ANALYSIS OF HOUSEHOLD ENERGY CONSUMPTION FOR COOKING AMONG HOUSEHOLDS IN RURAL AND URBAN AREAS OF KANO STATE

HADIZA NASIR IRO
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BEING A THESIS SUBMITTED TO THE DEPARTMENT OF ECONOMICS FACAULTY OF SOCIAL SCIENCES BAYERO UNIVERSITY KANO STATE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN (ECONOMICS)

SUPERVISOR
DR AMINA ABUBAKAR ISMAIL

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CERTIFICATION

This is to certify that the research work titled Analysis of Household Energy Consumption for Cooking among Households in rural and urban areas of Kano State were carried out under our supervision

Dr Amina Abubakar Ismail ………………………………………..

Supervisor Date

Dr Abubakar Hamid Danlami ………………………………………………

Internal Examiner Date

Prof Badayi Sani ………………………………………………

Head of Department Date

Prof Yahaya Zakari ………………………………………………

External Examiner Date

DEDICATION

This work is dedicated to my Parents Engnr Nasir Iro and Hajiya Amina Nasir Iro

And

To my Late Great Grand Mother Hajiya Hadiza May her soul rest in peace

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ABSTRACT

The objective of this study is to analyse household energy consumption for cooking in Rural and Urban areas of Kano State. For this study, field survey was carried out in which 768 Questionnaires were distributed to the households in three local government areas of Kano State namely; Tarauni, Dambatta and Garko each represented a particular Senatorial Zone. Multi stage cluster sampling technique was also employed. The study made use of multinomial logit (Mlogit) model to assess household energy choice for cooking, OLS model to examine household firewood consumption for cooking and Tobit model to determine household charcoal consumption. The result of Mlogit shows location, age, education, household size, employer, income, home ownership, home nature, interaction variable income and location as significant factors that affect household energy choice. The result further revealed that different factors significantly affect household firewood consumption. These include; location, age, household size, employer, income, home ownership, home nature, interaction variable Income and location. The result of the tobit model shows age of the household head, marital status, household size, employer, home ownership, dwelling share, interaction variables age and gender as significant factors that determined charcoal consumption. More so, firewood was found to be the most used fuel in both rural and urban households of Kano State. Moreover, the study recommends the state government to embark on policies and programmes aimed at increasing income of individuals through employment generations, empowerment and skills development. The local communities under their village leaders are also the immediate managers of the forest resources .A by –law at village level should be made to ensure that all wood fuel using households use improved stoves.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Energy plays the most vital role in the economic growth, progress, and development, as well as poverty eradication and security of any nation. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly (Oyedepo, 2012).

According to Salam (2006) energy is the indispensable force driving all economics activities. The benefits of energy to commercial, transportation, industrial and household cannot be over emphasized. Hence, an impressive performance of Gross Domestic Product (GDP) is driven by the effective supply and consumption of energy. Therefore, access to modern energy is assumed to be a precondition for poverty alleviation, sustainable development and the attainment of the millennium development targets. Energy sources range from the traditional biomass (fuel wood and charcoal) to modern fuel types like Liquefied Petroleum Gas (LPG) and electricity. As a key component of a national sector, energy (electricity and crude oil produce) are the major sources of a nation advancement and improvement in the standard of living of the people by stimulating other sectors like health, education, agriculture, commerce, transportation and industries. Emphasis has been shifted to modern energy (electricity and oil & Gas) as factor input with the economic importance of stimulating economic growth. At individual level, increased in energy consumption is likely to be one of the most important causes of improvement in welfare of the people. At national Level, in this period of the digital economy, it is not possible to envisage development without the use of modern energy (Worlde - Rufael, 2006).

The patterns of energy usage in Nigeria's economy can be divided into industrial, transport, commercial, agricultural, and household sectors (Energy Commission of Nigeria, 2003).The household cooking sector is the largest consumer of energy in Nigeria, using around 80% of the total, 90% of which is derived from biomass, particularly fuel wood (International Energy Agency, 2015).The household energy consumption pattern also can be majorly categorized into dimensions such as; cooking, lightening, heating and cooling, as well as transportation purposes. For satisfying the needs of cooking, the various sources available include; animal dung plant residues fuel-wood (mostly in developing countries), kerosene, gas and electricity, (Julius, 2013). For lightening purpose, the various choices mainly include; electricity or solar, petroleum or diesel (used for fuelling generators), kerosene, candles and traditional lamps as well as firewood, mostly based on socio-economic status of a household (Barness & Floor, 1996). Furthermore, for the purpose of space heating and cooling (also drinks cooling), the various energy sources available consist of mainly electricity and petroleum or diesel power generator. Lastly, for transportation purposes the major choice available are; petroleum and diesel for fuelling various transport vehicles. The fact that a household chooses one or more of these energy sources is a function of interaction of so many factors which consists of socio economic, demographic characteristics of households, climatic conditions, house, product or vehicle characteristics, attitudinal variables as well as environmental factors (Danlami, 2018).

Despite the different sources of cooking energy used in Nigeria such as; liquefied petroleum gas (LPG), kerosene, and electricity are expensive compared to biomass, which is available at little or no cost. With over 60% of people earning less than $1 per day (Bello & Roslan, 2010) biomass stands as the preferred source of household cooking energy in Nigeria.

The availability of electricity and other energy sources is alsoa major challenge, especially in rural areas.In fact, the total welfare of a household depends upon the total number of goods and services consumed or used (Oyedepo, 2013). However most of the goods and services that constitute the total welfare of a household ranging from food items, hot or cool and soft drinks, home facilities like; air conditioner, fan, electric lamp, television, water pump, satellites and room warmer, down to transportations depend wholly on relevant energy, to be useful. Hence households must demand energy not for direct consumption, but for the purpose of facilitating its use and consumption of other goods and services (Danlami, 2018).

In many developing countries, particularly in rural areas, traditional fuels, such as fuel wood, charcoal and agricultural waste, constitute a major portion of total household energy consumption (Odugbenro & Olajide, 1999). Furthermore, efficiency of a traditional fuel wood cooking stove is as low as 10 - 12 percent, compared with a Liquefied Petroleum Gas (LPG) stove efficiency of more than 40 per cent. About 70 percent of the population in developing countries use liquid fuels such as kerosene or bottled gas for cooking and heating (UNDP &WHO, 2009).

Khennas (1998) asserted that urban areas are responsible for the bulk of household energy consumption especially the conventional energy (electricity and petroleum products) is also true for traditional forms of energy such as biomass. Biomass fuel not only provides energy for poor rural population but also to people with higher incomes. In both cases, the fuels come from rural areas and the employment and income generated is crucial for rural populations.

Adetunji (2007) opined that energy option of any country is influenced by national economic condition, individual level of income, technological advancement, the state of energy infrastructure as well as the rate of population growth. The Nigerian energy sector is not well developed based on the fact that despite abundance various energy sources in the country, majority of the people are yet to have access to affordable and reliable energy.

Energy consumption patterns in the world today shows that Nigeria and indeed African countries have the lowest rates of consumption. Nevertheless, Nigeria suffers from an inadequate supply of usable energy due to the rapidly increasing demand, which is typical of a developing economy. Paradoxically, the country is potentially endowed with sustainable energy resources. Nigeria is rich in conventional energy resources, which include oil, natural gas, lignite, and coal. It is also well endowed with renewable energy sources such as wood, solar, hydropower, and wind (Okafor & Uzuegbu, 2010).

Nigeria is one of the most densely populated countries in Africa, with approximately 200 million people in an area of 920,000 km^2 and is also the country with the largest population in Africa and the seventh largest population in the world (World FactBook, 2018) .The implication of this demographic structure is that large amount of energy will be required for meeting obligations at both the urban and rural areas in the country.

The rural dwellers, whose needs are often basic, depend to a large extent on the traditional sources of energy for their domestic energy requirements while the majority of the urban dwellers depend on traditional energy sources and fossil fuels. However, the high level of poverty and other socio-economic problems inhibit both the rural and urban dwellers from having access to adequate and reliable sources of energy for domestic purposes.

Similarly, in terms of energy availability(CBN, 2007) reported that, there are various ample energy sources in Nigeria such as wind, solar, hydro, coal, oil and gas etc, which if properly managed will alleviate energy problems of the people most especially for domestic consumption. Obviously, Nigeria is naturally endowed with oil and gas and depends on it for her economic development. For example, oil accounts for 80.5 per cent of national revenue. These two energy sources are the major export commodities that provide foreign exchange for the country. Oil and gas also play major role in meeting energy needs of the various sectors of the nation's economy. For example, gas, petrol, diesel and kerosene provide energy for wide industrial and domestic application.Apart from oil and gas, other energy sources such as electricity, wood and coal also play significant roles in meeting energy demands in the country. However, among all these energy sources, only fuel wood is mostly available and utilized almost everywhere in the country for meeting domestic energy needs. Other energy sources are scarce most especially in the rural areas where fuel wood is their major energy carrier.

Petroleum products and electricity constitute the most widely used domestic energy sources in Nigeria. Because of inefficiency of the centralized energy industry, prices of these products have been unstable, while supply is grossly inadequate for the rapidly growing population. Therefore, the economy had suffered perennial energy crises with some huge economic losses and social consequences (Idowu, Ismail, Otunaiya,& Shittu, 2004). The political dimension of the crises can be vividly portrayed from the fact that while federal government often makes promises of energy sector reforms as ambitious legislative work, corruption in the public sector stands as impediment in the implementation processes.

World Bank (1993) linked Nigeria's energy crises to some inadequacies in supply and distribution, pricing, planning and manpower. Unmet households' energy demands have some adverse effects on the living standards of the population, with grossly degenerated income and energy poverty. The situation is more pathetic when one realizes the magnitude of nonrenewable resources that the nation is naturally endowed with (Iwayemi, 2008). It should also be noted that the mechanism for commodity price transmission is very strong when energy products are affected. This is because of weaknesses and inefficiency of existing transportation systems. Therefore, energy price increases or its acute shortages portend serious welfare losses to households because of reduction in their income purchasing power.

In continuation, Oyedepo (2012)highlights that the energy crisis, which has engulfed Nigeria for almost two decades, has been enormous and has largely contributed to the incidence of poverty by paralyzing industrial and commercial activities during this period. Nigerian energy sector is probably one of the most inefficient in meeting the energy needs of its people. This is most evident in persistent disequilibrium in the market for electricity and petroleum products, especially kerosene and premium motor spirit (PMS) (Iwayemi, 2008).

Orazulike (2012) further contends that Nigeria is endowed with all that is necessary to build a great nation. However, the quest to fast track the nation's development would be faster if the tripod of politics, law and private sector investments is adequately utilized in national planning, to ensure energy security for the country. One of the major problems of Nigeria today, argues Adisianya (2010) is energy insecurity. Every developed economy, posits Orazulike (2012) is built with the realization that a sustained availability of affordable energy in its various forms is fundamental to the provision of jobs, food, health services, education, housing, clean water and good sanitation. He further argues that energy security is the foundation, stone and the pillar, upon which every advanced world economy is built. Creating jobs will not be well successful without first solving energy problems. In fact, energy security is the main catalyst to job creation. Accordingly, all economic activities: the industries, the factories, the schools, the businesses, the markets, the hospitals, the service companies, the hotels, tourism and all the public and private sectors need constant energy to function effectively. Orazulike (2012) has also clearly posited that generally, energy security refers to a condition in which a nation and a majority or all of its citizens and businesses have access to sufficient energy resources at reasonable prices for the foreseeable future, free from serious risk of disruption of service.

