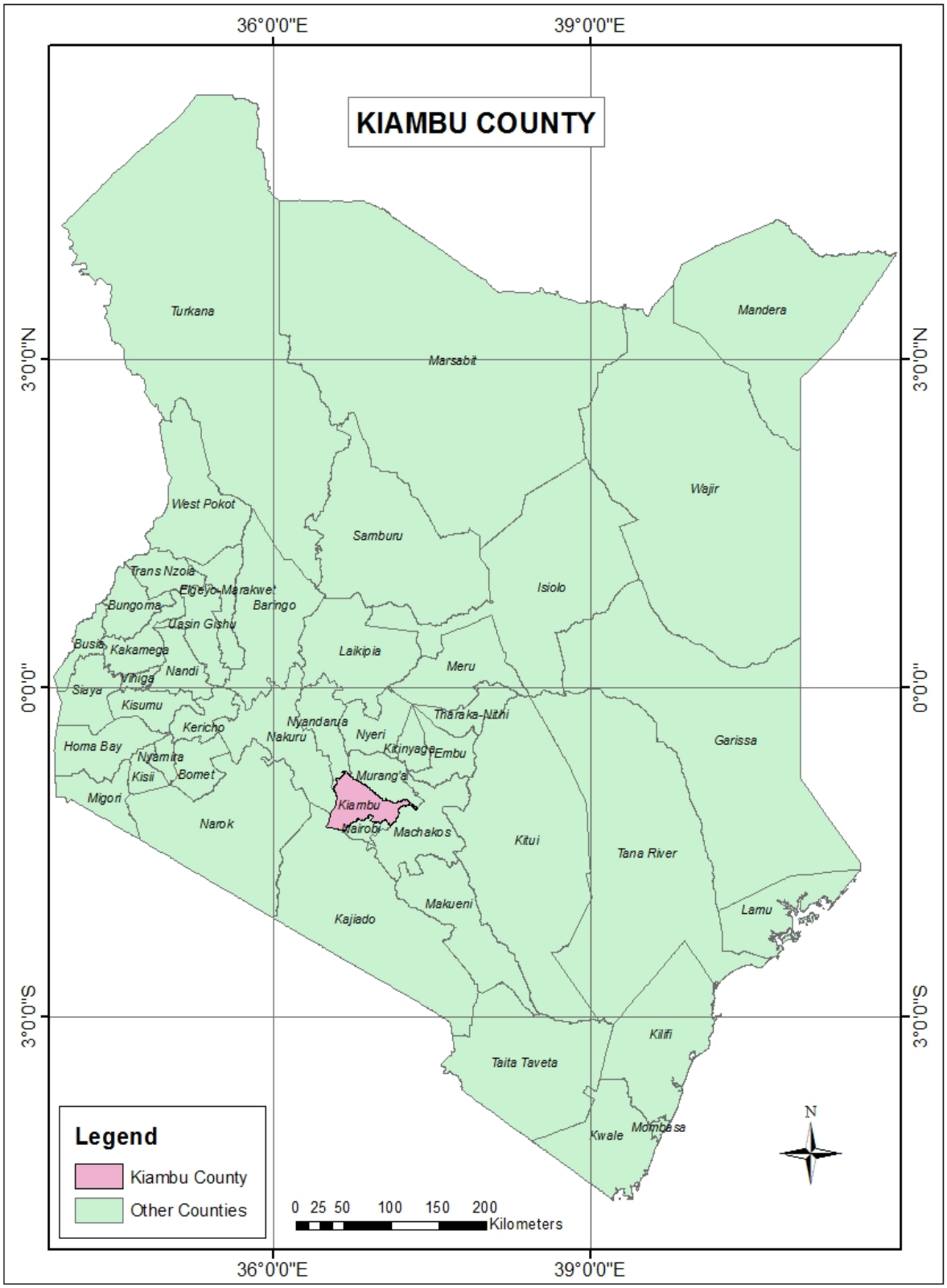


Figure 3.1: A Map of Kenya showing Kiambu County where Kikuyu District is located

Source: Author (2013)

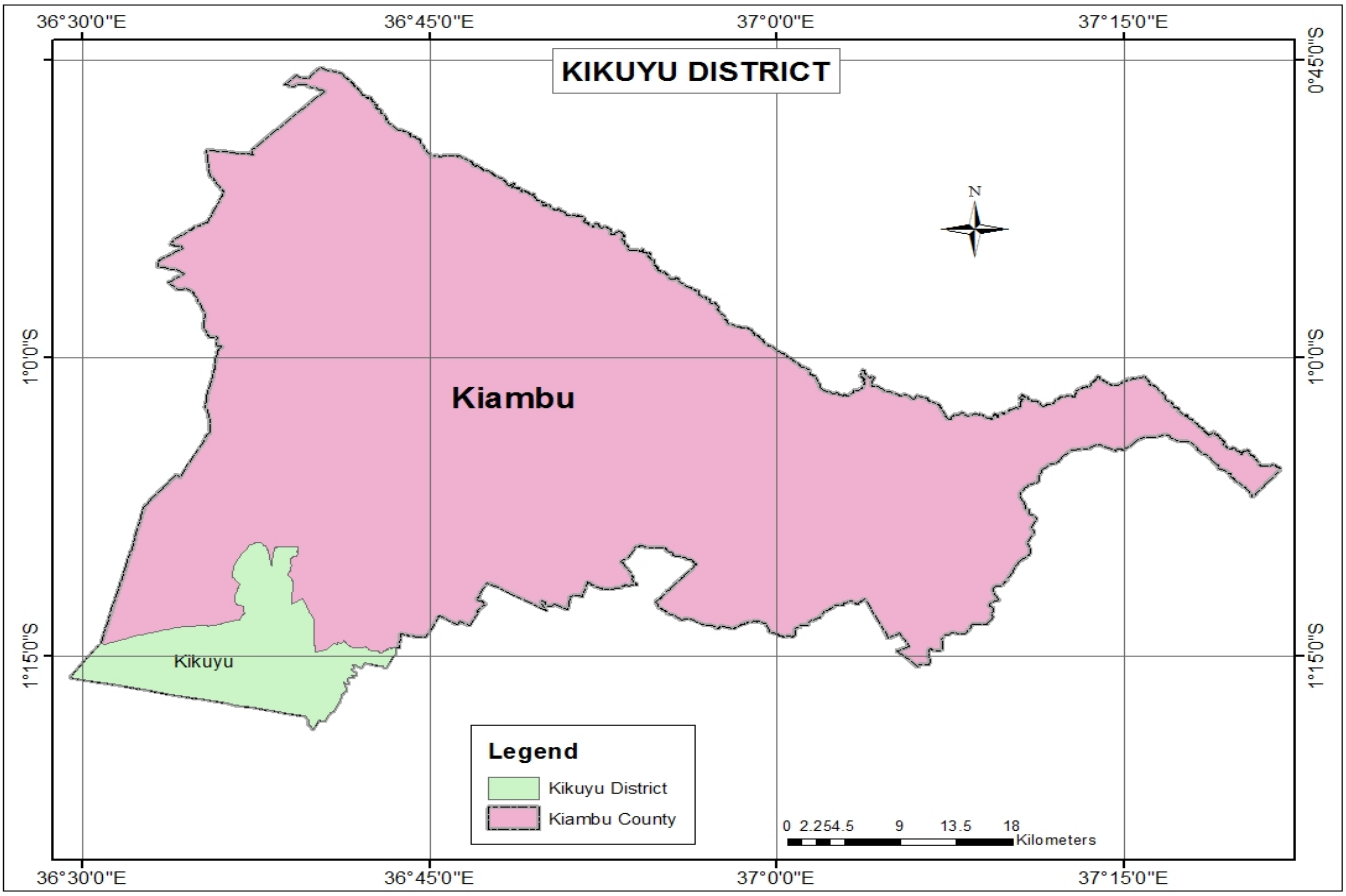


Figure 3.2: A Map of Kiambu County showing where Kikuyu District is located

Source: Author (2013)

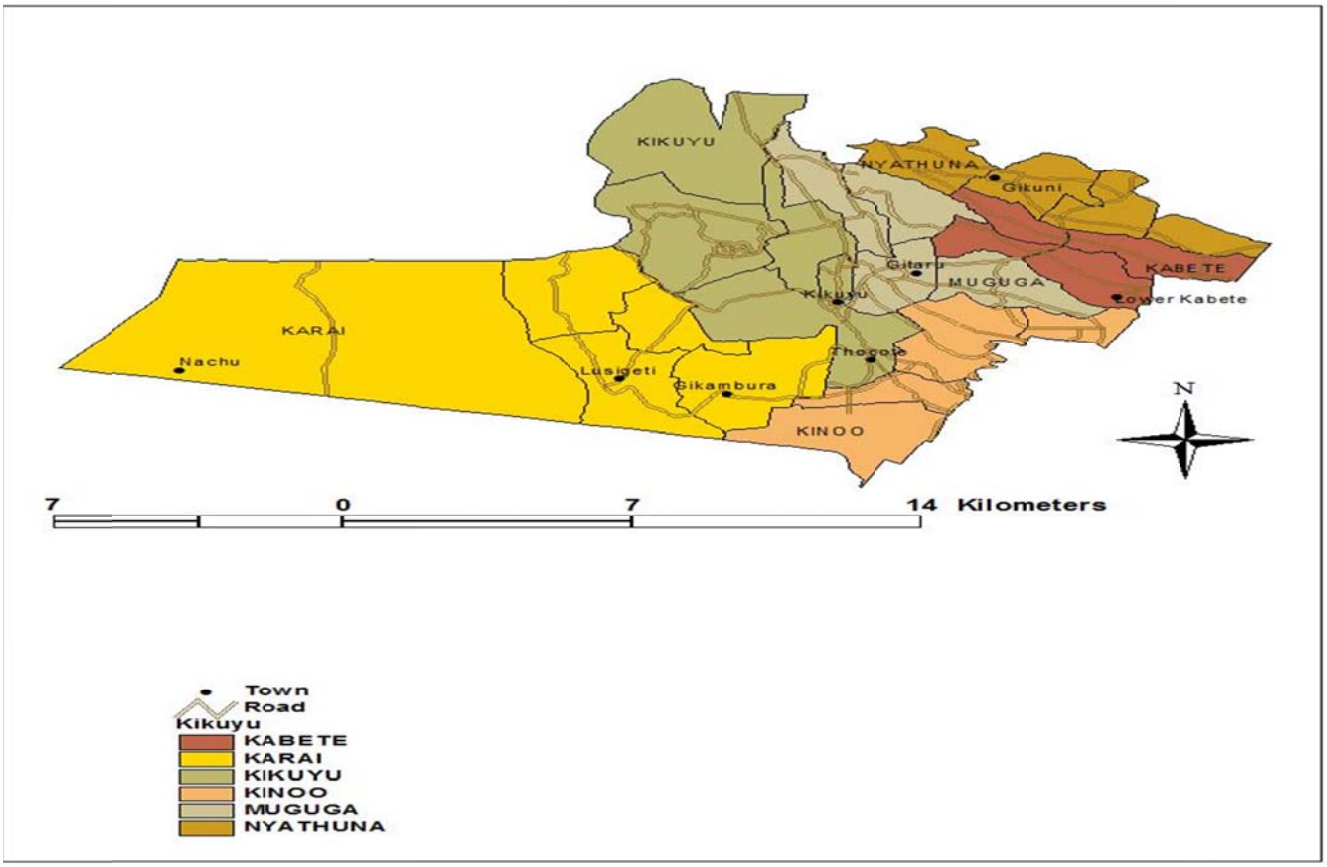


Figure 3.3: A Map of Kikuyu showing where Kikuyu Wards are located

Source: Author (2013)