The general pattern of fuel use for cooking in developing countries dictates that with increasing income people move up the energy ladder from firewood to charcoal or kerosene and then to LPG/ natural gas, or electricity. Analysts use a simple model, the 'energy ladder' (Leach & Mearns, 1988; Leach, 1992; Masera,Saatkamp & Kamonen, 2000) to describe a hierarchy of household energy options characterized by attributes such as cost, energy efficiency, cleanliness, and convenience.

While most energy in residential buildings in EU-15 countries is used for heating, an entirely different picture emerges in the dwellings of the lowest-income inhabitants of cities in developing countries, where energy (produced mainly by burning kerosene or charcoal) is primarily used for cooking. In developed countries, energy for cooking ranges from between 4 and 7 per cent of the total household energy consumption, while in a large number of developing countries, cooking comprises the majority of households' energy consumption. Use of traditional biomass fuels (such as animal dung, crop residues, wood, and charcoal) for cooking and heating is generally declining in non-slum urban areas of developing countries; many slum dwellers, too, are switching to non-biomass forms of energy as soon as they are in a position to afford it. Many households in African and Asian cities, however, still rely mainly on biomass fuels for cooking. With increasing disposable income and changes in life styles, households tend to move from cheapest to least convenient fuel (biomass) to more convenient and normally more expensive ones (charcoal, kerosene) and eventually to the most convenient and usually most expensive type of energy (LPG, natural gas, electricity).

Problems with the energy ladder model arise from the simplified way that the model is applied to policy-making and the mistaken conclusion that fuel choice is determined by purely economic factors. However, as in the movement on a ladder, it appears to imply that a move up to a new fuel is simultaneously a move away from previously used fuels (Heltberg, 2005).

Evidences from a growing number of countries suggest that modern fuel adoption often results in multiple fuel use, where households consume a portfolio of energy sources at different points of the energy ladder (Barnes & Qian, 1992; Davis, 1998; Hosier & Kipondya, 1993). Ease of access and consistent availability of fuels are important factors that determine the extent and or permanence of fuel switching in any household (Démurger & Fournier, 2010).

More recently, it has been argued that households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels which may include combining solid fuels with non-solid fuels as sources of energy. Thus, instead of moving up the ladder step by step as income rises, households choose different fuels as from a menu (Mekonnen & Kohlin, 2008). They may choose a combination of high-cost and low-cost fuels, depending on their budgets, preferences and needs (World Bank, 2003). This led to the concept of fuel stacking (multiple fuel use) as opposed to fuel switching or an energy ladder (Heltberg, 2005; Masera, Saatkamp& Kamonen, 2000).

Although energy use patterns in developed and developing countries differ considerably, the evidence on urban energy use in developing countries suggests that it is common practice for poor urban households to use a mix of fuels for different end uses and to switch when fuel prices or household incomes change (Pachauri & Jiang, 2008).

The reasons for multiple fuel use are varied and not dependent on economic factors alone although the affordability or cost of the energy service also has an important bearing on households' choices. In some cases, households use more than one fuel because they want to increase the security of supply. In other cases, the choice is dependent on cultural, social or taste preferences (Pachauri &Spreng, 2004). Therefore, the knowledge of determinants of households' fuel use clearly shows that not only increase of income alone act as an exclusively factor that determines a particular use of cooking fuel but there are other factors that affects the choice of cooking fuel.

There are virtually limited empirical researches on energy consumption for cooking considering the various households in rural and urban areas of Kano State. It is because of the vital role that energy plays at the household level, the study is intended to assess the household energy use in rural and urban areas of Kano State.

1.2 Statement of the Problem

Energy consumption pattern and level in Nigeria have produced a serious exploitative and disruptive environmental stress. The exploitative stress is most obvious in the amount of fuel-wood harvested daily to support the energy needs. The rate at which the natural vegetation has been exploited to meet the exponential human demand for energy has become highly disruptive of the ecological system (Adeokun *et al.,* 2003).

It was estimated that approximately 2.5 billion people in developing countries rely on biomass fuels to meet their cooking needs. For many of these countries, more than 90 percent of total household fuel is biomass. Without new policies, the number of people that rely on biomass fuels is expected to increase to 2.6 billion by 2015, and 2.7 million by 2030 (about one-third of the world's population) due to population growth (IEA,2006).

An increase in the proportion of households using wood fuel sources was reported in Kano State in Nigeria between 2002 and 2006 against a background of supply challenges for biomass sources of energy in the town's vicinity due to deforestation (Maconachic, *et al.,* 2009). Although availability of wood was reported to have reduced between 2002 and 2006, its utilization rose by about 40 percent by 2006.

Use of biomass fuels for cooking is a major cause of health problems in developing countries due to indoor air pollution (Bruce *et al.,* 2000; Ezzati & Kammen, 2001). For example, the World Health Organization (WHO) estimates that 1.5 million premature deaths per year are directly attributable to indoor air pollution from the use of solid fuels (IEA 2006).Recognizing the adverse effects of use of traditional biomass fuels, the United Nations Millennium Project. Recommends halving the number of households that depend on traditional biomass for cooking by 2015, which involves about 1.3 billion people switching to other fuels (IEA, 2006).

Incidences of respiratory infections and cataracts in some rural areas have been linked to emitted smokes from biomass fuels (UNDP & ESMAP, 2003). Fuel wood occupies a lot of space so its storage in cities is a problem; it litters the environment and sometimes injured ones hand when handled. The smoke from the use of firewood pollutes the environment and darkens pots and kitchen walls. The use of fire wood as a cooking fuel has a devastating impact on the environment because of continuous felling of trees which leads to desert encroachment and decreases the availability of medicinal plants. Frequent sitting near firewood flame can cause hypertension while the smoke may damage the user's eyes. Above all, cooking with fire wood is very inefficient in terms of low percentage of the heat generated that is actually utilized in the cooking. Despite all these problems, fire wood is still the predominant fuel for cooking in cities, towns and villages in Kano State. Worse still, some people use dried cornstalk as fuel (Kano State ministry of science and technology, 2013).

Bruce & Doig (2000) also reported some of the health problems associated with household energy emitting smoke to include; lower respiratory infection, chronic obstructive lung disease, carbon monoxide poisoning, lung cancer, low birth weight, tuberculosis and eye problems. They also mentioned other hazards like burns from open fires and kerosene, and poisoning to children drinking kerosene in stored soft drink bottles. Biomass energy is mostly utilised in the most primitive and ancient methods in Nigeria. Fuel wood still constitutes the major source of cooking fuels for the rural and even urban dwellers. It has been established that Nigeria contributes about 10 percent global annual deaths from smoke related illness caused by indoor and outdoor pollution due to overdependence on biomass for cooking fuels (Newsom, 2012; Nwofe, 2013).

Moreover, the households in Kano State and other developing countries find it difficult to adopt modern sources of cooking fuels due to the problems of voltage fluctuation, power supply inconsistency, family size, income, home nature and attendant electric shock is another discouraging factor towards use of electricity (electric stoves) for cooking even in urban areas..

This has pushed up the percentage of household that use other source of fuels for cooking as reflected in the works of (Taru *et al.,* 2011; Oyekale , 2012; Nnaji, Ukwueze & Chukwu,.2012; Ojo & Chuffor, 2013).

Based on the problems stated above, this study is intended to provide answers to the following research questions.

1.3 Research Questions

i. What are the patterns of household energychoice for cooking in Kano State?

ii. What are the factors that affect household firewood consumption for cooking in Kano State?

iii. What are the determinants of household charcoal consumption for cooking in Kano State?

1.4 Objectives of the Study

The main objective of the study is to analyse the pattern of household energy consumption for cooking in Kano State. Specifically;

i. to examine the pattern of household energy choice for cooking in Kano State;

ii. to determine the factors that affect household firewood consumption for cooking in Kano State;

iii. to assess the determinants of household charcoal consumption for cooking in Kano State.

1.5 Scope and Limitations of the study

This study was carried out in Kano State Nigeria. Kano State which is the center of commerce, second most industrialized State in Northern Nigeria, the economic nerve center of the north and most politically active and sophisticated people in the northern part of the Country (K-SEEDS, 2004). Due to limitations of time and money, this study focused on household energy use for cooking in three local government areas of Kano State namely; Tarauni, Dambatta and Garko local government. Cooking accounts for a staggering 91% of household energy consumption (ECN 2005) The types of energy use for cooking covered in the study include; liquefied petroleum gas (LPG), firewood, charcoal, electricity, dried cornstalk and kerosene.

The study alsocomprised low, middle and high income households living inTarauni, Dambatta and Garko Local Government Areas of Kano State.

More so, in the course of distribution of the questionnaires, the study made use of six research assistants only due to cost. Similarly, some of the respondents were not willing to answer the questionnaires at spot. Therefore, different methods of persuasionwere used to get the necessary information needed.

1.6 Significance of the study

The purpose of this study is to analyse household energy consumption in some selected local government areas of Kano state. The study offered a better understanding of what happens in the real world. Such knowledge and understanding can then be used for energy planning and setting up of policies by Nigerian government in cooperation with different international and nongovernmental organisations to help reduce solid fuel consumption, protect the environment, improve the quality of life of the consumers and enhance the overall development.

The relative importance of fuel stacking (multiple fuel use) and fuel switching has also not been well established in the literature (Heltberg 2005). Studies that undertake a rigorous examination of fuel stacking in developing countries are very limited (Masera *et al.,* 2000; Heltberg 2005).By using the concept of energy ladder and fuel stacking, the study examined the differences in the pattern of energy use in households based on the economic status of the households. It also explored other factors that contribute to the consumption of energy by the residential sector in Kano State Nigeria. The survey investigated the choice of energy for households and the ways of consumption plus collection of additional data which helped fill the gap in the country. More so, the study helped in understanding the main determinants of energy across the urban and rural areas as this will contribute to assisting the formation of relevant energy policies by the government designed in a direction to improve household energy security.

More so,thefinding of the study is a valuable input for policy intervention that is intended to reduce the health impact of indoor air pollution resulting from use of inferior fuels and to rehabilitate the natural environment and the resulting ecological decay. Policy interventions in the energy sector especially rural household will encourage an effort of alleviating poverty especially in rural areas were most of the households are using solid fuels for cooking.

This work will also open new avenues for research and will add to the existing body of literature.

1.7Organization of the study

This research work has five chapters. Chapter one constitutes general introduction. It has covered background to the study, statement of the research problem, research questions and objectives of the study, significance of the study, scope and limitations of the study as well as the organization of the study.

Chapter two presents the literature review, conceptual literature and theoretical framework. This chapter also provides the empirical literature review and theoretical framework of the study.

Chapter three contains explanations of the study areas. It provided the detailed analysis of the methodology that were used in the work and specify the models that were adopted from previous works. The chapter also contained the research design, population of the study, sample size, sampling technique, data collection procedure, model specification, definitions and measurement of instrument as well as method of data analysis.

Chapter fouralso contained data presentation and analysis of the results.

Chapter five contains the summary of the work, recommendations based on the findings of the study, conclusion drawn from the findings, contribution of the study and recommendations for further researches.

CHAPTER TWO

REVIEW OF RELATED LITERATURE AND THEORETICAL FRAMEWORK

2.1 INTRODUCTION

This chapter review the literature .The contributions made by different scholars, publications on household energy consumption were analysed.

2.2 Conceptual framework

2.2.1 The Concept of Energy

Sambo (1992) defined energy as the capacity of a physical system to perform work. Energy in essence could be said to be the ability to do work and may represent the capability (or potential) of doing work (known as potential energy as in stored water in a dam) or its manifestation in terms of conversion to motive power (known as kinetic energy as in the case of wind or tidal waves). Energy is usually defined as the ability to do work or to produce heat. Normally heat could be derived by burning a fuel- i.e. a substance that contains internal energy which upon burning generates heat or through other means- such as by capturing the sun's rays, or from the rocks below the earth's surface (IEA, 2004).

2.2.2 Household Energy Consumption

The household has been variously defined, but of relevance to energy is the definition by McGraham and Kaijser (1994) that the 'household' as relates to energy analysis refers to those who live and eat together. As is the practice, the world over, the household is situated in residence. The residential compound in Northern Nigeria is usually defined by an enclosed residence through a single entrance in most indigenous houses or a gate in divided urban houses). It may contain several households. For broader use the definition could include all fuel types in the household.

2.2.3 Cooking Energy Types

Different terminologies and definitions are used in categorizing household cooking energy types. Depending on typical level of energy development, type of fuels used for cooking in households can be categorized as "traditional", "intermediate" and "modern".

Based on the way these cooking energy types are produced or extracted, they are sometimes termed as "primary" and "secondary" energy types. Cooking energy types can be categorized as "renewable" and "non-renewable". These categorizations, in general, include "rural" and "urban" households, and "low" income and "high" income households.

2.2.3.1 Modern, Intermediate and Traditional Energy

World Energy Outlook (2006) classified household energy into three distinct groups, namely:

i. Traditional fuel (such as dung, agricultural residue and fuel wood);

ii. Intermediate fuel (such as charcoal and kerosene); and

iii. Modern fuel (such as LPG, biogas, ethanol gel, plant oil dimethyl ether (DME) and electricity).

Modern energies are those which are obtained from some extraction or transformation processes and require modern technologies to use them.

On the other hand, traditional energies are those which are obtained using traditional simple methods and can be used without modern gadgets. Often modern fuels are commercial energies and traditional energies are non-commercial. But this definition does not prevent traditional energies to be commercial either. However, if a traditional energy is sold in the market it can still remain traditional (IEA, 2000).

Adelekan (2006),Aina and Odebiyi (1998), Dunkerley (1981), Gupta & Kohlin (2006), World Energy Outlook (2006) classified traditional fuels into three namely:

i. Wood fuels (which comprise fuel wood and charcoal);

ii. Residue fuels (made up of dung from cattle or other animals); and

iii. Crop waste (such as wheat straw, sugar cane, bagasse, cassava stick etc).

Mekonnen andKöhlin(2009)**,** grouped the primary fuels used by households into solid fuels (charcoal and wood), non-solid fuels (kerosene and electricity), and a mixture of these (when households reported both solid and non-solid fuels as their main fuel).

The availability of alternative source of energy – fossil fuel like kerosene and liquefied petroleum gas (LPG) led to its use as a 'clean' energy in Nigerian homes. Raufu(2003) observed that in Nigeria, kerosene and gas are the major cooking fuels in the urban centers.

Moreso, Amuwa and Arele (2008) observed that before kerosene became widely available in the country, the choice items for domestic cooking were firewood, and charcoal. Therefore it is not an unusual sight to see people selling huge quantities of firewood and charcoal both in rural and the urban centers.

2.2.3.2 Primary and Secondary Energy

Based on the way these cooking energy types are produced or extracted, they are sometimes termed as "primary" and "secondary". The term primary energy is used to designate an energy source that is extracted from a stock of natural resources or captured from a flow of resources and that has not undergone any transformation or conversion other than separation and cleaning (IEA, 2000). Examples include coal, crude oil, natural gas, solar power, nuclear power, etc.

Secondary energy on the other hand refers to any energy that is obtained from a primary energy source employing a transformation or conversion process. Secondary energy types , include petroleum products (kerosene, LPG, dimethyl ether) from crude oil, ethanol from sugar cane, charcoal and wood pellets from fuel wood, biogas produced from animal dung and agricultural waste, electricity produced from combustion of fossil-fuels and from renewable energy sources such as solar, hydro and wind.

2.2.3.3 Renewable and Non-Renewable Energy

The non-renewable sources are essentially fossil fuels like petroleum oil, gas and coal. According to Enger &Smith (2004) the formation of fossils fuels takes millions of years and is finite in availability; they are formed as a result of accumulation of energy rich organic molecules produced by organisms as a result of photosynthesis. Considering the time it takes to be formed and its finite nature, rational use of energy should be paramount. This source constitutes about 90 percent of world commercially traded energy (OPEC Fund for International Development, 2011).A non-renewable source of energy is one where the primary energy comes from a finite stock of resources. Drawing down one unit of the stock leaves lesser units for future consumption in this case. For example, coal or crude oil comes from a finite physical stock that was formed under the earth's crust in the geological past and hence these are non-renewable energies.

On the other hand, if any primary energy is obtained from a constantly available flow of energy, the energy is known as renewable energy. Solar energy, wind and biomass are called renewable energies. Renewable energy sources replenish themselves or are continuously present as a feature of solar system. For example, in plants, photosynthesis converts light energy into Chemical Energy. This energy is stored in the organic molecules of plants as wood, starch, oils or other components. Any form of biomass plant, animal, algae or fungus can be traced back to the energy of the sun (Pickering & Owen, 1995).

Garba (1999) described biomass as organic carbon based material that reacts with oxygen in combustion and natural metabolic process to release heat. The initial material, he said may be transformed by chemical and biological processes to produce immediate bio-fuels such as methane gas, ethanol or charcoal. The resources of Nigeria can be identified as wood, forage, grasses and shrubs as well as waste materials from animals, forestry, agricultural, municipal and industrial activities. Plant biomass can be converted to produce solid briquettes which can then be utilized as fuel for household use. Sambo (1992) estimated the biomass resources of Nigeria has been about 8 x 103mj. He cited solar, geothermal and tidal energy as other forms of renewable energy.

Some stocks could be renewed and used like a renewable energy if its consumption (or extraction) does not exceed a certain limit. For example, firewood comes from a stock that could be replenished naturally if the extraction is less than the natural growth of the forest. If however, the extraction is above the natural forest growth, the stock would deplete and the resource turns into a non-renewable one.

Figure 2.1 depicts the categorization of household cooking fuel types.

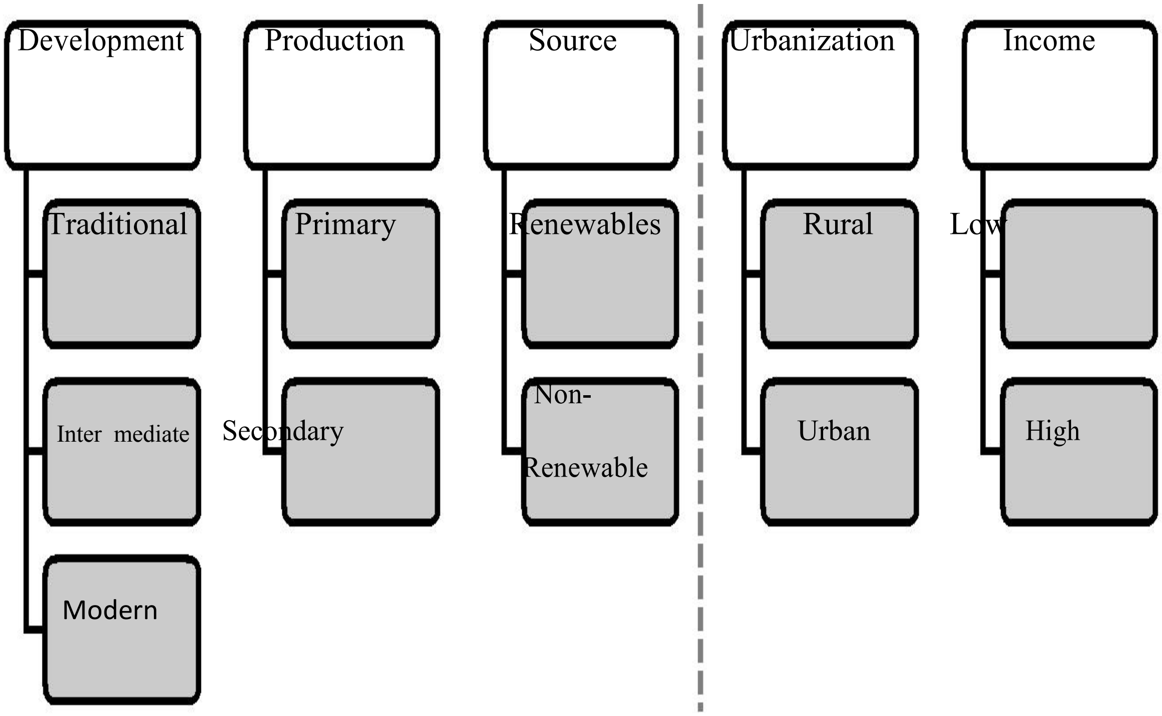


Figure 2.1: Schematic illustration of categorizing household cooking energy types.
Sources :(UN (1982, 2011), IEA (2005, 2012).

2.2.4 Forms of Energy Usage

2.2.4.1 Direct and Indirect Energy Usage

Direct energy use refers to the energy that people consume through their own activities (Green & Mathur, 2008). The amount of gasoline burned through car travel, the natural gas used to heat homes and the electricity used to run electronics and appliances are all examples of direct energy. Direct energy consumption is relatively easy to calculate by adding up a few utility bills. As a result, it is often the primary focus of energy consumption.

Indirect energy use is the sum of all the energy that went into producing and transporting a product to the point of purchase (Green & Mathur, 2008). A bottle of Soft drink or a Wrist-watch may have no direct energy cost associated with it for example, but it has a chain of indirect energy costs stretching all the way down the supply chain to the source of the raw materials.