Kikuyu District has a large network of roads with the main Nairobi-Nakuru road that passes across the constituency. The southern by pass which is currently under construction cuts right across Kikuyu town as well as the fiber optic cable that runs through the constituency and this is foreseen to boost the trading activities once completed. The constituency is also privileged to have a railway line with an active railway station connecting it to the city and western region. The two main economic activities of Kikuyu constituency are mainly trade and agriculture that is boosted by the presence of high fertile volcanic soils and presence of efficient modes of transport. Moreover, the constituency is one of the main suppliers of horticultural produce like vegetables within the Nairobi region. In addition, it is well known for poultry rearing and dairy farming. Some of the constituents have invested in rental houses while others engage in small-scale farming. Indeed the constituency prides itself in having one of the largest closed air markets (Wangige market) and plans are underway in the economic stimulus programme to construct a fresh produce market within Kikuyu town.

3.3 Research Design

The study used a survey design to investigate factors influencing the sustainability of household energy consumption; the case of biomass fuels in Kikuyu District. The study design used was descriptive in nature. Greene, William H. (2002), noted that descriptive study determines and reports the way things are and commonly involves assessing attitude, opinions towards individuals, organizations and procedures. Descriptive survey design was relevant to this study since the study sought to collect data from respondents about their opinions on the factors affecting the consumption of biomass fuel in the district would be enhanced to improve energy use and management in a sustainable manner. According to Mugenda Mugenda (1999), descriptive studies are conducted in communities to establish the extent of a range of social issues such as health and education. The studies are also limited in geographic scope and hence tend to be logistically easier and simpler to conduct. In this regard this design was preferred for this study.

3.4 Target Population

Kikuyu District consists of a population size of 265,829 people and a total number of 77,045 households thus according to the 2009 National Population and Housing Census (Kenya National Bureau of Statistics, 2009). The study is based on these census figures (and not projections) though it was carried out in the 2012-2013 period.

3.5 Types and sources of data:

This study uses both Primary data and Secondary data. Primary data is derived from the structured questionnaire (see Appendix 1) while secondary data is derived from National Population and Housing Census (Kenya National Bureau of Statistics, 2009)

3.6 Sample design

The study was based on a sample of 198 households as shown below: First, the study applied Yamane (1967:886) formula as quoted by Israel (1992) to compute the sample size.

$$n = \frac{N}{1 + N(e)^2}$$

Where: n= Sample size, N= Population size e= Level of Precision.

At 95% level of confidence and ρ=.005

$n=77,045/ (1+77,045\{0.05\}^2)$

n=397.9

=398 households

Second, due to financial and time constraints, a sample size of 398 households as calculated from Yamane (1967:886) formula was too large, hence it was reduced to 198 households, this being half of the calculated sample size. Though no plausible science could explain the 50% reduction, the general assumption held was that this would not have critically undermined the findings of the study in any way.

Third, using the administrative unit called "ward" as strata, stratified random sampling was used to proportionally distribute the 198 households in the 6 wards of Kikuyu District based on the total number of households in each ward. For example, the number of households that were selected from Kabete Ward was computed as follows: 10,015/77045* 198=26 households. The disproportionate distribution is shown in Table 3.3 below.

Table 3.1: Stratified random sample applied by the study

	Targeted sample size		
Ward	**No. of Households**	**Sample size**	**%**
Kabete	10,015	26	13
Karai	13,097	34	17
Kikuyu	11,557	30	15
Kinoo	20,031	51	26
Muguga	13,868	36	18
Nyathuna	8,475	22	11
Total	**77, 045**	**198**	**100**

Source: (Kenya National Bureau of Statistics, 2009)

The actual households to be contacted/surveyed from each Ward were selected from a randomized sampling frame using systematic random sampling based on a predetermined sampling interval. Each selected household was detailed by name appearing in the sampling frame and ward of residence. During actual data collection, selected households that ceased to exist were replaced by the nearest households while preserving the gender of the household head.

3.7 Data Collection Methods

A structured questionnaire (see Appendix 1) was applied to collect primary data from the sample of 198 households. The questionnaire was self-administered but supervised by the researcher. A total of 198 questionnaires were administered. Self-administration was made possible by the relatively high literature levels in the study area. Self-administration is often a preferred method because it saves time and preserves the perspectives of the respondent (Mugenda and Mugenda, 1999)

3.7.1 Ethical Considerations.

Ethical consideration in research should be an integral part of the research planning and implementation process, not viewed as an afterthought or a burden. There should be increased consciousness of the need for strict ethical guidelines for researchers. Some of the ethical issues touch on deception and invasion of privacy (Frankel, R. Jack & Norman E. Wallen, 2000)
There are three main ethical principles that were considered:

a) Beneficence***:*** Maximizing good outcomes for science, humanity, and the individual research participants and minimizing or avoiding unnecessary risk, harm, or wrong.
b) Respect***:*** Treating people with respect and courtesy, including those who are not autonomous (e.g., small children, people who have mental retardation or senility).
c) Justice***:*** Ensuring that those who bear the risk in the research are those who benefit from it; ensuring that the procedures are reasonable, non-exploitative, carefully considered and fairly administered.

3.8 Data Analysis Techniques

On completion of data collection, the first step towards data analysis was editing the filled household questionnaires. The questionnaires were first checked for data gaps and incomplete information. The concerned respondents were contacted to give more information where possible but where the questionnaire had serious data gaps and the contact could not be reached, a decision was made to leave the questionnaire out of the data analysis. Consequently, a total of 18 questionnaires were excluded from analysis for lack of adequate information. This means the actual data analysis was based on 180 questionnaires.

After editing, the questionnaires were coded and data entered into the analysis system by use of Statistical Package for Social Scientists (SPSS). All other analytical procedures were called from the SPSS system. The software was selected since it is the most used package for analyzing survey data that provides much detailed information. The software has the following advantages: it is user friendly, can easily be used to analyze multi-response questions, cross section and time series analysis and cross tabulation; (i.e. relate two sets of variables) and it can also be used alongside (Cohen, Cohen, West, & Aiken, 2003).

The data was presented in charts, frequency tables and regression analysis which was used to determine factors that affect household biomass energy consumption. Regression analysis is a flexible method of data analysis that may be appropriate whenever a quantitative variable (the dependent or criterion variable) is to be examined in relationship to any other factors (expressed as independent or predictor variables). (Cohen, Cohen, West, & Aiken, 2003). Relationships may be non-linear, independent variables may be quantitative or qualitative, and one can examine the effects of a single variable or multiple variables with or without the effects of other variables taken into account (Ibid).

Regression Equation

$$\mathbf{Y= \beta_1 X_i + \mu}$$

Where

Y = Dependent variable which is energy consumption

Xi = Age, Education, Daily cooking frequency, Household Size, and Cost of Energy

α, β, are the Estimated coefficients of the regression model

μ = Residual term that includes the net effect of other factors not in the model and measurement errors in the dependent and independent variables and thus the regression analysis model becomes.

Household energy consumption = $\alpha + \beta_1$ (Age) +error term

3.8.1 Validity and reliability of Instruments

Mugenda and Mugenda, (1999) defines validity as the extent to which a measure actually measures what it's supposed to measure. Validity therefore has to do with how accurately the data obtained in the study represents the variables of the study. To ascertain the content validity

of the research instruments, the researcher used simple understandable language; a thorough training of the research assistants was done to ensure that they were able to guide the respondents in the filling of questionnaires.

Reliability is the degree of constancy between 2 measures of the same thing. The questionnaires were pretested to a selected sample of 25 in Kikuyu District location so as to determine its reliability. The raw data obtained by the instruments was converted to numerical codes representing the measurement of the variables. This coding facilitated the determination of reliability. The Cronbach co-efficient alpha was then computed to determine how the variables collated among themselves. Cronbach's Alpha is the general formula of the K under Richardson (K-R) 20 (Mugenda and Mugenda, 1999) The K-R 20 formula is as follows

K-R 20= (K) (S^2-summation s^2)/ (S^2) (K-1)

Where:-

KR20 is the reliability co-efficient of internal consistency

K is number of items used to measure the concept

S^2 is the variance of all scores

S^2 is variance of individual items.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

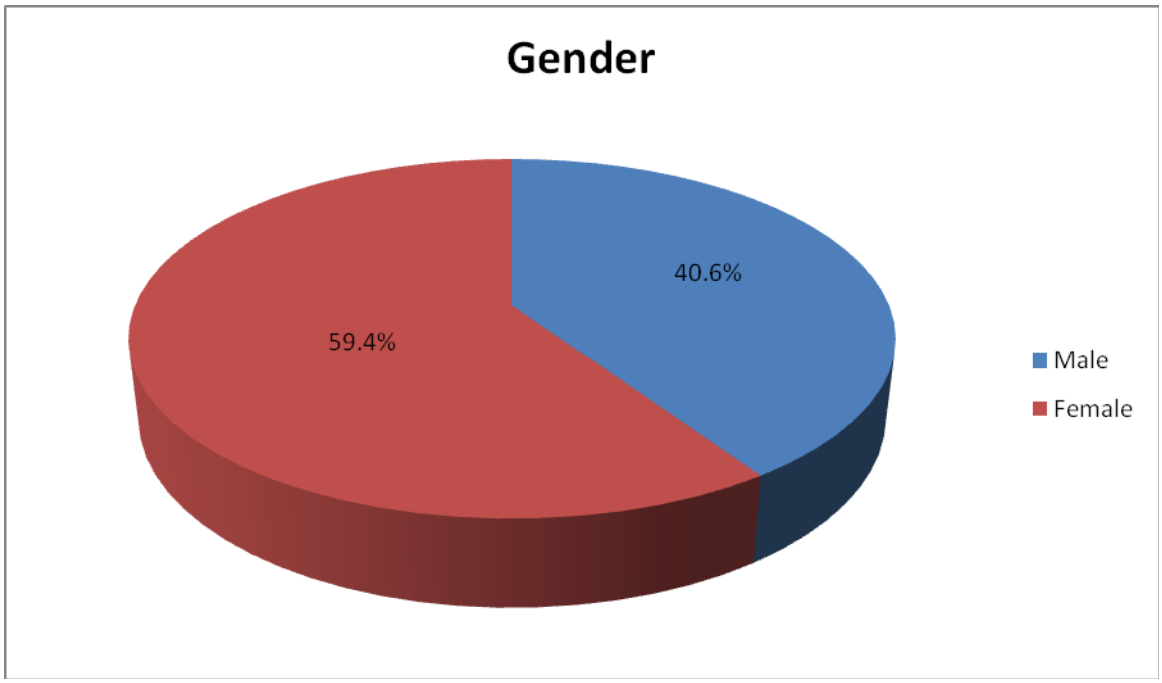
This chapter presents data collected from respondents in Kiambu County and information was presented in the tables showing the various percentages of responses from the respondents. The data was analyzed using both qualitative and quantitative methods.