2.3 Theoretical Literature Review

The Random Utility Theory

The utility theory has its roots in the thoughts of early twentieth century economists such as Alfred Marshall and Hicks (Albarran, 2010). Utility is the satisfaction or pleasure and benefit derived from the consumption or use of a particular commodity or service. According to the utility theory given a household budget constraints, the household consumes a commodity that maximize their utility. Consumers are assumed to be rational and have preferences that are consistent and invariants and are known and ordered. The following function represents a typical utility function of a household;

$$U = u(S(E, CS), X; D; G) \ldots \ldots (2.1)$$

Where;

S = the composite energy commodity

E= the relevant fuel source example wood, kerosene, electricity, gas and, diesel;

CS = the capital stock of energy use of appliances;

X = the purchased goods that directly yield satisfaction;

D and G are the demographical and geographical features respectively of household that influence the households' preferences. Many previous study on household energy choice and consumption such as; Suliman (2010), Danlami (2016) have based this theory as a framework for their analysis.

Given the budget function;

$$Y = P_1X_1 + P_2X_2 + \ldots \ldots + P_nX_n \quad (2.2)$$

Where Y is the household given income

$P_1, P_2 \ldots \ldots P_n$ are the various prices of the relevant commodities

X_1, X_2…………………………………………Xn are the quantities of commodities to be consumed.

However, by concentrating on only household energy consumption and choice the modified utility function and the corresponding budget constraints can be expressed as;

$U = u\,(ES(E_1,E_2\ldots\ldots E_n,CS)D;G)$………………………(2.3)

St $Y \leq P_1E_1 + P_2E_2\ldots\ldots + PnEn$………………………………. (2.4)

Where U, D, CS and G are as known before.

ES = expressed composite energy consumption function;

E_1= energy source from option 1

E_2=energy source from option 2

E_n=energy source from option n

To maximize households utility from energy consumption the following langrangian multiplier function is assumed as follows;

$L=U(ES(E_1,E_2\ldots\ldots Cn,Cs)D;G)+\lambda(Y-P_1E_1P_2E_2\ldots\ldots P_nE_n)$……………………(2.5)

The first order condition for utility maximization from the lagrangian function perspective can enable the marshallian demand function to be derived with respect to various energy sources as;

$$\frac{\eth L}{\eth E_1} = U_1^1 - \lambda P_1 = 0 \ldots\ldots\ldots\ldots\ldots\ldots 2.6$$

Equation (2.6) is the partial derivative of equation (2.5) with respect to energy source 1 (E_1);

$$\frac{\eth L}{\eth E_2} = U_2^1 - \lambda P_2 = 0 \ldots\ldots\ldots\ldots\ldots\ldots 2.7$$

Equation (2.7) is the partial derivative of equation (2.5) with respect to energy source 2 (E_2);

$$\frac{\eth L}{\eth E_n} = U_n^1 - \lambda P_n = 0 \ldots\ldots\ldots\ldots\ldots\ldots 2.8$$

Equation (2.8) is the partial derivative of equation (2.5) with respect to the energy source n (E_n). Therefore, there are more than two energy choice categories (E_1, E_2, E_n) .A multinomial logit model (MNLM) can be used to examine and estimate the determinants of the households' fuel choice.

$$Prob\ (Y_{ij}) = \frac{exp(\alpha_{ij} W_i)}{\sum_{j=0}^{m} exp\ (\alpha_{ij} W_i)} = f\ (z_1\ z_2\ z_3 \ldots\ldots z_n)$$

Where j = 1, 2………m ie, the various energy source options and Z,…………n = the various independent variables.

Households therefore, tend to choose various energy sources available that best maximise their utility.

2.4 Empirical Literature Review

2.4.1 Literature on Household Energy Consumption around the Globe

Energy consumption in residential sector is caused by households. Traditionally, as described by Swan and Ugursal (2009), studies in household energy consumption usually adopt "top-down" and "bottom-up" approaches. Based on macroeconomic theories and the interactions between the energy sector and the whole economy, the top-down approach uses aggregated economic data such as empirically observed historic trends to predict future changes in energy consumption and CO_2 emissions. Top-down methods usually use econometrics and multiple linear regression models to explain the variance between dependent and independent variables (Swan &Ugursal, 2009; Kelly, 2011). The bottom-up methods treat housing in a disaggregated way and make it possible to analyze the energy consumption impact of different housing attributes as well as of household characteristics and occupant behavior. They see individual households as the basic units of domestic energy consumers and try to understand the patterns of energy consumption at that level (Swan & Ugursal, 2009; Kelly, 2011).

The demand for various sources of energy also has been analyzed theoretically and empirically using energy ladder hypothesis (Kebede, Bekele & Kedir, 2002; Arnold *et al.,* 2006; Davis, 1998; Masera. Saatkamp & Kamonen, 2000; Barnett, 2000), the Engle curves (Amacher *et al.,*1993, 1996, 1999; Mekonnen, 1999; Helberg *et al.,* 2000; Gundimeda & Kohlin, 2003; Baland *et al.,* 2005), and energy demand functions (Athukorala *et al.,*2007; Erdogdu, 2006). These studies have considered different factors that influence the energy demand patterns and usage analyzed both at micro and macro levels.

The literature on household energy demand and choice has shown that households in transition (that is, those between low income and high income) consume transition fuels such as charcoal and kerosene. While low income households use biomass fuels, higher income households consume energy that is cleaner and more expensive such as liquefied petroleum gas and electricity (Hosier and Dowd, 1987; Barnes and Floor, 1999; Heltberg, 2005).

The energy ladder hypothesis is one of the most common conceptualizations of energy use dynamics among households. It postulates that low income households generally use traditional stoves and cooking fuels such as animal dung, charcoal and wood, while those households with higher income use modern cooking technology and fuels. As income increases, households transit from traditional fuels and cooking stoves to modern fuels and cooking technology (Baldwin, 1986; Smith, 1987; Leach, 1992).

Peng, Hisham and Pan (2010) study household's fuel switching in rural Hubei. Based on an analysis of a rural household survey data in Hubei province in 2004, they explore patterns of residential fuel use within the conceptual framework of fuel switching using statistical approaches. Cross-sectional data show that the transition from biomass to modern commercial sources is still at an early stage, incomes may have to rise substantially in order for absolute biomass use to fall, and residential fuel use varies tremendously across geographic regions due to disparities in availability of different energy sources. Regression analysis using logit and tobit models suggest that income, fuel prices, demographic characteristics, and topography have significant effects on fuel switching. Moreover, while switching is occurring, the commercial energy source which appears to be the principal substitute for biomass in rural households is coal. The data presented here confirm other findings that the fuel stacking model is a more accurate description of household energy than the energy ladder model.

World Bank Energy Sector Management Assistance Programme (ESMAP) (2003) analyzed fuel consumption patterns using a Guatemalan household survey data set. The results of logit and multinomial logit regression analysis suggest that expenditure, education, household size, region, ethnicity, electrification status, and gender composition are important in influencing fuel choice. It was observed that as incomes grow people start to demand more diversified energy sources.

In their study Alem, Hassen and Kohlin (2013) used a panel multinomial logit model with random effects to model household fuel choice in urban Ethiopia. As the price of firewood increases, the demand for solid and mixed fuels decreases. In other words, households tend to shift to clean fuel sources, such as electricity and kerosene, when firewood price increases. That means increasing the price and reducing the availability of firewood may promote fuel switching by urban households. Price of electricity has a positive and significant effect on the choice of mixed fuels, while it is positive but not significant in the case of solid fuels. This may show that households do not completely switch back to solid fuels as price of electricity increases, but they try to minimize the budget burden by reducing part of their electricity consumption and satisfy the rest from solid fuels. An increase in kerosene price has a positive and significant effect on the choice of solid fuels but is not significant in the case of mixed fuels.

Kebede, Bekele and Kedir (2002) examine the affordability of modern fuels (electricity, butane gas and kerosene) by the urban poor in Ethiopia. The study categorized energy sources into solid, mixed and clean fuels. The results show that household expenditure, price and education play an important role in determining fuel choice. However, income is not the only factor in the fuel switching process. It was found that prices play an important role in inter-fuel substitution. Higher education levels are associated with a higher probability of clean fuel use and a lower incidence of solid fuel use. It was also found that modern fuels are chosen in relatively big cities in the country.

Athukorala *et al* (2007) estimated the household demand for electricity in Sri Lanka by which the importance of household characteristics and the influence of selected macroeconomic variables were investigated. The findings on income elasticity suggested that electricity is a normal good and has an inelastic demand in the Kandy area. The estimated cross price elasticity elicits that electricity is a complement to both gas and kerosene.

Similarly, Chambwera (2004) investigated the consumer demand for energy using household energy mix model. Following Deaton andMuellbauer (1980), he used a two stage budgeting process undertaken by the consumers in the process of decision making. It was assumed that the expenditure of a consumer is first allocated to a broad group of commodities and then sub allocated to specific commodities in that group in subsequent stages. An Almost Ideal Demand Systems (AIDS) model was empirically estimated in Harare – Zimbabwe, in linear approximate form incorporating other household characteristics in addition to income and prices by Chambwera (2004). Other household characteristics tested were household income, household size, household size square, housing space, energy appliances, level of education, occupancy, employment, gender and ownership of the house.

More so, Vita, Endresen and Hunt (2005) in their study on energy demand in Namibia, apply Autoregressive Distributed Lag (ARDL) bounds testing Approach to cointegration, they estimate the long-run elasticities of the Namibian energy demand function at both aggregated level and by type of energy (electricity, petrol and diesel) for the period 1980 to 2002. The main results show that energy consumption responds positively to changes in GDP and negatively to changes in energy price and air temperature.

Mansouri *et al*. (1996) conduct a survey among householder's resident in the south-east of England. The survey focused on identifying environmental attitudes and beliefs, energy-use behaviour, ownership levels for certain appliances and their utilisation patterns. Through the survey the authors find that members of the general public are interested in receiving information concerning household energy use and the associated environmental impact, and willing to modify their behaviour in order to reduce household energy consumption and environmental damage. Therefore, the authors conclude that there is an urgent need to provide end-users with accurate energy-consumption and environmental-impact information, persuasively presented, to stimulate energy-rational and environmentally sustainable behaviour. Similar results were found in Brandon and Lewis (2002), in which the energy consumption of 120 households was monitored over a 9-month period. Participants in the study received feedback in various forms, i.e. consumption compared to previous consumption or to similar others; energy saving tips in leaflets or on a computer; or feedback relating to financial or environmental costs. From the study the authors find that participants with positive environmental attitudes, but who had not previously been engaged in many conservation actions, were more likely to change their consumption in response to the energy consumption information.

Brounen, Kok and Quigley (2011) in their Study on Residential Energy Use and Conservation Economics and Demographics in Dutch homes and their occupants analyze the extent to which the use of gas and electricity is determined by the technical specifications of the dwelling as compared to the demographic characteristics of the residents. Their analysis is based on a sample of more than 300,000 Dutch homes and their occupants. The results indicate that residential gas consumption is determined principally by structural dwelling characteristics, such as the vintage, building type and characteristics of the dwelling, while electricity consumption varies more directly with household composition, in particular income and family composition. Combining these results with projections on future economic and demographic trends, they found that, even absent price increases for residential energy, the aging of the population and their increasing wealth will roughly offset improvements in the energy efficiency of the building stock resulting from policy interventions and natural revitalization.