4.2 Sample household characteristics

4.2.1 Gender of the respondents

Below is a pie chart that shows the gender of the respondent collected in the study area of Kikuyu district Kiambu County

Figure4.2: Gender of Respondents



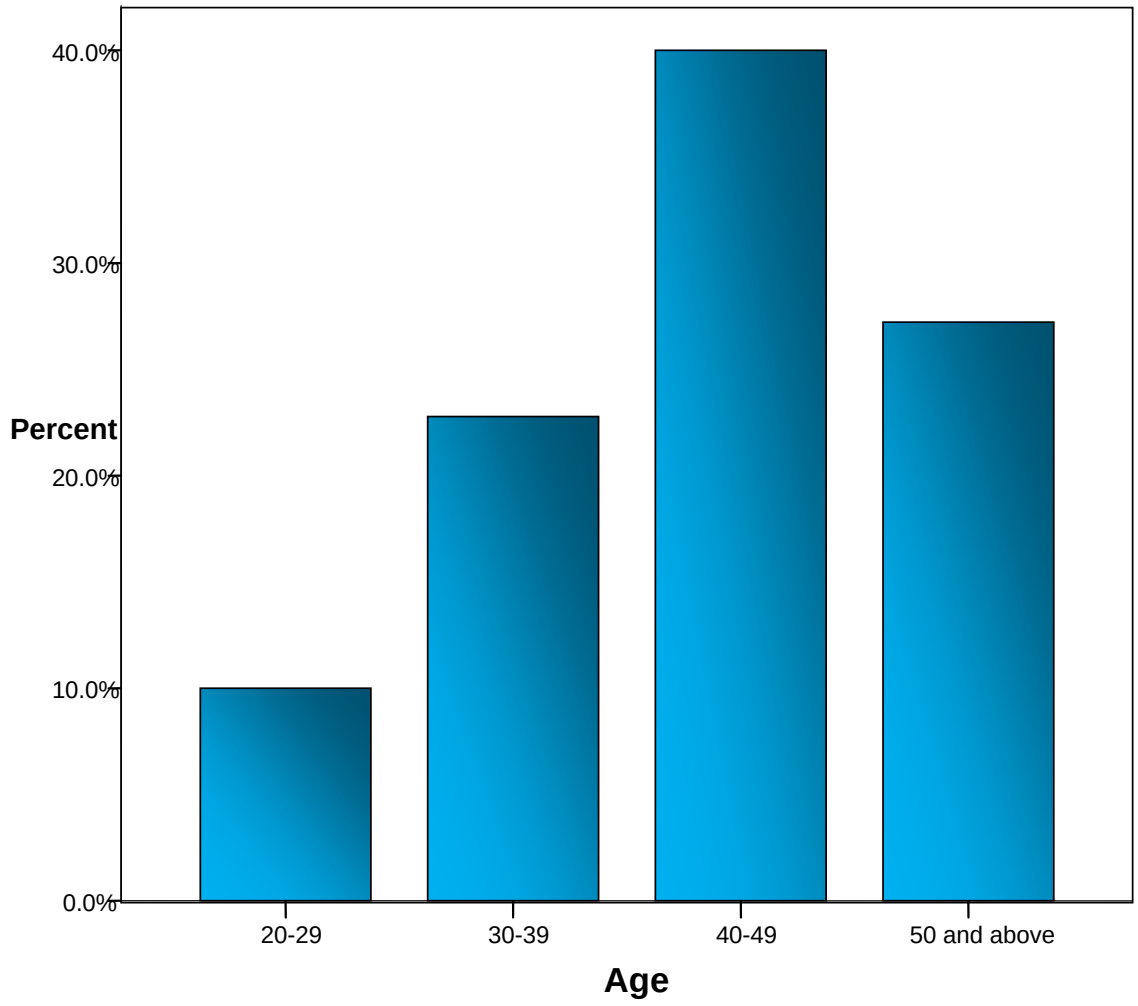
Source Author (2013)

From the findings of the analysis as depicted in Figure 4.2, 59.4% of the respondents were female while 40.6% of the respondents were male. This indicates that female respondents were generally responsible for the supply of the household energy in Kikuyu District.

4.2.2 Age of the Household head.

Figure 4.3 is used to show the age of the household head.

Figure 4.3: Age of the household head.

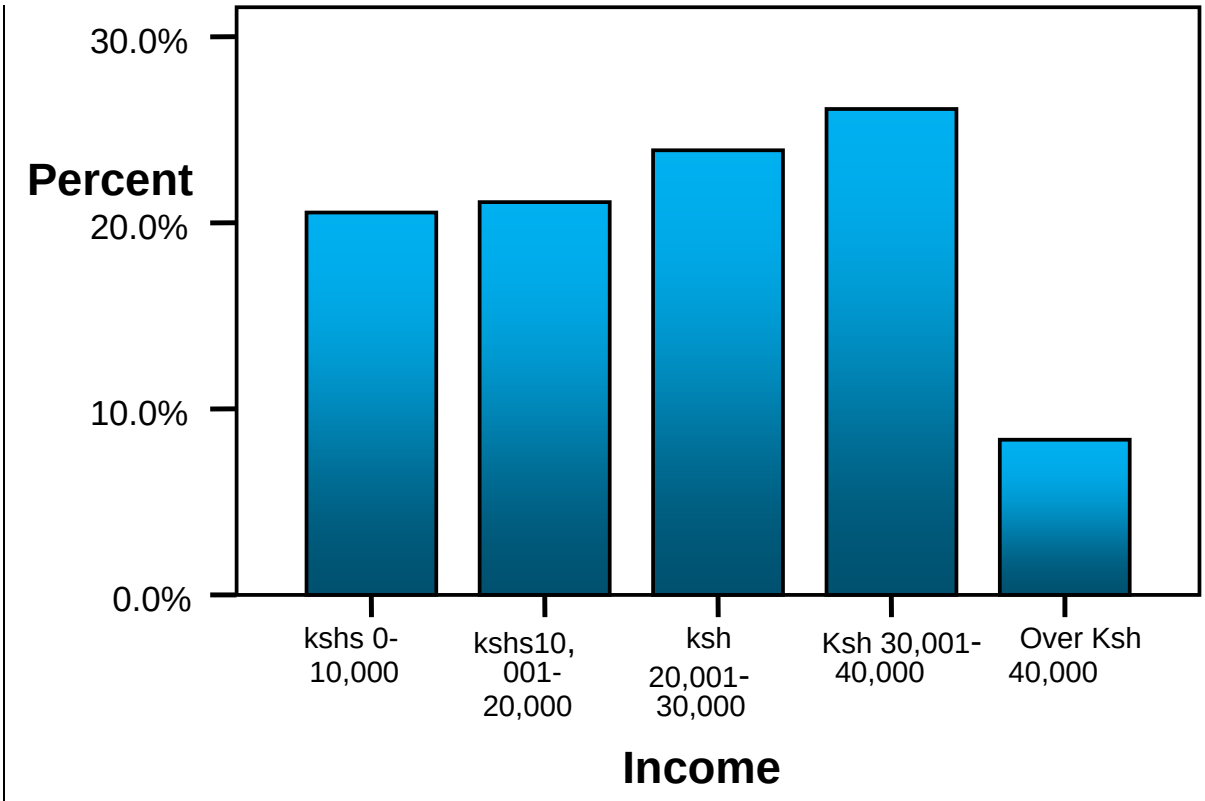


Source Author (2013)

It was established from the study that most of the household head were between the age bracket of 40-49 years (40.0%), followed by over 50 years who comprised of 27.2%. 22.8% of the respondents were in the age bracket of 30-39 years and 20-29 years who comprised of 10.0%. It is therefore deduced that the household head had the responsibility for provision of household energy.

4.2.3 Monthly income of household heads

Figure 4.4: Monthly Income of Household Heads



Source Author (2013)

The study sought to establish the monthly income of the household head in Kikuyu District. 26.1% of the household head stated that their household income was between Kshs 30,000-40,000 a month, 23.9% of the household head stated that their income was between Kshs 20,000-30,000 a month, 21.1% of the household head stated that their household income was between Kshs. 10,000-20,000 a month, 20.6% of the household head stated that their income was less than 10,000 and lastly 8.3% stated that of the household head income was over Kshs 40,000 a month.

4.2.4 Household head characteristics

Data on household head characteristics collected is represented as in table 4.1 below

Table 4.1: Head of the household

	Frequency	Percentage
Father	96	53.3
Mother	56	31.1
Elder siblings	28	15.6
Total	**180**	**100**

Source Author (2013)

The study sought to determine who headed the various households within the research area. It was established that 53.3% of the respondents had their fathers as the heads of households followed by households headed by mothers constituted of 31.1%. Minority of the households were established to be headed by elder siblings that constituted of 15.6% as shown in table 4.1 above. It was expected that parents; 'father and mother' to be the majority in terms of household heads characteristics.

4.2.5 The highest level of formal education of household heads

Table 4.2: The highest level of formal education of household heads

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lower Primary	26	14.4	14.4	14.4
	Upper Primary	23	12.8	12.8	27.2
	KCPE	39	21.7	21.7	48.9
	Secondary	19	10.6	10.6	59.4
	KCSE	20	11.1	11.1	70.6
	Certificate	15	8.3	8.3	78.9
	Diploma	25	13.9	13.9	92.8
	Undergraduate	8	4.4	4.4	97.2
	Post Graduate	5	2.8	2.8	100.0
	Total	**180**	**100.0**	**100.0**	

Source: Author (2013)

Lower primary –Class 1-4

Upper primary – Class 5-8

KCPE – Completed Primary level of education and sat for KCPE

Secondary – Form 1-4 but didn't sit KCSE

KCSE – Completed Secondary level of education and sat for KCSE

It was established from the study that majority (21.7%) of the household heads had completed primary level education, followed by those with lower primary level education (14.4%), then those with diploma level education (13.9%). Those with upper primary level education (12.8%) and those that completed secondary with (11.1%).Those having certificate level of education comprised of 8.3% of the respondents followed by those with undergraduate level of education (4.4%) and lastly post graduate level of education that comprised of 2.8%. The findings show that the literacy levels within the district is moderate and the information provided by the respondents is viable.

4.2.6 Daily cooking frequency of a household

Data on the household daily cooking frequency of a household is represented in the table 4.3 below

Table 4.3: Daily cooking frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once	14	7.8	7.8	7.8
	Twice	21	11.7	11.7	19.4
	Thrice	58	32.2	32.2	51.7
	Four times	52	28.9	28.9	80.6
	More than four times	35	19.4	19.4	100.0
	Total	**180**	**100.0**	**100.0**	

Source Author (2013)

It was established from the study findings that majority 32.2% of the total number of households cooked thrice a day followed by 28.9% who cooked four times a day. 19.4% comprised of those who cooked more than four times a day while those who cooked twice a day comprised of

11.7%. Only 7.8% of the households which were the minority cooked once per day as presented in Table 4.3 above.

4.2.7 Number of members in households

Different households had different numbers of members. This was revealed by the data collected and is represented in table 4.4 below.

Table 4.4: Number of members in households

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	One	14	7.8	7.8	7.8
	2-3	58	32.2	32.2	40.0
	4-5	78	43.3	43.3	83.3
	Above 5	30	16.7	16.7	100.0
	Total	**180**	**100.0**	**100.0**	

Source Author (2013)

The study sought to establish the size of households of the respondents. It was established that 43.3% of the respondents who were the majority stated that their households comprised of members ranging from four to five members, 32.2% of the respondents said that their households comprised of members ranging from two to three followed by households with more than five members totaling to 16.7% and lastly, 7.8% of households who were the minority comprising of only one member as shown in table 4.4 above.

Table 4.5: Number of children in households

	Frequency	Percentage
1 child	23	12.8
2children	32	17.8
3 children	67	37.2
More than 4 children	58	32.2
Total	**180**	**100.0**

Source Author (2013)

It was established from the study findings that the majority 37.2% of the respondents indicated that their households consisted of three children, followed by 32.2% who stated that their households had more than four children while 17.8 % of the respondents stated that their households had 2 children and lastly 12.8% of the respondents who were the minority stated that they only had one child. The number of children in a homestead was an important factor for determining the amount of energy used since the larger the number of children in a given household, the higher the rate of biomass usage.

4.2.8 Monthly expenditure on biomass energy per household

The data on amount of money spent in the purchase of biomass energy was collected and is represented in table 4.6 below

Table 4.6: Monthly expenditure on biomass energy per household

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than Kshs 500	45	25.0	25.0	25.0
	Kshs 500-1000	36	20.0	20.0	45.0
	Kshs 1000-1500	59	32.8	32.8	77.8
	More than Kshs 1500	40	22.2	22.2	100.0
	Total	**180**	**100.0**	**100.0**	

Source Author (2013)

It was established from the study findings that majority (32.8%) of the respondents spent between Kshs. 1000- Kshs. 1500 per month for purchasing biomass energy for household use while 25.0% of the respondents stated that they used less than 500 on the same. 22.2% of the

total number of respondents spent more than 1500 and 20.0% who were the minority of respondents spent less Kshs. 500- Kshs 1000 on biomass expenditure.

4.3 Sources of energy for the households

4.3.1 Energy sources used normally for lighting, cooking and water heating in this household.

Energy in the household is mainly used for cooking, lighting and heating up of bathing water. Table 4.7 represents the different uses and the energy choice type.

Table 4.7: Energy sources used normally for lighting, cooking and water heating in this household

	Lighting		Boiling bathing water		Cooking	
	Fr	%	Fr	%	Fr	%
Electricity	72	40	34	18.9	18	10
Kerosene	94	52.2	30	16.7	39	21. 7
LPG	0	0	20	11.1	26	14. 4
Charcoal	0	0	42	23.3	45	25
Firewood	0	0	54	30.0	52	28. 9
Solar Energy	14	7.8	0	0.0	0	0
Candle	0	0	0	0.0	0	0
Generator	0	0	0	0.0	0	0
Total	**180**	**100**	**180**	**100**	**180**	**100**

Source Author (2012)

The study sought to determine the various source of energy for the households in the Kikuyu District. It was determined from the study that 52.2% of the respondents said that they used kerosene for lighting while electricity was used by 40% of the household. For those who indicated that they used solar energy was a paltry of 7.8%. 30% of the respondents said that they boiled their bathing water using firewood, 23.3% of them said that they used charcoal followed by 18.95 of the respondents who said that they used electricity while 16.7% of the respondents indicated that they used kerosene as source of energy for boiling bathing water. 28.9% of the respondents said that they used firewood for cooking purposes followed by 25% who indicated

that they used charcoal. 21.7% of the respondents indicated that they used kerosene for cooking while those used LPG for cooking were14.45 and 10% cooked using electricity.

4.4 Results

4.4.1 Age influences on household energy consumption

The study sought to determine the extent to which age of household heads determines "type of energy used by households" and "amount of energy consumed by households". Table 4.11 below presents the findings. It was determined that majority 25(13.9%) of the respondents whose household heads age bracket ranged between 40-49 years opted for kerosene followed by 20(11.1%) of 50 and over age bracket who used firewood. 17(9.4%) of the respondents who were between 40-49 years used charcoal while 16(8.9%) used kerosene in the range between 30-39 years and this was a clear indication that the older the household head the more they were inclined to use charcoal, firewood and kerosene as compared to those who used cleaner energy such as the LPG and electricity .Table 4.8 below is used to show a cross tabulation of age and sources of energy for households

Table 4.8: Cross tabulation on the age and the Sources of energy for the households

		Sources of energy for the households					Total
		Electricity	Kerosene	LPG	Charcoal	Firewood	
Age	20-29 Years	2	5	3	5	3	18
	30-39 Years	3	16	8	9	5	41
	40-49 Years	7	25	13	17	10	72
	50 and Over	2	8	5	14	20	49
Total		**14**	**54**	**29**	**45**	**38**	**180**

Source Author (2013)

4.4.2 Influences of household size on household energy consumption

Cross tabulation of household size and sources of energy carried out is represented as in table 4.9

Table 4.9: Cross tabulation on household size and Sources of energy for the households

		Sources of energy for the households					Total
		Electricity	Kerosene	LPG	Charcoal	Firewood	
hh_size	one member	1	7	1	3	2	14
	2-3 member	3	15	12	8	20	58
	4-5 member	7	27	7	24	13	78
	Above five members	3	5	9	10	3	30
Total		**14**	**54**	**29**	**45**	**38**	**180**

Source Author (2013)

The above Table 4.9 presents the findings on the influences of household size on household energy consumption. It was determined that the higher the household size the more the household used kerosene, charcoal and fire wood as compared to the use of the LPG and the electricity. It was evident that majority 27(15.0%) had 4-5 members and used kerosene, 24(13.3%) used charcoal and 2-3 member had 20(11.1%) used firewood. For those household which had above five members, majority in that used tied using charcoal 10(5.6%)

4.4.3 Influences of education of household head on household energy consumption

Education level of the household head which was an objective of the study is cross tabulated with source of energy as shown in the table below

Table 4.10: Cross tabulation on the household head education level and Sources of energy for the households

		Sources of energy for the households					Total
		Electricity	Kerosene	LPG	Charcoal	Firewood	
Level of educated	Low pry	0	9	1	8	8	26
	Upper pry	1	9	1	7	5	23
	KCPE	3	10	6	7	13	39
	Secondary	1	8	1	4	5	19
	KCSE	2	4	4	7	3	20
	Cert	2	2	3	5	3	15
	Diploma	2	7	8	7	1	25
	Undergrt	2	3	3	0	0	8
	Post grt	1	2	2	0	0	5
Total		14	54	29	45	38	180

Source Author (2013)

The study sought to determine the influence of the education of the household head on the type of the energy used. It was determined that a mere number of those who had university education used kerosene and none used charcoal and firewood, while those who had completed primary education, majority used 13(7.2%) used firewood and 10(5.5%) used kerosene. For those respondents who their household heads had lower and upper primary education, 9(5.0%) majority used kerosene. Those with certificate level of education majority used charcoal 5(2.8%) while those with diploma majority used LPG 8(4.4%). This indicated that the level of education of the household head had a strong significant on the type of the energy used by the household.

4.4.4 Influences of number of cooking on household energy consumption

Table 4.11: Cross tabulation on the no of cooking times and Sources of energy for the households

		Sources of energy for the households					Total
		Electricity	Kerosene	LPG	Charcoal	Firewood	
no_of_cooking_times	Once	2	7	2	3	0	14
	Twice	4	7	5	3	2	21
	Thrice	4	23	10	12	9	58
	Four times	2	10	8	20	12	52
	More than four times	2	7	4	7	15	35
Total		14	54	29	45	38	180

Source Author (2013)

Further, the study sought to establish if the number of cooking by the households influenced on the type of the energy used. It was determined that those households that cooked more than four times used firewood at 15(8.3%), 20 (11.1%) for those who cooked four times, thrice had majority 23(12.8%) who used kerosene, those who cooked twice 7(3.9%) used kerosene and 7(3.9%) who used firewood as charcoal to cook once as in the Table above.