Mekonnen and Kohlin (2009) looks at the fuel choice of urban households in major Ethiopian cities, using panel data collected in 2000 and 2004. It examines use of multiple fuels by households. The results suggest that as households' total expenditures rise, they increase the number of fuels used, even in urban areas, and they also spend more on the fuels they consume (including charcoal but not wood). The findings of the study also show that even fuel types such as wood are not inferior goods. The study support multiple fuel use (fuel stacking) better describes fuel-choice behavior of households in developing countries, as opposed to the idea that households switch (completely) to other (more expensive but cleaner) fuels as their incomes rise.

The study shows the relevance of fuel stacking (multiple fuel use) in urban areas in sub-Saharan Africa.

Also, Hosier and Dowd(1987) analyzed household fuel choice in Zimbabwe using a multinomial Logit model. Findings from their study despite confirming the energy ladder hypothesis that income is a major determinant of the choice of fuel type also reveal a myriad of factors (household size, location of household, i.e. urban households) that influence the type of household fuel use.

Reddy (1995) also found that although households in Bangalore, India ascend an energy ladder and the choice is largely determined by income, factors such as family size and occupation of the head of the household also influence the household 's cooking fuel choice.

Golley *et al* (2008) conduct a cross-sectional study on China's urban direct and indirect energy consumption based on a household survey. Their focus is to identify impacts of household characteristics on energy consumption and associated emissions and they found that while richer households do indeed emit more per capita, poorer households tend to be more emission intensive – that is, generating higher emissions per Yuan spent.

Wei *et al* (2007) and Golley *et al* (2008) also consider indirect energy consumption defined in terms of the energy inputs needed in the production of goods and services consumed ultimately by households. Based on the application of a Consumer Lifestyle Approach, Wei *et al.,* (2007) quantify the direct and indirect energy use and related carbon emissions during the period of 1999-2002 and find that residents' lifestyle can have an important and significant impact on energy use and related carbon emissions.

Rajmohan andWeerahewa (2010) examined the pattern of household energy consumption among urban, rural and estate sectors, over time and across income groups inSri Lanka. The 'energy ladder' hypothesis was tested and Engle functions were estimated using Consumer Finances and Socio Economic Survey data from 1978/79 to 2003/04. Results reveal that the energy ladder hypothesis holds for Sri Lanka and the country as a whole is moving towards modern fuels such as liquefied petroleum gas (LPG) and electricity. The urban sector proceeds much faster than the rural sector. Engle functions estimated for individual fuels and for different sectors reveal that the budget elasticity values were negative for firewood and kerosene, in the urban and estate sectors, indicating that they are inferior goods. LPG and electricity had positive budget elasticities indicating that they are normal goods. Budget elasticities estimated for the estate sector were insignificant eliciting that factors other than income influence the fuel Consumption decisions.

Jackson (2005) showed that the number of people living on less than $2 per day tends to decrease sharply when access to electricity is guaranteed. The study found a strong correlation between modern energy consumption and Gross National Product (GNP) per capita. Indeed, it showed that GNP tends to increase rapidly as commercial energy use per capita increases, mainly for low income countries. When the countries reach a high level of per capita GNP, factors such as efficient utilisation of energy by industries, energy production and transformation systems tend to make the difference for economic growth to continue so that more energy consumption for a country no longer implies more income for the country.

Robic, Olshanskaya, Vrbensky and Morvaj (2010) revealed that Tajikistan suffered from acute case of energy poverty where people lacked both physical access to energy and the ability to afford it. The study provided an overview of energy poverty situation in Tajikistan and recommended that a provision of three kilowatts per household for the most vulnerable group would result in significant benefits that would show not only in the relief for the energy poverty stricken households but which would show in the overall poverty alleviation for the country.

Barnes *et al* (2010) studied the welfare impacts of household energy use including that of modern energy and estimates the household minimum energy requirement that could be used as a basis for an energy poverty line. It was found that the use of both traditional (biomass energy burned in conventional stoves) and modern (electricity and kerosene) sources improve household consumption and income; the return on modern sources is 20 to 25 times higher than that on traditional sources. In addition, after comparing alternate measures of the energy poverty line, they observed that some 58 per cent of rural households in Bangladesh were energy poor compared to 45 per cent that were income poor.

Farsi, Filippini and Pachauri (2005), in their study on Fuel choices in urban Indian households applies an ordered logit model to fuel choices and patterns of cooking fuels in urban Indian households. The analysis is used to determine the responsiveness of fuel choices to own price, income, price of alternate fuels and variables relating to demographic and geographic characteristics of households. The descriptive analysis and the econometric results reported in the paper suggest that the observed patterns in the data are consistent with the "energy ladder" theory. Firewood and LPG at the two extremes are more likely to be used with kerosene in the middle, than with each other. The results show that in addition to income, there are several socio-demographic factors such as education and sex of the head of the household, which are important in determining household fuel choice. Household income has a significant positive effect on the probability of choosing LPG as a cooking fuel over either firewood or kerosene. The size of the household and the age of the head of the household also have a positive effect on the probability of choosing LPG, as does the household being headed by a female. The household head being illiterate or only having primary education increases the probability of choosing firewood or kerosene as a cooking fuel, whereas those households where the head has a higher level of education are more likely to use LPG. Living in larger cities or metros also increases the probability of choosing LPG as cooking fuel.

Also, Demurger and Fournier (2011) used descriptive statistics from the household survey carried out in northern China to analyse the general dependence of households upon forest resources as well as energy consumption patterns in the studied villages. The study used probit model to determine the marginal effects of various socio-economic variables on coal consumption. It observed that income is a key factor in explaining energy use and fuel substitution. It also noted that wealth is a significant and negative determinant of household firewood consumption.

More so, Ouedraogo (2006) used multinomial logit model to analyse the factors determining urban household energy preferences for cooking in Ouagadougou. The analyses show that the inertia of household cooking energy preferences are due to poverty factors such as low income, households' poor access to electricity for primary and secondary energy uses, low housing standards and household size. The utilization rates of firewood decrease from low income households to households with higher incomes. The marginal effects of ''household income'' are not significant for firewood and charcoal. The marginal effect of ''primary education level'' is significant at one per cent level and with positive sign: when this variable changes from higher education level to primary education, the probability of using firewood as main cooking energy increases by 0.61 per cent. The household size, cooking habits and formal education level of household heads have significant effects on wood energy preferences.

Brounen *et al* (2012) is another study of residential energy use in the Netherlands. The results indicate that residential gas consumption, which is used for heating, is determined principally by structural dwelling attributes such as e g type and vintage of the building, while electricity consumption varies more directly with household characteristics, in particular income and family composition. It is for example shown that families with children consume significantly more electricity than those without children. The results for gas consumption are in line with those reported by Guerra Santin *et al* (2009) concerning the dominance of housing attributes over occupant characteristics as explanatory factors and the strong impact of dwelling size.

According to Costa and Kahn (2011) analysed how the electricity price, at the time when a home was built, influences it later observed electricity consumption. They conclude that low electricity prices at the time of construction are an important determinant of a home’s electricity consumption, even several years later on and that the opposite also holds. Their study confirms the strong impact of housing vintage on energy consumption.

Kelly (2011) explores factors influencing the energy expenditure among a sample of around 2500 British households and finds that family size and income as well as floor area all have a significant and positive impact. The energy expenditure was also positively related to the difference between outdoor and indoor temperature and to the time different rooms are heated during weekends and daytime. More unexpectedly, the study also found that only a small proportion of the variance in energy consumption between the households can be related to the energy performance of their homes.

Moreover, Hårsman andWahlström (2014) assess the role for energy consumption played by socio-economic characteristics of the residents as compared to physical attributes of the house. Another is to estimate the influence of housing attributes and climate on the “engineering estimates" of the conservation potentials and analyze to what extent the two estimated relationships are consistent. The results show that while the quantitative impact of physical attributes dominate the energy use for heating and cooling, the opposite holds for the consumption of household electricity. The assessed conservation potential, amounting to 15 percent of the energy consumption, is significantly related to both the housing attributes and the energy consumption.

Costanzo *et al*(1986) proposed a social-psychological model of energy conservation consisting of two interacting sets of factors: psychological (i.e., factors shaping consumers' information-processing and decision-making, such as perception, evaluation, understanding and memory) and positional/situational (i.e., factors that facilitate or constrain consumers' actions, such as disposable income, home ownership, home repair skills, and own-home technology). More recently, Abrahamse *et al* (2005) proposed that both micro-level factors (e.g., preferences, attitudes, values, abilities, opportunities) and macro-level factors (e.g., availability of new technology, economic and population growth, government regulations and policies, socio-cultural change) can influence household energy consumption. Kollmuss & Agyeman (2002) have also distinguished multiple influences of pro-environmental behavior, such as demographic factors (e.g., gender, years of education), external factors (e.g., social, cultural, economic, institutional), and internal factors (e.g., motivation, environmental knowledge, awareness, values, attitudes, emotion, locus of control, responsibilities, priorities).

Similarly, Stern (2000) has proposed that environmental behavior is shaped by a range of attitudinal variables (e.g., general environmentalist predisposition, behavior-specific norms and beliefs, perceived costs/benefits, non-environmental attitudes), personal capabilities (e.g., literacy, social status, financial resources, behavior-specific knowledge and skills), contextual factors(e.g., social norms and expectations, material costs/rewards, available technology, advertising, and laws, policies and regulations), and habits and routines .residential energy use is more strongly related to socio-demographic variables, whereas changes in residential energy use over time are more dependent on psychological and motivational variables .Abrahamse & Steg, (2009).

However, Maun, Botswana, Hiemstra-van der Horst and Hovorka (2008) study examined the energy ladder for household energy use and found that consumers do not follow the predictions of the energy ladder model; i.e. they do not simply switch from one fuel to another as their income improves; instead they found that households use multiple energy sources because the different fuels that they use are not entirely inter–substitutable. In fact, the results of the survey indicate that despite nearly universal use of commercial alternatives, fuel wood was chosen by households across the income spectrum as a strategic energy source important for particular applications.

Rajmohan and Weerahewa (2007) investigated household energy consumption patterns of urban, rural and estate sectors in Sri Lanka. The results show that the energy ladder hypothesis holds for Sri Lanka and the country as a whole is moving towards modern fuels such as liquefied petroleum gas (LPG) and electricity. The urban sector proceeds much faster than the rural sector.

Longhi(2014) uses a large household panel survey to analyse the impact that various individual, household and dwelling characteristics have on energy expenditures of UK households. The results suggest that household socio-economic characteristics such as income, the presence of people of pensionable age, jobless, or in poor health, and the overall household pro environmental behaviour have a statistically significant but small impact on energy expenditures. Characteristics of the accommodation contribute up to 20% to gas expenditures and up to 10%

for electricity, while the most important differences between per capita household costs are due to the size of the household whereby one additional individual decreases per-capita expenditures on average by 32-38%. Similarly, most of the changes in household energy expenditures over time are related to changes in household size while changes in other socio-economic and dwelling characteristics have a relatively small impact.

Guptilla and Kohlin (2003) in Kolkata India besides income, identify convenience, price and reliability of supplies as the main attribute influencing transition to charcoal use. In general, they observe that charcoal consumption decisions depend on how household characteristics interact with external factors such as prices, forest cover, population and urbanization. It was observed that increase in population, family size; economic activities in household often lead to increase in the use of fuel. Also, Olubusola (2007) claims that the choice between firewood and charcoal among urban families seems to be dictated to a large extent by poverty, with charcoal having the highest figure.

Study carried out by Gundimeda and Kohlin (2003) in India shows charcoal to be a significant substitute for firewood. The study also shows that the use of firewood declines by 3% for every 10% increase in its price relative to kerosene, while the use of charcoal increases by about 6% for every 10% increase in the price of firewood relative to kerosine. Gundimeda and Kohlin (2003) further explained that this is consistent with the hypothesis that firewood scarcity near urban areas accompanied by rising prices causes switching from firewood to charcoal.

Furthermore, Leach and Gover (1987) indicated that there is relationship between income and domestic energy consumption in India, Pakistan and Brazil; the use of biomass has decline.Itwas also investigated that there is positive link among income, inflation and wood fuel consumption in Ghana. The relationship shows that there is a negative correlation between income and quantity of wood fuel consumed and a positive correlation between inflation and quantity of wood fuel consumed (Abakah, 1990).

Mwaura, Okoboi and Ahaibwe(2014) in their study on the determinants of household's choice of cooking energy in Uganda, examines utilization of various forms of cooking energy sources among households using data from the 2005/6 Uganda National Household Survey (UNHS). A multinomial probit model (MNP) was used to estimate coefficient of determinants of energy choices. Socio-economic factors affecting choice of energy source for cooking have been observed as consumption expenditure (welfare); whether a household is in urban or rural areas, age of household head, number and composition of members in households, geographical regions, and marital status and sex and education levels of household head. Results indicate that utilization of modern energy sources was only by 4 percent of households. There is direct relationship between households' consumption expenditure levels and energy poverty. Predicted probability values confirmed that most households had very high probability (89.7 percent) of adopting firewood for cooking. Households with a probability of choosing charcoal as energy source accounted for 9.7 percent of Uganda's households, while those that could have a probability of choosing modern energy made up less than 1 percent of the population.

Mensah and Adu(2013)investigated household cooking energy choices and their determinants in Ghana using a nationwide household survey data. The underlying empirical model was estimated using the ordered probit model. The results show that biomass is by far the most predominant source of energy for Ghanaian households. Biomass energy is the main source of cooking fuel in Ghana used by 89.2% of households compared with 10.8% which use modern energy sources such as LPG, electricity and kerosene for cooking. The findings of their study also lend support to the energy ladder hypothesis that household income is a major determinant of household energy choice. Further, social and demographic factors as well as access to energy supplies are key determinants cooking fuel type in Ghana.

In a study done by Heltberg (2005) in Guatemala using household survey data set and employing the logit and multinomial logit regressions, found a positive relationship between household size and firewood use. A number of explanations have been given to this finding. First, a larger household size may mean larger labour output, which is needed in firewood collection. Secondly, it is assumed to be cheaper to cook for many people using firewood than its alternatives. Larger households are more likely to have extra labour (for example children's labour) that can be used to freely collect firewood from public fields. It is assumed that free collection of firewood lowers the price of firewood relative to alternatives which cannot be obtained freely.

Pundu and Fraser (2003) analysed data from rural Kisumu, Kenya using multinomial logit model. The study found that the level of education improves knowledge of fuel attributes, tastes and preferences for better fuels. Highly educated woman is likely to lack time to collect firewood and may prefer to use firewood alternatives.

Wuyuan *et al*. (2010) explained that when the resident's education level is higher, they use less biomass or more commercial fuel because their opportunity cost of biomass collection is increasing. More so, Schlag and Zuzarte (2008) found that high fuel prices made household more likely to use traditional fuels than modern fuels.

Albebaw (2007) in his study found a negative relationship between fuelwood consumption and distance. The reason behind this finding is that households may consider distance as an additional cost to the market fuel price. In this regard, the farther distance implies that households have to bear more cost in terms of transportation and this makes household be reluctant to choose such fuels for use.

With increasing disposable income and changes in lifestyles in the urban areas, households tend to move from the cheapest and least convenient fuels (firewood) to more convenient and normally more expensive ones (charcoal, kerosene) and eventually to the most convenient and usually most expensive types of energy (LPG, natural gas, electricity). There is also correlation between the choice of cooking fuels and the value of women's time. Women who enter the formal workforce demand more convenience in their use of household fuels. This leads to a preference for LPG compared to more traditional fuels. There is a strong positive relationship between growth in per capita income and growth in household demand for commercial fuels. For most developing countries, demand for commercial fuels has risen more rapidly than per capita incomes since 1970. This reflects the increasing desire for comfort and discretionary energy consumption (Dzioubinski &Chipman, 1999).

Habtie and Dembel(2015) study looks into household energy choice and demand in selected urban areas using a survey data of 251 urban households in Wolaita zone Ethiopia. The survey indicated the use of traditional fuels dominate households' energy consumption. Probit analysis of decision to consume fuel revealed probability of consuming modern fuels in general increases with increase in price of traditional fuels, income and household education whereas probability of consuming traditional fuels in general increases with increase in price of modern fuels, household size and house head age. In his analysis of multiple fuel use patterns in South Africa, Davis (1998) found that changes in fuel choice were not a smooth transition from biomass to commercial fuels, but a continual switching between different combinations. He found that while high-income electrified households were more likely to rely on only electricity, low-income households were more likely to rely on four or more fuels even if they were electrified.

The situation in Tanzania indicated by Hossier andKipondya (1993) shows that kerosene consumption decreases with income, electricity accounts for larger share of energy requirement and the importance of charcoal varies little as income increases. This indicates that households use a mix of different fuels almost at all levels of income, and hence emphasizing the importance of maintaining sustained provision of almost all types of energy at any point in time.

2.4.2 Literature on household energy consumption in Nigeria

Zaku *et al*(2015) investigated the household energy use in Gwagwalada Town and Gwako village of Gwagwalada area council; FCT Abuja Nigeria. Stratified sampling technique was used to select the sample size of 100 respondents. The result showed that Gwagwalada households utilized modern domestic energy types (LPG, kerosene and electricity) than Gwako households. The result of the Pearson correlation analysis showed that there is a significant positive correlation between the type of energy use and dwelling places, education qualification and monthly income. Those who live in the Gwagwalada Town, place much emphasis on safety and convenience in their choice of energy use while the majority of the Gwako dwellers emphasized income in their choice of cooking energy.

Medayese*et al*(2012)in their study on Household Domestic Energy Consumption inMinna, Nigeria, indicated that over the years, the consumption of biomass has been on the increase due to its cheapness, availability, traditional affinity, while the consumption of alternative, clean, safer, environmental friendly an sustainable ones are dwindling. The analysis indicated that there is significant relationship between choice of energy and income as well as between energy use and household size. The increase in the price of LPG, Kerosene and Electricity tariff has dropped the number of household using these sources so as to reduce their expenditure on domestic energy use. The change in energy consumption types can be related to income level, poverty and the affordability of different types of sources. The survey shows that the trend of the use of biomass will continue except urgent and proactive measures are put in place to change the consumption pattern and income of the households in Minna.

Oyekale *et al*(2012), In their study on the Assessment of rural households 'cooking energy choice during kerosene subsidy in Nigeria: A case study of Oluyole Local Government Area of Oyo State compared the demand for different cooking energy sources before and after implementation of kerosene subsidy and determined the correlates of choosing fuel wood/charcoal. The results revealed that the proportion of households that depended on kerosene increased from 49.2% before the subsidy to60. 83% after the subsidy. Also 16.67 and 14.17% of the respondents collected firewood before and after the subsidy, respectively. Furthermore 6.67% of the respondents indicated that kerosene was scarce after the subsidy, as against 41.67% that indicated same before subsidy. The SUBP regression results revealed that using fuel wood/charcoal as cooking fuel before subsidy significantly reduced the probability of choosing fuel wood/charcoal after subsidy. As the price of kerosene increased, the probability of using fuel wood/charcoal significantly decreased. It was concluded that subsidy on kerosene portends a very high likelihood of leading to reduction in deforestation and indoor air pollution due to less usage of fuel wood or charcoal.

In a demand analysis of gas consumption in Nigeria, Adegbulugbe and Dayo (1986) observed that several energy studies have been carried out to model the demand for energy, and that these are econometric in nature and usually relate energy consumption to such independent variables as disposed income, price, transportation and energy substitutes. How responsive charcoal demand is to its own price is at the heart of the charcoal scarcity issue.

More so, Adepoju, Oyekale and Aromolaran (2012) examined the factors influencing choice of energy by rural households in Ogun State Nigeria. Data were collected from randomly sampled households. Analysis was done with descriptive statistics and Logit regression. Result showed that the largest proportion of the respondents used kerosene oil for cooking and lighting. Logit regression results showed that there was gender influence in fuel wood choice. Also, illiterate household heads had higher likelihood of choosing charcoal. Choices of kerosene oil and electricity were influenced by proximity. However, if prices of fuel wood and charcoal increase due to scarcity less of them would be bought. Household heads that were not formally educated reported higher likelihoods of using charcoal and fuel wood. Households that were headed by males had lower likelihood of using fuel wood. Female headed households may be poorer than their male-headed counterparts due to low access to production resources as a result of traditional gender issues in resource allocation. This can also be linked to the fact that female members of households are some time ago directly responsible for fuel wood gathering. Mode of transportation was significant and positive.

Ogwumike, Ozughalu and Abiona (2014) examined household energy use and its determinants in Nigeria based on the 2004 Nigeria Living Standard Survey data obtained from the National Bureau of Statistics. The result of the study shows that most households in Nigeria use firewood as cooking fuel and kerosene for lighting. Kerosene is mostly consumed by households in the urban areas and most of the households use it for cooking through kerosene stoves and for lighting via kerosene lanterns. Energy use in Nigeria supports fuel stacking rather than energy ladder hypothesis. Among the factors that significantly influence household energy use for cooking are educational levels of father and mother, per capita expenditure and household size. The multinomial logit estimates indicate that the urban sector is inversely related to household firewood use but positively related to kerosene, LPG and electricity use. The estimates also reveal that household size is positively related to firewood and LPG use but inversely related to kerosene use. Male headship of household affects firewood use negatively and kerosene use positively; it does not significantly affect LPG and electricity use. M

Moreover, Ojo, Bawa andChuffer(2013) investigate the relationship of women's socioeconomic factors and household fuel wood consumption in Dambao Local Government Area (LGA) of Borno State, Nigeria. Forty households were randomly selected from where respondents for the study were obtained. Data obtained from the study were analyzed by the use of descriptive statistics and multiple regression analysis. The result showed that most of the women in the study were forty years and below (75%) while literacy among the women was about 92.5%. Over 45% of the respondents had household size of more than five persons. The study further observed that 97.5% of respondents used fuel wood solely or complimented with other sources of domestic energy. The quantity of fuel wood consumed by respondent households was determined by income, age, family size, and marital status of the respondents.