4.4.5 Influences of cost of energy on household energy consumption

Table 4.12: Cross tabulation on energy cost and Sources of energy for the households

		Sources of energy for the households					Total
		Electricity	Kerosene	LPG	Charcoal	Firewood	
energy_cost	Less than Kshs 500	1	14	2	12	16	45
	Between Kshs 500 - Kshs 1000	2	10	6	6	12	36
	Between Kshs 1000- Kshs 1500	8	17	14	13	7	59
	More than Kshs 1500	3	13	7	14	3	40
Total		14	54	29	45	38	180

Source Author (2013)

The above Table 4.15 presents the study findings on how the cost of the energy influenced the type of the energy used by the respondents. It was determined that for the energy that did cost between kshs 1000-1500, majority used kerosene 17(9.4%) and while the energy that did cost less than kshs 500 majority used 16(8.9%) firewood. Those who used more than 1500 majority used charcoal at 14(7.8%) followed by those who spent between kshs 500-1000 as majority used firewood at 12(6.7%). This indicated the cost of the energy played a great role in determining the type of the energy the household used.

4.4.6 Relationship analyses

4.4.6.1 Correlation analysis

To quantify the strength of the relationship between the variables, the study used Karl Pearson's coefficient of correlation. The Pearson product-moment correlation coefficient (or Pearson correlation coefficient for short) is a measure of the strength of a linear association between two variables and is denoted by *r*. The Pearson correlation coefficient, *r*, can take a range of values from +1 to -1. A value of 0 indicates that there is no association between the two variables. A value greater than 0 indicates a positive association, that is, as the value of one variable increases so does the value of the other variable. A value less than 0 indicates a negative association, that is, as the value of one variable increases the value of the other variable decreases.

Table 4.13: Correlation analysis between the variables

		Age	HH size	level of education	Daily cooking frequency	Energy cost
Age	Pearson Correlation	1	.321(**)	-.042	.445(**)	.351(**)
	Sig. (2-tailed)		.000	.575	.000	.000
	N	180	180	180	180	180
HH size	Pearson Correlation	.321(**)	1	-.003	.481(**)	.414(**)
	Sig. (2-tailed)	.000		.966	.000	.000
	N	180	180	180	180	180
level of education	Pearson Correlation	-.042	-.003	1	.005	.220(**)
	Sig. (2-tailed)	.575	.966		.948	.003
	N	180	180	180	180	180
Daily cooking frequency	Pearson Correlation	.445(**)	.481(**)	.005	1	.630(**)
	Sig. (2-tailed)	.000	.000	.948		.000
	N	180	180	180	180	180
Energy cost	Pearson Correlation	.351(**)	.414(**)	.220(**)	.630(**)	1
	Sig. (2-tailed)	.000	.000	.003	.000	
	N	180	180	180	180	180

** Correlation is significant at the 0.01 level (two tailed)

Source Author (2013)

4.4.6.2 Multicollinearity effect

Multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated, meaning that one can be linearly predicted from the others with a non-trivial degree of accuracy. In this situation the coefficient estimates may change erratically in response to small changes in the model or the data. Multicollinearity does

not reduce the predictive power or reliability of the model as a whole, at least within the sample data themselves; it only affects calculations regarding individual predictors. That is, a multiple regression model with correlated predictors can indicate how well the entire bundle of predictors predicts the outcome variable, but it may not give valid results about any individual predictor, or about which predictors are redundant with respect to others (Chatterjee et al 2000).

The consequences of high multicollinearity are increased standard error of estimates of the β's (decreased reliability) and usually misleading results. In this study age, house hold size, level of education, daily cooking frequency, and cost of energy are highly correlated, such that education can predict household size as well as daily cooking frequency can predict energy cost (Chatterjee et al 2000). One of the features of multicollinearity is that the standard errors of the affected coefficients tend to be large. In that case, the t- value may not be significant. Due to this effect, the researcher conducted simple regression (Chatterjee et al 2000)

4.4.7 Regression analysis.

Simple linear regression is the least squares estimator of a linear regression model with a single explanatory variable. In other words, simple linear regression fits a straight line through the set of points in such a way that makes the sum of squared residuals of the model (that is, vertical distances between the points of the data set and the fitted line) as small as possible (Kenney and Keeping 1962).

Table 4.14: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Age	.739 [a]	.546	.543	.79343
HH size	.799 [a]	.638	.636	.70818
HH head education	.082 [a]	.007	.001	1.17339
Daily cooking frequencies	.773 [a]	. 598	.596	.74647
Cost of energy	.857 [a]	. 734	.733	0.70635

Source: Author 2013

Coefficient of determination explains the extent to which changes in the dependent variable can be explained by the change in the independent variables or the percentage of variation in the dependent variable (biomass energy consumption of the household) that is explained by all the five independent variables (age, education level of the household head, daily cooking frequencies of cooking, household size and the cost of the energy

Analysis in table above shows that the coefficient of determination (R square) for all the independent variables when each is regressed against household energy consumption. From the findings age of the household head explain 54.6%, HH size explain 63.8% while, education of the household head explain 0.7%, number of cooking times explain 59.8% and the cost of the energy explain 73.4% of the variance household energy consumption**.** The all five variables explained 50.5% of the factors that affect energy consumption in the district. Therefore, further research should be conducted to investigate the other factors (49.5%) that affect the biomass energy usage with respect to the income of the household head in the Kikuyu District.

Table 4.15 ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
Age	Regression	134.670	1	134.670	213.920	.000[a]
	Residual	112.057	178	.630		
	Total	246.728	179			
HH size	Regression	157.457	1	157.457	313.958	.000[a]
	Residual	89.271	178	.502		
	Total	246.728	179			
HH head education	Regression	1.648	1	1.648	1.197	.275[a]
	Residual	245.080	178	1.377		
	Total	246.728	179			
Cooking freq	Regression	147.543	1	147.543	264.787	000 [a]
	Residual	99.184	178	.557		
	Total	246.728	179			
Cost of Energy	Regression	161.673	1	161.673	324.025	.000[a]
	Residual	85.055	178	.478		
	Total	246.728	179			

a. Dependent Variable: Energy consumption by the household

b. Predictors: (Constant), Age, Hh size, Education hh, Daily cooking frequency and Cost of energy

Source Author (2013)

From the table the F statistics for the four variables are less than 0.05 except for the variable of level of education of household head which is more than 0.05. From these findings four predictor, variables (Age, HH income, cooking frequency and cost of energy) explain variation in the dependent variable (household energy consumption) while one variable (Household head level of education) did not explain variation on dependent variable.

Table 4.16: Model Summary/ Coefficients of regression equation

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.713	.151		4.736	.000
	age	.789	.054	.739	14.626	.000
2	(Constant)	.426	.141		3.023	.003
	HH size	.855	.048	.799	17.719	.000
3	(Constant)	2.565	.181		14.154	.000
	level of education	.042	.039	.082	1.094	.275
4	(Constant)	.614	.142		4.330	.000
	Cooking frequency	.837	.051	.773	16.272	.000
5	(Constant)	.413	.137		2.983	.000
	Cost of Energy	.864	.043	.857	17.853	.000

Source Author (2013)

A simple regression analysis was conducted so as to determine the effect of the independent variables (Age, Household size, Education, cooking frequency, and the cost of energy) on the dependent variable (energy consumption by the household)

The data findings analyzed also showed that taking all other independent variables at zero, a unit increase in age led to a . 789 increase in higher amount of biomass energy use by the household ; a unit increase in size of the household led to a 0.855 increase in amount of biomass energy use by the household; a unit increase in education of the household head led to a 0.042 increase in amount of biomass energy use by the household, a unit increase in cooking frequency led to a 0.837 increase in amount of biomass energy use by the household, and a unit increase in the cost of the energy led to 0.864 increase in amount of biomass energy use by the household. This infers that cost of the energy affected more the amount of biomass energy use by the household

followed by the household size, then cooking frequency, with age and the education of the household head with the least contribution to the amount of biomass energy use by the household.

At 0.05 level of significance and 95% level of confidence, age had a 000 level of significance; age had 0.000, household size showed a 0.000, Daily cooking frequency showed a 0.000 level of significance and the cost of energy showed 0.000, hence age, household size, daily cooking frequency and cost of energy were the most significant factors that determined to the amount of biomass energy consumption by the households in the Kikuyu

Level of education showed a 0.275 level of significance hence was not a significant factor in determination of biomass energy consumption

4.4.8 Tests of hypothesis

The study sought to test five hypotheses if there was any significant relationships between the age of household head, education of household head, cooking frequency, household size and energy cost significantly influence the amount of biomass energy consumed in a household. This was done using the T test. The following table presents the various hypotheses and their t statistics and the conclusion, either rejection or the failure to reject them.

Table 4.17 Hypothesis testing

Hypothesis	Critical t value	T statistics	Conclusion
H0: There is no significant relationship between age of the household head and the energy consumption by the household. H1: There is significant relationship between age of the household head and the energy consumption by the household.	1.96	14.626	Reject H0,
H0: There is no significant relationship household size and the energy consumption by the household. H1: There is significant relationship household size and the energy consumption by the household.	1.96	17.719	Reject H_0
H0: There is no significant relationship between education of the household head and the energy consumption by the household. H1: There is significant relationship between education of the household head and the energy consumption by the household.	1.96	1.094	Failed to Reject H0,
H0: There is no significant relationship between the daily cooking frequency and the energy consumption by the household. H1: There is significant relationship between the daily cooking frequency and the energy consumption by the household.	1.96	16.272	Reject H_0,
H0: There is no significant relationship the cost of energy and the energy consumption by the household. H1: There is significant relationship the cost of energy and the energy consumption by the household.	1.96	17.853	Reject H_0

Source Author (2013)

There was significant relationship between age of the household head, household size, daily cooking frequency, the cost of the energy with biomass energy consumption since all the t values

for the individual predictor variables were greater than 1.96. The Null hypotheses were therefore rejected and the Alternative hypothesis failed to be rejected.

The Null hypotheses there was no significant relationship between level of education of the household head with energy consumption was less than 1.96 hence failed to reject the Null hypotheses

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter provides a summary of the findings; discussions; conclusion and the recommendations of the study which sought to determine the factors influencing household energy usage: the case of biomass fuels use in Kikuyu District.

5.1 Summary of findings (Key findings)

5.1.1 Relationship between age of the household and the energy consumption

It was established from the study that 40.0 % of household headed by the age bracket of 40-49 years had the highest biomass energy usage, followed by over 50 years who comprised of 27.2%. 22.8% comprised those of the age bracket of 30-39 years and 20-29 years who comprised of 10.0%. It is therefore deduced that the households headed by older household heads consumed more biomass energy.