The urban household energy use patterns in Nigeria as found out by Adegbulugbe *et al* (1995) with respect to income groups, fuel preferences, sources and reliability of energy supply and expenditure was found to be LPG, kerosene, fuel wood, charcoal and electricity. Dependence on biomass fuels is rapidly giving way to the use of fossil fuels (especially LPG and kerosene) and electricity in urban households, the reasons been that of convenience, cleanliness and social status. He further stressed the dominance of kerosene, LPG and electricity in all the high income groups, while fuel wood is used mostly in the low-income groups. Although with increase in disposable income and changes in lifestyles, households tend to move from the cheapest and least convenient fuels (biomass) to more convenient and normally more expensive ones charcoal, kerosene and eventually to the most convenient and usually most expensive types of energy (LPG, natural gas, electricity).

Kayode *et al*. (2015), on the analysis of household energy consumption in Nigeria using data obtained from 501 households confirmed a positive and significant association between the locality of the property, ownership status, age, education status, the expenditure on electricity and consumption of energy The analysis of the data collected did not show any statistically significant difference between the consumption of any of the energy fuels among the high-income earners and certainly there was not an abandonment of one form of energy in preference to another due to income. It was discovered that the notion of the energy ladder did not hold in this instance as the increase in income which may have resulted in spending more on electrical appliances leading to increase in energy did not result in any significant corresponding effect. This is contrary to the perception that an increase in income may result into increase in the demand for a particular form of energy or abandoning one fuel for another. In the urban areas, more people tended to consume more electricity than gas or kerosene. Males consumed a higher level of electricity than females but within the sample population, there were more males that were heads of their households. The analysis also showed that education plays a major role in energy consumption and this study suggested that higher levels of education can be associated with a greater probability of the household using modern fuels. More of those with post-secondary education used more gas than electricity or kerosene.

Moreover, Lusambo (2016) in the study onHousehold Energy Consumption Patterns in Tanzania found that Tanzanian households depend primarily on wood fuel as a source of energy. However, the consumption patterns and intensities remain poorly understood. Stratified random sampling design was used in order to capture fuel consumption patterns between rural, peri-urban and urban populations and across household wealth categories. Households in each randomly selected site were stratified into low, medium and high wealth categories. Data was collected using pre-tested and pilot-tested questionnaires, direct measurements, direct observations, interviews and focus group discussions. A total of 568 households were sampled: rural (258); peri-urban (177) and urban (133). The sample was drawn from across all wealth categories: low-198 households (34.9%); medium-255 households (44.9%) and high-115 households (20.2%). Several hypotheses were found to be true: Socio-economic and demographic factors have effects on household fuel choice; There is significant household preference to miombo woodlands as source of wood fuel. Factors which were found to be important in influencing choice of fuel are: location of household, residence ownership, dwelling category, household income, and education level of household head; Household survey revealed a sizeable preference towards miombo woodlands as a source of wood fuel.

Okunade(2010) in her study on the current use of Charcoal as an alternate energy source among urban households in Ogbomoso metropolis of Oyo state randomly selected thirty households from the three LGAs to give a total of ninety households. In all ninety women were randomly selected from the household chosen. Information was gathered through the use of a well-structured interview schedule. Data were described using frequencies, percentages while regression was used to determine the relationship between socio-economic characteristics and frequency of use of charcoal. The results shows that majority of the women regardless of their economic status combine the use of charcoal with other source of energy in their household, most of the women found charcoal convenient, cheap and neat as source of energy. However, they experienced hike in price and scarcity as constraints especially during the rainy season. There is significant relationship between occupation, family size, and years of schooling, age and frequency of use of charcoal. The implication of the result of the study is that the use of charcoal has become an established trend among the urban residents in the study area.

In their study on Household Energy Consumption Pattern in Offa City, Kwara State Nigeria, Kadiri and Alabi (2014), examined the household energy consumption patterns in different apartments of various households. Analysis to see result of financial gain, monthly earning and unit size on quantities of energy sources usage was done on modal statistical method and percentage analysis. The analysis on age range, energy resources in the selected areas and consumption patterns were based on descriptive statistics. Systematic sampling was applied to sample 800 households. Well-structured questionnaire with oral interview and measuring Equipment was used to obtain and evaluate data. The findings enveloped that 20% of the respondents were above 45 years old on average and about 80% had a household size of 1 - 6 members. The findings of their study show that household size and income earning had significant impact on the quantities of charcoal and kerosene consumed, while household income had more significant influence on Standard of living depending on income earned by individual Household and it also has significant influence on cost of living which determined household Low budget on energy consumption. Charcoal seems to be the major source of fuel Consumed in the Local Government Area because of its low cost, availability and affordability more than other sources of energy. More importantly, electricity is not readily available due to inadequate supply.

Furthermore, Irimiya, Humphery andAondover,(2013) in their study on the assessment of energy use pattern in residential buildings of Kano and Kaduna Northern Nigeria, The energy usage and intensities of the buildings as-built (Conventional) and when retrofitted with green features were studied and the impact of the green retrofits documented. An Analysis of Variance (ANOVA) was conducted at 0.05% which indicates a significant difference in the Energy consumption between the Conventional and Green features in the six study areas. With the introduction of green appliances, a drastic reduction in the buildings annual energy consumption was recorded which stood at 20.57 kwh/m2 representing about 18.26% reduction in annual energy consumption which indicates a significant energy saving. In Kano VAC consumed the highest energy 12.49 kwh/m2 of the total consumption of all end-users. When replaced with energy efficient appliances the consumption dropped to 7.95 kwh/m2 representing 34.14% reduction.

Bello (2011) Using Cross-Sectional survey data from a sample of 500 households' in Gombe State of Nigeria the study investigates the impact of wealth distribution on energy consumption, and analysis the determinants of households' energy choice for cooking. The simple descriptive statistics and multinomial logit model is used in analysing the data obtained. An empirical result of the logit model reveals that the choice of cooking energy is mainly determined by the economic wealth of households'. Besides the economic wealth, the analysis also shows that size of households' and level of education are found to be key factors in energy consumption behaviour, especially when dealing with energy source switching. Economic wealth of households' was found to be a major determinant of the type of cooking energy used by households' in Nigeria. Wood was used by the low-income households' as the main source of cooking energy while the modern fuels are used by the upper class in the society. Similar findings were obtained by Gangopadhyay *et al.* (2003), Campbell *et al.,* (2003) and Farsi, *et al.,* (2005).

Shittu *et al.*(2004), in their study on the demand for energy among households in Ijebu division Ogun State Nigeria, examines the influence of households' socio-economic characteristics on household demand for electricity, petrol, diesel, kerosene, firewood, domestic gas, and transport in commercial vehicles. Primary data obtained in a cross-section survey of 90 households selected across six communities in Ijebu-Division of Ogun State, Nigeria was used in estimating a system of energy demand equations and elasticities. The study reveals that an average household in the sample had about five members, headed by a 52 year old male that had about nine years of formal education. The mean monthly household consumption expenditure was ₦ 15,458.63, of which about 25% was expended on the seven commodities. While the influence of education and household size on household energy use were insignificant; income (budget size), household ownership of electrical/electronic appliances and automobiles, as well as age of household heads exercised significant influence on the relative shares of some or all of the seven energy commodities in household budgets in the study area. The income effects were positive for all the energy commodities, except firewood. Demand for petrol, diesel and domestic gas were income elastic. Thus, the study concludes that improvement in income would cause increase in demand for electricity and petroleum products in the study area, but worsening real income would place greater demand on biomass fuel.

Desalu, *et al.* (2016) in a comparative study of the household consumption pattern and determinants of cooking energy among rural and urban dwellers in South Western Nigeria found the majority of the households in urban areas used multiple sources of energy for cooking which was different to the rural areas where most household used single source of cooking energy. The prevalence of solid fuel and kerosene use was higher in the rural areas than urban areas while the use gas, electricity and agricultural waste was higher in the rural areas. The choice of cooking fuel in both rural and urban was influenced by age, education, wealth, income, availability of fuel kitchen location and awareness of the harmful effects of smoke from solid fuel.

Udoffia and Thompson (2015) study the socioeconomic impacts of kerosene (paraffin) pricing on alternative sources of energy in Ibadan, a city in South West Nigeria. Both descriptive statistics and multinomial logistic regression model were used for the empirical analysis. The variables included sex, marital status, employment status, and income level as well as expenditure pattern on fuel. The descriptive analyses showed that affordability, efficiency of fuel type were the major factors that made the respondents to prefer kerosene to other sources of fuel. The multinomial logistic analysis showed that income is the major determinant for the choice of fuel type and this determines their spending pattern on fuel type selected. However, as the price of kerosene increase, individuals are compelled to opt for less efficient fuel like charcoal, and firewood. This therefore confirms the fact that income plays major role in the choice of fuel type in the study area. Respondents preferred more of kerosene other sources of fuel despite the fluctuating price of kerosene, this suggest that kerosene is for efficient fuel compared to charcoal and fuelwood. However, the respondents would prefer liquefied petroleum gas (LPG) when their income improves. This is because LPG is seen as the most efficient fuel when compared to other sources of fuel. Thus improvement of income of respondents would largely influence the spending pattern and shift from less efficient fuel type to more efficient fuel.

Ampitan and Oyerinde(2015) study was carried out to ascertain the pattern of household energy utilization among the residents of Jos in Plateau State, Nigeria with its attendant consequences on the environment. The Findings of the study indicated fuel wood and charcoal has been preferred by the household to other sources of energy. A choice of energy by household was determined by economic and social status, family size, availability and prices. The study also revealed that fuel wood been the cheapest energy was sourced from the forests and there is no correlation between educational advancement of the respondents and family size. Most respondents have large family size and it is expected that household with large family size will use more fuel wood than those with moderate family size, As a result of the long distance travelled by wood vendors to get fuel wood and an upsurge in human population, most household had to spend more money per week to purchase fuel wood. Even though the cost of using fuel wood is generally lower than those of alternative fuels, it is believed strongly that money spent on fuel wood by household is having negative impact on the income of the respondents.

Survey of energy use in Northern Nigeria by Silviconsult (1991) identified that households whose heads have little or no formal education consume more wood than those with some background of formal education. The reason could be that modern knowledge has motivated people to the use of less energy and less health risky energy sources than the traditional wood commonly used. They found out that fuel preference also affects the pattern of energy use, and that *Anogeissus leiocarpus (marke)* tree species was the most preferred for cooking due to its burning speed, convenience and relative cost. On the issue of seasonality, the same study identified that 85 percent of the household use more wood during the cold season for heating and lighting, while 25 percent use charcoal, kerosene, gas and electricity. The study therefore identified cold season as a motivating factor for more consumption of energy in the household especially for heating.