5.1.2 Relationship between education of the household and the energy consumption

It was established that that a mere number of those who had university education used kerosene and none used charcoal and firewood, while those who had completed primary education, majority used 13(7.2%) used firewood and 10(5.5%) used kerosene. For those respondents who their household heads had lower and upper primary education, 9(5.0%) majority used kerosene. Those with certificate level of education majority used charcoal 5(2.8%) while those with diploma majority used LPG 8(4.4%). This indicated that the level of education of the household head had influence on the type of the energy used by the household.

5.1.3 Relationship between Daily cooking frequencies of the household and the energy consumption

It was established from the study that 32.2% of the total number of the households cooked thrice a day followed by those who cooked four times a day and comprised 28.9%. 19.4% of the respondents said that their households cooked more than four times while those who said that they cooked for more than twice in day comprised of 11.7%. Only 7.8% of the households

cooked once in a day. The number of times a household cooked also determined the amount of the biomass fuels and this was indicated by the amount of money spent by the household for the purchase of the fuels as those who cooked a lot used more money.

5.1.4 Relationship between household size and the energy consumption

The study established that 43.3% of the respondents said that their households comprised of four and five members, 32.2% of them said that their households were comprised of two and three members and they were followed by those who indicated that their households were comprised of above five members and constituted 16.7%. 7.8% of the respondents said that their households were comprised of one member. 37.2% of the respondents indicated that their households had three children and were followed by those who said that their households had more than four children and they constituted 32.2%. 17.8 % of the respondents said that their households had 2 children and 12.8% of the respondents said that they had one child. The number of children in a homestead was an important factor in determining the amount of energy used as the bigger number of children in a household would lead to a higher rate of biomass usage.

5.1.5 Relationship between cost of energy and the energy consumption

It was established from the study that majority 59(32.8%) of the respondents indicated that their households spent between Kshs 1000- Kshs 1500 per month for the purchase of source of energy for the household and 45(25.0%) of the respondents said that they used less than Kshs. 500 for the purchase of biomass energy per month. Those who said that they used more than Kshs 1500 per month were 40 (22.2%) and 36(20.0%) said that they used between than Kshs 500- Kshs 1000 for purchase of biomass fuels in their homesteads. It can be surmised that for those who used less than Kshs 500 per month did have less than two children in their households and for those who had more than four children in their households used more than Kshs 1500.

The five independent variables that were studied, explained only 50.5% of the factors that affect the usage of the biomass energy by the households. This therefore means that other factors not studied in this research contribute 49.5 % of the factors that affect the biomass usage in Kikuyu District. Therefore, further research should be conducted to investigate the other factors (49.5%) that affect the biomass energy usage with respect to the income of the household head in the Kikuyu District.

According to the regression equation, a unit increase in age of the household head led to a .546 increase in higher amount of biomass energy use by the household ; a unit increase in education of the household head led to a 0.082 increase in amount of biomass energy use by the household, a unit increase in daily cooking frequency led to a 0.598 increase in amount of biomass energy use by the household, a unit increase in size of the household led to a 0.638 increase in amount of biomass energy use by the household and a unit increase in the cost of the energy led to 0.734 increase in amount of biomass energy use by the household. This infers that cost of the energy affected more the amount of biomass energy use by the household followed household size then daily cooking frequency then age of the household head. Level of education of the household head with the least contribution to the amount of biomass energy use by the household and was not significant factor in biomass energy consumption.

5.2 Discussion of the Findings

5.2.1 Age of household heads

The study established that the 67.2% of the respondents were older than 40 years and were responsible for the provision and making decisions on the energy type to be used. This agreed to the study done by Nyang (1999) who age of the household heads is said to have influence on the likelihood of consuming a particular fuel type. Households with older heads are most likely to consume wood fuel than non-wood fuels. Mekonnen and Kohlin (2009) found that households with older heads in major Ethiopian cities were much more likely to use wood and kerosene than electricity and charcoal while demand of wood increased with age.

5.2.2 Household size

The study showed that the higher the household size the more the household used charcoal fire wood and kerosene as compared to the use of the LPG and the electricity. It was evident that households with above five members majority 10(5.6%) used charcoal which agreed to the findings by the FAO (2009), which showed that the direct determinants of household energy consumption patterns are found precisely at the level of households. Household size has been observed to be sometimes a more important determinant of household energy consumption than income. High income has been associated with more family members (more people contributing to household income), thus increasing total household consumption.

5.2.3 Education level of household heads

According to Mekonnen and Kohlin (2009) they indicated that education level of household heads is postulated to have an inversely proportional relationship with consumption and demand of less clean fuels. In other words, the higher the level of education of household heads the higher the probability of consuming/using clean fuels. The determinants of household fuel choice in major cities of Ethiopia estimated that higher education. The study agreed to this findings as a mere number of those who had university education used firewood, charcoal and kerosene, while those who had secondary education, majority used 18(10%) used kerosene while 11(6.1%) used charcoal.

5.2.4 Energy costs

Cost of the energy was a key factor in the determining they type of the energy consumed by the household. It was determined that for the energy that did cost more than ksh 1500 was not opted for by the majority of the respondents, but between kshs 1000-1500, majority used Kerosene 17(9.4%), while the energy that did cost between kshs 500-1000 majority used firewood at 12(6.7%). Heltberg (2003) indicated that there is a large variation across countries in the composition of households' energy expenditures. In wealthier countries, electricity is the energy source on which much money is spent. Among the cooking fuels, hydrocarbons (LPG and kerosene) tend to be where most of the fuel budget is spent by income-rich households though such households may spend as much or more on wood and hydrocarbons (Hetberg 2003).

5.2.5 Number of cooking times

The number of times a household cooks as well as the time taken to prepare a single meal determines the amount of energy a household uses. A household that cooks more often in a single day tends to use more energy as compared to households that cook for much lesser time in a single day. The study established that households that cooked more than four times used firewood at 15(8.3%), for those who cooked four times, majority used 20(11.1%) used charcoal and this was attributed to the availability and the cost of the type of the energy consumed

5.3 Conclusion

Biomass energy continues to be a major source of fuels for households. This study sort to identify factors that influence the use of biomass fuels in Kikuyu District. The factors examined were age of household head, household size, education level of the household head, daily

cooking frequency and cost of energy. This study determined that age of the household head, household size, daily cooking frequency and cost of biomass fuels were the significant factors that influenced the use of biomass fuel at household level. Level of education of the household head was not a significant factor in the use of biomass fuels at household level. The five independent variables that were studied, explained only 50.5% of the factors that affect the usage of the biomass energy by the households with the relation to energy consumption of the household head as represented by the R^2. This therefore means that other factors not studied in this research contribute 49.5% of the factors that affect the biomass usage in Kikuyu District. Therefore, further research should be conducted to investigate the other factors (49.5%) that affect the biomass energy usage with respect to the energy consumption in Kikuyu District. From the regression analysis the study found cost of energy contributed more to the amount of biomass energy use by the household followed by the household size and then cooking frequency. Level of education of the household head did not emerge as a significant factor on biomass energy usage by the household.

5.4 Recommendations

5.4.1 Recommendations for Policymakers

a) Capacity building among households would promote creation of awareness in biomass energy utilization. This could be enhanced through media and campaigns that dwell on energy issues.
b) Involvement of government and NGOs' in energy related activities in order to facilitate sustainable biomass energy utilization such as provision of funding to support energy related projects.
c) Involvement of both genders in energy related activities so as to promote diversity in sharing and implementing of knowledge, skills and ideas that would be useful in supporting sustainable biomass energy utilization.

5.4.2 Recommendations for Further Research

This study has examined factors influencing household energy usage: the case of biomass fuels use in Kikuyu District. To this end therefore the same study should be carried out in other areas in Kenya to find out if the same results would be obtained. The study mainly focused on biomass fuels and a study should be for other sources of energy for the households; the study used a

sample size of 198 and thus the study suggests that for other studies dealing factors influencing the amount of energy consumed by the household, a larger sample size should be used.

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APPENDICES

APPENDIX I: Household Survey Questionnaire

QUESTIONNAIRE FOR THE LOCAL COMMUNITY

The questionnaire will assist to find out the factors influencing household energy consumption, the case of biomass fuels in Kikuyu District. Do not write your name on the questionnaire since the information you shall give will be treated confidentially and will only be used for the purpose of this research.

Kindly respond to all the questions.

Instructions

Please respond to each item by putting a tick [√] next to the response applicable as you deem necessary.

SECTION A: BACKGROUND INFORMATION

I. What is your gender

Male ( )
Female ( )

II. What is your age

(i) Under 20 Years ( )
(ii) 20-29 Years ( )
(iii)30-39 Years ( )
(iv)40-49 Years ( )
(v) Over 50 Years ( )

III. What is your highest academic qualification?

(i) Lower primary ( )
(ii) Upper primary ( )
(iii)KCPE ( )
(iv)Secondary level ( )
(v) KCSE ( )
(vi)Diploma ( )
(vii) Undergraduate ( )

(viii) Post graduate ( )

(ix) Others ( )

SECTION B: Background information on the various biomass energy uses by the households

a) What is the Monthly Income of Household Head?

(i) Less than Kshs 10000 a month ( )

(ii) Between Kshs 10000-20000 a month ( )

(iii) Between Kshs 20000-30000 a month ( )

(iv) Between Kshs 30000-40000 a month ( )

(v) More than Kshs 40000a month ( )

b) What is the economic activity of the household head?

i) Employed ( )

ii) Self-employed (farming/business) ( )

iii) Casual laborer ( )

Sources of energy for the households

c) What are the energy sources used normally for lighting, cooking and water heating in this household?

(i) Electricity ( )

(ii) Kerosene ( )

(iii) LPG ( )

(iv) Charcoal ( )

(v) Firewood ( )

(vi) Solar Energy ( )

(vii) Candle ( )

(viii) Generator ( )

d) Reasons for Using Energy Options for Lighting

(i) Cheap and affordable ( )
(ii) Always available ( )
(iii) Convenient ( )
(iv) Has brighter light ( )
(v) Economical ( )
(vi) Easy to use ( )
(vii) No other source of lighting ( )
(viii) Can be used for both lighting and cooking( )

e) How recently did this household use kerosene, Electricity, LPG, Charcoal, Firewood and Solar Energy**?**

(i) Past 7 days ( )
(ii) Past 1-2 months ( )
(iii)Past 3-6 months ( )
(iv)Past 7-12 months ( )
(v) Over 12 months ( )
(vi)Don't use ( )

f) Does the household have access to electricity?
Yes ( )
No ( )

g) In case of an electric power failure, what are the backup sources of lighting used by this household?

(i) Candle ( )
(ii) Flashlight ( )
(iii) Rechargeable Fluorescent ( )
(iv) Kerosene ( )

(v) Generator ( )

h) For what purposes does this household use LPG?

(i) Cooking ( )
(ii) Water Heater ( )
(iii) Home Business ( )

i) What does this household use to heat water for bathing?

(i) Solar heater ( )
(ii) Electric heater ( )
(iii) Gas heater ( )
(iv) Heat on stove ( )
(v) Other ( )
(vi) Does not heat ( )

SECTION B: FACTORS INFLUENCING HOUSEHOLD ENERGY USAGE WITH RELATION TO THE INCOME OF THE HOUSEHOLD HEAD-IN KIKUYU DISTRICT

Age

1 Who is the head of the household?

(i) Father ( )
(ii) Mother ( )
(iii)Elder siblings ( )

2 Does he/she provide money for the purchase of biomass fuel for the household?

Yes ( )
No ( )

Number of cooking times

3. How many times do you cook food in a day?

(i) Once ( )
(ii) Twice ( )
(iii) Thrice ( )

(iv) Four times ( )

(v) More than four times ( )

4. How long does it take to prepare a single meal?

(i) 20 minutes ( )

(ii) 30 minutes ( )

(iii) 45 minutes ( )

(iv) One hour ( )

5. Does the household use any energy saving techniques? Such as use

(i) Lids while cooking, ( )

(ii) Use of energy saving jikos ( )

(iii) Hot pots and thermos flasks ( )

(iv) Others ……..specify ( )

Education of the household head

6. What is the highest education level of the household head/ or the person who provides money for the purchase of the energy for the household?

(i) Lower primary ( )

(ii) Upper primary ( )

(iii) KCPE ( )

(iv) Secondary level ( )

(v) KCSE ( )

(vi) Diploma ( )

(vii) Undergraduate ( )

(viii) Post graduate ( )

(ix) Others ( )

Household size

7. How many members does the household have?

(i) 1 ( )

(ii) 2 ( )

(iii) 3 ( )

(iv) 4 ( )

(v) 5 ( )

(vi) 6 ( )

(vii) More than 6 ( )

8. How many children are there in the household?

(i) 1 ( )

(ii) 2 ( )

(iii) 3 ( )

(iv) 4 ( )

(v) More than 4 ( )

Cost of the energy

9. How much money does the household use on energy per month?

(i) Less than Kshs 500 ( )

(ii) Between Kshs 500 - Kshs 1000 ( )

(iii) Between Kshs 1000- Kshs 1500 ( )

(iv) More than Kshs 1500 ( )

10. Does the household have other substitutes for use if the main type of energy diminishes?

(i) Yes ( )

(ii) No ( )

11. If yes how much does the household spend on it?

(i) Less than Kshs 500 ( )

(ii) Between Kshs 500 - Kshs 1000 ( )

(iii) Between Kshs 1000- Kshs 1500 ( )

(iv) More than Kshs 1500 ( )

APPENDIX II: SIMPLIFIED SAMPLE DATASET

Questionnaire Serial No	Gender	Age in Years	Household Size	Income of the Household head in Kshs	Highest level of Formal education	Daily cooking frequency	Cost of Energy in Kshs	Energy Consumption
1	Male	50 and above	4-5	Over 40000	Undergraduate	more than four times	500 - 1000	41-60
2	female	30-39	4-5	30,001-40000	Undergraduate	four times	over 1500	more than 61
3	Male	40-49	4-5	20,001-30,000	KCPE	Thrice	500 - 1000	21-40
4	female	40-49	4-5	30,001-40000	Secondary	four times	1000-1500	41-60
5	female	40-49	4-5	Over 40000	Undergraduate	more than four times	over 1500	more than 61
6	female	20-29	4-5	30,001-40000	Upper primary	more than four times	500 - 1000	21-40
7	female	40-49	4-5	30,001-40000	Undergraduate	more than four times	500 - 1000	21-40
8	female	30-39	4-5	30,001-40000	Undergraduate	four times	1000-1500	41-60
9	Male	40-49	4-5	30,001-40000	Diploma	more than four times	over 1500	more than 61
10	female	40-49	4-5	30,001-40000	KCSE	four times	500 - 1000	21-40
11	female	30-39	4-5	30,001-40000	Undergraduate	Thrice	1000-1500	41-60
12	Male	20-29	4-5	20,001-30,000	Diploma	Once	Less than 500	21-40
13	Male	40-49	4-5	Over 40000	Undergraduate	Thrice	over 1500	more than 61
14	female	40-49	2-3	20,001-30,000	Secondary	four times	Less than	21-40

							500	
15	male	30-39	2-3	20,001-30,000	KCPE	four times	Less than 500	20 and below
16	female	40-49	2-3	30,001-40000	Lower prim	more than four times	over 1500	more than 61
17	male	40-49	4-5	30,001-40000	Diploma	Thrice	over 1500	more than 61
18	female	40-49	2-3	30,001-40000	KCPE	Twice	over 1500	more than 61
19	female	20-29	One	30,001-40000	KCPE	Once	500 - 1000	21-40
20	Fe`male	30-39	4-5	10,001-20,000	Lower prim	Twice	Less than 500	20 and below
21	male	50 and above	4-5	20,001-30,000	Undergraduate	four times	over 1500	more than 61
22	female	40-49	2-3	Over 40000	Undergraduate	Twice	over 1500	more than 61
23	male	20-29	One	30,001-40000	KCPE	Once	Less than 500	20 and below
24	male	40-49	4-5	30,001-40000	KCPE	more than four times	1000-1500	41-60
25	female	50 and above	4-5	30,001-40000	Secondary	Twice	over 1500	more than 61
26	female	30-39	4-5	30,001-40000	KCPE	Thrice	500 - 1000	21-40
27	female	30-39	4-5	10,001-20,000	Lower prim	four times	over 1500	more than 61
28	female	20-29	One	30,001-40000	Upper primary	Thrice	Less than 500	21-40
29	male	40-49	4-5	10,001-20,000	KCPE	more than four times	500 - 1000	41-60
30	female	40-49	4-5	30,001-40000	Diploma	four times	over 1500	more than 61

31	female	30-39	above 5	30,001-40000	Secondary	more than four times	over 1500	more than 61
32	male	50 and above	4-5	10,001-20,000	Lower prim	Thrice	Less than 500	20 and below
33	male	40-49	4-5	30,001-40000	KCPE	four times	500 - 1000	21-40
34	male	30-39	above 5	Over 40000	Secondary	four times	Less than 500	20 and below
35	female	40-49	2-3	30,001-40000	KCPE	Thrice	over 1500	more than 61
36	female	40-49	One	10,001-20,000	Lower prim	Thrice	over 1500	more than 61
37	female	50 and above	2-3	30,001-40000	KCPE	Twice	over 1500	more than 61
38	male	40-49	2-3	10,001-20,000	Upper primary	Thrice	Less than 500	20 and below
39	male	30-39	4-5	20,001-30,000	Secondary	Thrice	Less than 500	20 and below
40	female	50 and above	4-5	30,001-40000	Lower prim	four times	1000-1500	41-60
41	female	30-39	2-3	30,001-40000	Undergraduate	more than four times	over 1500	more than 61
42	female	30-39	4-5	Over 40000	Secondary	more than four times	over 1500	more than 61
43	female	50 and above	4-5	30,001-40000	Upper primary	Thrice	over 1500	more than 61
44	female	30-39	4-5	20,001-30,000	KCPE	four times	500 - 1000	21-40
45	male	20-29	One	30,001-40000	KCPE	more than four times	500 - 1000	21-40
46	male	50 and above	above 5	30,001-40000	Lower prim	four times	over 1500	more than 61

47	male	30-39	4-5	30,001-40000	KCPE	more than four times	Less than 500	20 and below
48	male	50 and above	2-3	30,001-40000	KCPE	four times	1000-1500	41-60
49	female	30-39	above 5	0-10,000	Secondary	thrice	1000-1500	more than 61
50	male	40-49	4-5	10,001-20,000	Lower prim	four times	1000-1500	41-60
51	male	50 and above	4-5	30,001-40000	KCPE	more than four times	1000-1500	more than 61
52	female	40-49	4-5	30,001-40000	Upper primary	four times	500 - 1000	21-40
53	female	30-39	4-5	Over 40000	Diploma	four times	1000-1500	41-60
54	male	40-49	4-5	Over 40000	Undergraduate	thrice	1000-1500	more than 61
55	male	40-49	4-5	Over 40000	Undergraduate	four times	Less than 500	20 and below
56	male	40-49	4-5	Over 40000	Secondary	four times	Less than 500	41-60
57	male	40-49	4-5	30,001-40000	Upper primary	more than four times	over 1500	more than 61
58	male	50 and above	2-3	10,001-20,000	KCPE	four times	over 1500	more than 61
59	male	30-39	2-3	30,001-40000	KCPE	thrice	over 1500	more than 61
60	female	50 and above	4-5	Over 40000	Upper primary	more than four times	over 1500	more than 61
61	male	30-39	4-5	30,001-40000	KCPE	thrice	500 - 1000	21-40
62	female	40-49	2-3	30,001-40000	Lower prim	four times	over 1500	more than 61
63	male	40-49	2-3	20,001-30,000	Lower prim	four times	500 - 1000	21-40

64	male	50 and above	4-5	20,001-30,000	KCPE	four times	Less than 500	20 and below
65	male	40-49	4-5	30,001-40000	KCSE	twice	over 1500	more than 61
66	male	50 and above	4-5	20,001-30,000	Lower prim	four times	Less than 500	21-40
67	female	30-39	above 5	30,001-40000	Upper primary	four times	1000-1500	more than 61
68	female	50 and above	4-5	20,001-30,000	KCPE	more than four times	500 - 1000	21-40
69	female	30-39	4-5	30,001-40000	Upper primary	more than four times	1000-1500	more than 61
70	female	50 and above	above 5	0-10,000	Lower prim	four times	500 - 1000	21-40
71	male	40-49	4-5	30,001-40000	Upper primary	more than four times	500 - 1000	21-40
72	female	40-49	2-3	30,001-40000	KCPE	four times	over 1500	more than 61
73	male	50 and above	2-3	30,001-40000	KCPE	more than four times	1000-1500	more than 61
74	female	40-49	above 5	30,001-40000	KCSE	four times	over 1500	more than 61
75	female	40-49	2-3	10,001-20,000	Upper primary	four times	1000-1500	more than 61
76	female	50 and above	4-5	10,001-20,000	Diploma	thrice	Less than 500	21-40
77	female	30-39	4-5	10,001-20,000	KCPE	twice	Less than 500	21-40
78	female	40-49	2-3	30,001-40000	Lower prim	thrice	1000-1500	more than 61
79	male	20-29	2-3	20,001-30,000	KCSE	more than four	1000-1500	more than 61

						times		
80	female	40-49	above 5	10,001-20,000	KCPE	thrice	500 - 1000	21-40
81	female	50 and above	above 5	30,001-40000	KCSE	thrice	1000-1500	more than 61
82	female	50 and above	2-3	0-10,000	Upper primary	four times	500 - 1000	21-40
83	female	30-39	One	Over 40000	Undergraduate	thrice	Less than 500	20 and below
84	male	40-49	2-3	Over 40000	Undergraduate	four times	Less than 500	20 and below
85	male	20-29	One	30,001-40000	KCSE	thrice	Less than 500	20 and below
86	male	30-39	4-5	30,001-40000	KCPE	four times	over 1500	more than 61
87	female	40-49	4-5	0-10,000	Lower prim	more than four times	Less than 500	21-40
88	male	20-29	2-3	20,001-30,000	Secondary	thrice	500 - 1000	21-40
89	male	50 and above	4-5	Over 40000	Secondary	four times	over 1500	more than 61
90	male	40-49	above 5	30,001-40000	KCPE	four times	1000-1500	more than 61
91	female	50 and above	4-5	30,001-40000	Upper primary	thrice	500 - 1000	41-60
92	male	40-49	4-5	30,001-40000	KCPE	four times	500 - 1000	21-40
93	male	40-49	4-5	30,001-40000	Upper primary	thrice	Over 1500	more than 61
94	male	40-49	above 5	20,001-30,000	KCPE	more than four times	1000-1500	more than 61
95	male	50 and above	4-5	Over 40000	KCPE	four times	1000-1500	more than 61
96	female	50 and above	2-3	s10,001-20,000	Upper primary	four times	1000-1500	more than 61

97	male	40-49	4-5	s10,001-20,000	Upper primary	more than four times	1000-1500	more than 61
98	male	30-39	2-3	30,001-40000	KCSE	four times	500 - 1000	20 and below
99	female	20-29	One	20,001-30,000	Upper primary	once	Less than 500	20 and below
100	female	40-49	2-3	30,001-40000	KCPE	more than four times	1000-1500	more than 61
101	male	40-49	4-5	s10,001-20,000	KCSE	once	Less than 500	20 and below
102	female	50 and above	above 5	30,001-40000	Lower prim	four times	over 1500	41-60
103	female	40-49	4-5	Over 40000	Undergra duate	twice	500 - 1000	more than 61
104	female	40-49	4-5	Over 40000	Undergra duate	four times	over 1500	more than 61
105	female	50 and above	4-5	20,001-30,000	Diploma	twice	500 - 1000	41-60
106	male	20-29	above 5	30,001-40000	Lower prim	thrice	500 - 1000	20 and below
107	female	40-49	2-3	30,001-40000	KCPE	twice	Less than 500	21-40
108	female	20-29	2-3	s10,001-20,000	KCPE	twice	Less than 500	21-40
109	female	40-49	above 5	s10,001-20,000	Upper primary	once	Less than 500	21-40
110	female	40-49	4-5	Over 40000	Undergra duate	four times	over 1500	more than 61
111	female	40-49	2-3	20,001-30,000	KCSE	more than four times	500 - 1000	20 and below
112	female	50 and above	4-5	30,001-40000	KCSE	twice	500 - 1000	41-60
113	female	40-49	above 5	30,001-40000	KCPE	four times	over 1500	more than 61

114	female	20-29	One	s 0-10,000	Lower prim	more than four times	500 - 1000	20 and below
115	female	40-49	above 5	20,001-30,000	Undergraduate	four times	over 1500	more than 61
116	female	30-39	2-3	s 0-10,000	KCSE	four times	1000-1500	more than 61
117	female	50 and above	above 5	s 0-10,000	Secondary	four times	1000-1500	more than 61
118	female	30-39	2-3	30,001-40000	Lower prim	four times	over 1500	41-60
119	male	30-39	2-3	Over 40000	Undergraduate	once	Less than 500	20 and below
120	female	50 and above	2-3	Over 40000	Undergraduate	four times	44	more than 61
121	male	40-49	2-3	30,001-40000	KCSE	thrice	1000-1500	21-40
122	male	30-39	One	30,001-40000	Secondary	four times	1000-1500	20 and below
123	female	50 and above	4-5	30,001-40000	KCSE	four times	500 - 1000	more than 61
124	male	40-49	2-3	30,001-40000	KCPE	twice	500 - 1000	more than 61
125	female	50 and above	above 5	30,001-40000	Undergraduate	twice	500 - 1000	41-60
126	male	40-49	4-5	30,001-40000	KCPE	four times	Less than 500	41-60
127	female	20-29	above 5	30,001-40000	KCPE	four times	1000-1500	more than 61
128	male	30-39	4-5	30,001-40000	Upper primary	thrice	1000-1500	more than 61
129	female	20-29	2-3	s 0-10,000	Upper primary	more than four times	1000-1500	41-60
130	male	40-49	2-3	20,001-30,000	KCPE	thrice	1000-1500	more than 61
131	female	50 and above	2-3	s 0-10,000	Diploma	four times	1000-1500	more than 61
132	female	40-49	above 5	30,001-40000	KCSE	four times	1000-1500	41-60

133	male	40-49	2-3	20,001-30,000	Secondary	thrice	33	more than 61
134	female	50 and above	2-3	30,001-40000	Lower prim	four times	over 1500	more than 61
135	male	20-29	One	30,001-40000	Secondary	twice	Less than 500	21-40
136	male	40-49	2-3	30,001-40000	KCPE	twice	over 1500	more than 61
137	male	20-29	One	30,001-40000	Secondary	four times	over 1500	more than 61
138	female	50 and above	above 5	30,001-40000	KCPE	twice	500 - 1000	more than 61
139	female	30-39	2-3	30,001-40000	Lower prim	four times	1000-1500	41-60
140	female	40-49	2-3	30,001-40000	KCPE	twice	over 1500	more than 61
141	male	20-29	One	20,001-30,000	Diploma	thrice	1000-1500	20 and below
142	female	50 and above	2-3	20,001-30,000	KCPE	more than four times	over 1500	more than 61
143	male	30-39	2-3	30,001-40000	Secondary	four times	1000-1500	21-40
144	female	30-39	4-5	30,001-40000	KCPE	thrice	500 - 1000	41-60
145	male	50 and above	4-5	30,001-40000	KCPE	more than four times	500 - 1000	more than 61
146	male	30-39	above 5	30,001-40000	Upper primary	thrice	1000-1500	21-40
147	female	40-49	4-5	s 0-10,000	KCPE	twice	500 - 1000	more than 61
148	male	30-39	2-3	s10,001-20,000	KCPE	thrice	500 - 1000	21-40
149	female	50 and above	4-5	30,001-40000	Lower prim	four times	over 1500	more than 61
150	male	40-49	2-3	20,001-30,000	KCPE	more than four times	Less than 500	20 and below

151	female	50 and above	2-3	s10,001-20,000	Lower prim	thrice	1000-1500	more than 61
152	female	40-49	above 5	s 0-10,000	Secondary	twice	500 - 1000	41-60
153	female	50 and above	4-5	30,001-40000	KCPE	thrice	1000-1500	more than 61
154	male	40-49	2-3	s10,001-20,000	Secondary	four times	Less than 500	20 and below
155	male	50 and above	4-5	20,001-30,000	KCPE	thrice	1000-1500	more than 61
156	female	40-49	4-5	30,001-40000	Lower prim	four times	over 1500	more than 61
157	male	20-29	4-5	30,001-40000	Upper primary	more than four times	1000-1500	21-40
158	female	40-49	4-5	20,001-30,000	KCSE	thrice	Less than 500	20 and below
159	female	30-39	4-5	30,001-40000	Lower prim	four times	500 - 1000	41-60
160	female	30-39	4-5	30,001-40000	KCPE	twice	500 - 1000	21-40
161	female	30-39	4-5	30,001-40000	Lower prim	four times	1000-1500	more than 61
162	female	40-49	above 5	20,001-30,000	Secondary	thrice	Less than 500	20 and below
163	female	50 and above	4-5	s10,001-20,000	Lower prim	thrice	over 1500	more than 61
164	female	40-49	4-5	s10,001-20,000	Secondary	thrice	500 - 1000	41-60
165	female	50 and above	4-5	30,001-40000	KCPE	once	over 1500	more than 61
166	female	50 and above	4-5	20,001-30,000	KCSE	more than four times	over 1500	more than 61
167	female	30-39	4-5	30,001-40000	KCSE	thrice	1000-1500	21-40
168	female	50 and above	4-5	30,001-40000	KCPE	four times	1000-1500	more than 61

169	male	20-29	2-3	30,001-40000	KCPE	thrice	Less than 500	20 and below
170	male	40-49	4-5	30,001-40000	Upper primary	thrice	500 - 1000	41-60
171	female	50 and above	2-3	Over 40000	post graduate	more than four times	500 - 1000	41-60
172	female	40-49	4-5	30,001-40000	Undergraduate	thrice	over 1500	more than 61
173	female	50 and above	2-3	Over 40000	KCSE	more than four times	1000-1500	more than 61
174	female	30-39	4-5	30,001-40000	KCSE	thrice	1000-1500	41-60
175	female	40-49	2-3	30,001-40000	Undergraduate	twice	1000-1500	41-60
176	female	30-39	4-5	30,001-40000	Undergraduate	thrice	1000-1500	more than 61
177	female	50 and above	4-5	Over 40000	Undergraduate	more than four times	over 1500	more than 61
178	female	30-39	4-5	20,001-30,000	KCPE	once	Less than 500	21-40
179	male	30-39	4-5	30,001-40000	KCSE	more than four times	1000-1500	more than 61
180	female	30-39	4-5	30,001-40000	Undergraduate	twice	over 1500	more than 61

Lower primary - Class 1-4

Upper primary- Class 5-8

KCPE -Completed Primary education

Secondary- Form 1-4

KCSE- Completed Secondary education

PHOTOGRAPHS OF STUDY AREA

Kikuyu town

Firewood collected and kept to dry in the sun

Dried firewood stored for use

Firewood being used to prepare a meal

Charcoal being sold in debes

Charcoal being sold in sacks

Charcoal sold in different sizes of containers

Poorly ventilated kitchen