However, Ekhuemelo, Gaklime and Okochi (2015) assessed household energy utilization in Mikang Local Government Area of Plateau State. Mikang Local Government was purposively selected in Plateau State for the study. Among the 4 Districts in Mikang LGA, 30% of the towns/villages (12) including the District Headquarters were selected by simple random sampling out of the 36 towns/villages. In each of the towns/villages 15 households were randomly selected and 15 copies of questionnaire were administered to each household head to elicit information on sources of energy for domestic use. Data obtained was analyzed with aid of descriptive statistics such as tables, percentages, charts and figures. Results showed that firewood was the highest singled used energy source in the Mikang LGA while electricity and gas were the least. Some respondents combined two energy sources as firewood and charcoal, charcoal and kerosene, firewood and kerosene and electricity and kerosene. Preference of energy sources indicated that firewood was the most preferred energy source followed by charcoal, kerosene, electricity and sawdust stove.

2.4.3 Gap Identified from review of previous studies

From the review of literature, there are varying conclusions arrived by previous studies. Based on the review, no previous studies captured the impact of income via location on household cooking choice. Similarly, no previous study captured the interaction between income and location and its impact on household firewood consumption.

More so, the interaction between age and gender of household head and its effect on charcoal consumption were also not captured by previous studies.

Also, the interaction between gender and income of household head and its impact on household cooking choice were not empirically assessed and therefore this study intend to fill the above mention gaps identified from the review of the previous studies.

However, despite the above situation, the understanding of household energy use patterns is very limited especially in the context of some regions of the developing world (Kowsari & Zerriffi, 2011 cited in Danlami *et al.* 2018). Future studies are also required to fully understand the main determinants of energy across the urban and rural regions as this will contribute to assisting the formation of relevant energy policies.

This study therefore analyse household energy consumption in rural and urban areas of Kano State.

2.5 Theoretical Framework

2.5.1 The Energy-Ladder Theory

Household energy choice is usually based on the 'energy ladder theory' and the associated notion of 'fuel-switching' (Heltberg, 2003). The energy ladder hypothesis is predicated on the economic theory of consumer behavior (Hosier & Kipondya, 1993). The energy-ladder hypothesis emphasises the role of income in determining fuel choices. However, it appears to imply that a move up to a new fuel is simultaneously a move away from previously used fuels. The energy-ladder theory places emphasis on income in explaining energy choice. One of the main factors that determine the selection of a fuel and the movement towards other alternatives is the income of the households. The energy ladder hypothesis explains the movement of energy consumption from traditional sources to more sophisticated sources along an imaginative ladder with the improvement in the economic (income) status of households. However, when income increases, households not only consume more of the same good they also shift to more sophisticated goods with higher quality. Furthermore, the energy ladder hypothesis assumes that cleaner fuels are normal economic goods while traditional fuels are inferior goods (Rajmohan & Weerahewa, 2007; Demurger & Fournier, 2011).

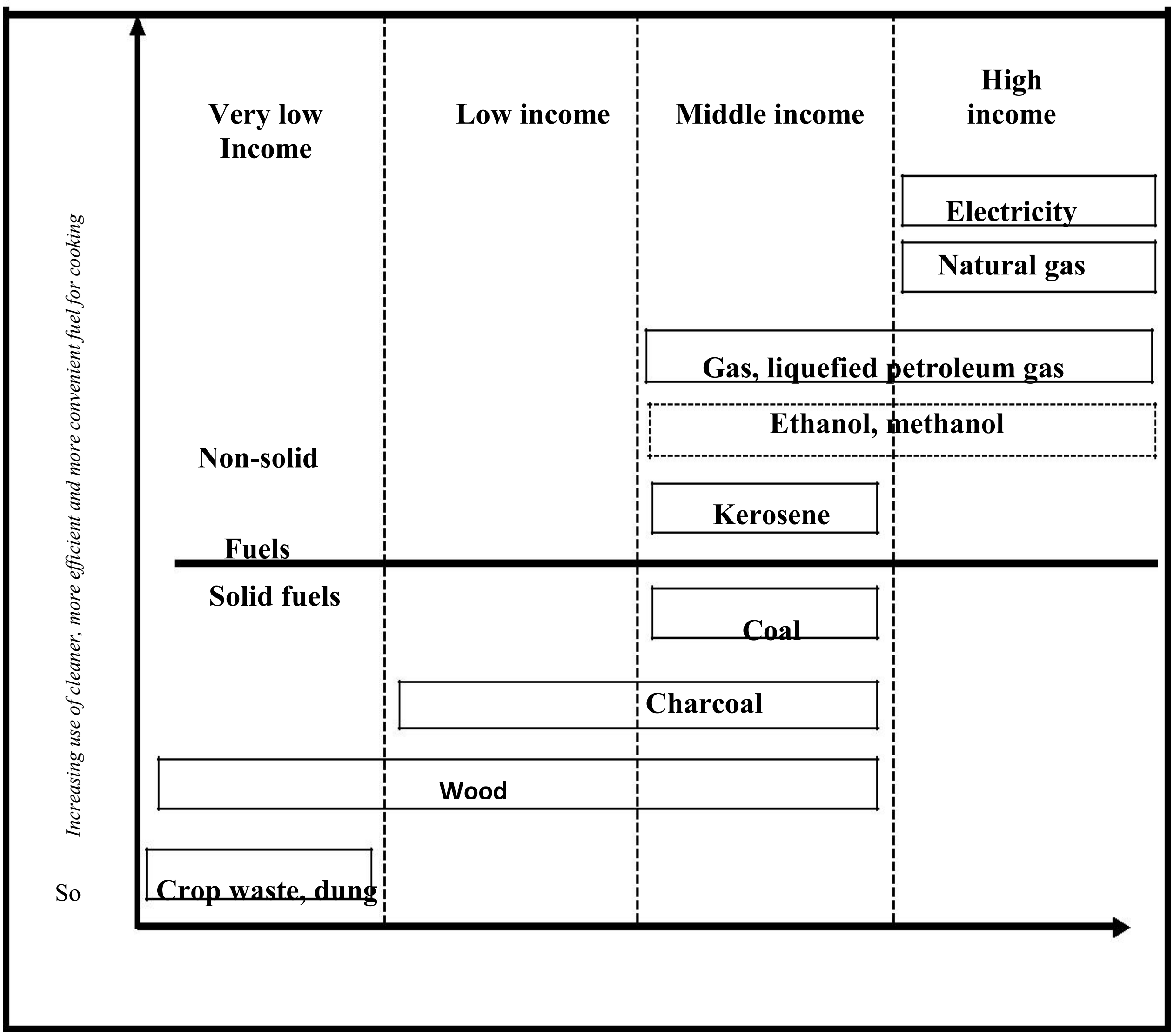
The theory states that, a household energy choice undergoes a three-stage linear switching process. The stages are:

i. The first stage is marked as the past centuries era, when all households depend on biomass as their source of residential energy. During that time, there were no other energy sources such as fossil fuels, electricity etc. The households depend mainly on the biomass available.

ii. The second stage is called a 'transition phase' involving the use of semi-modern energy sources such as kerosene, coal and charcoal. This is a stage where the income of the household has increased to some level, leading the transition.

iii. The third stage or rather, the last stage of the model emphasises a situation where the income of the household increased substantially. According to the model, this is the situation where the household switches to the use of Liquefied Natural Gas LPG), natural gas and electricity.

Energy Ladder can be shown diagrammatically in figure 2.2.



(Source: WHO, 2006)

Figure 2.2: The energy ladder: household energy and development inextricably linked

However, critics argue that the energy ladder hypothesis is overly simplistic as it implies that a move up the ladder to modern fuels necessarily imply a move away from traditional fuels used hitherto (Heltberg, 2003).

2.5.2 Fuel stacking

However, the linear relationship between income and energy demand and preferences; as upholds in the ladder hypothesis, have been criticized as being simplistic because factors other than income could equally explain fuel choices and demand. For example, a pure demand effect, associated with increasing income, will result in substitution because of convenience and changing uses of time. Supply factors will also play a role as scarce or higher production cost fuels have higher prices and will be less available and or affordable. In addition, households may not switch completely from one fuel to another as income rises but rather use combination of modern and traditional fuelsthis leads to the concept of fuel stacking (Davis, 1998).

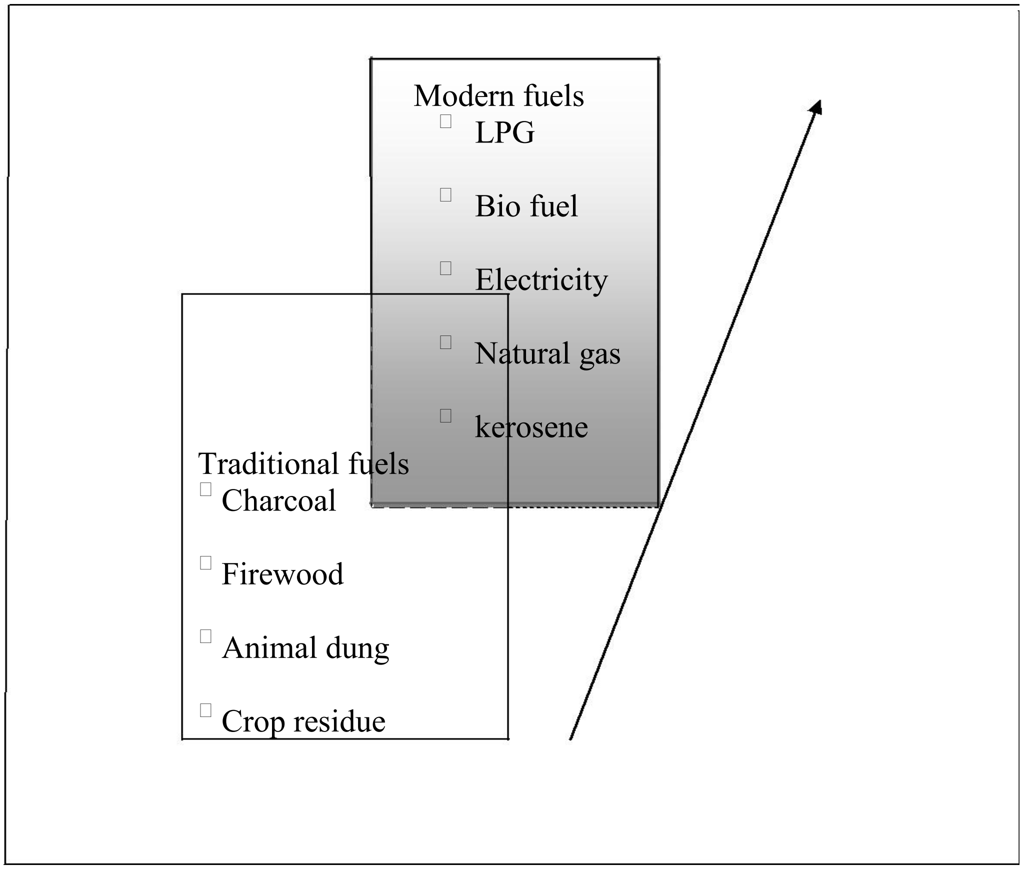


Figure 2.3: Energy stack model

(Source: Adapted from Schlag & Zuzarte, 2008)

The literature on fuel choice had shown that many factors other than income could influence the household fuel adoption decision. The main among these are the household size, gender composition, location, cooking habitat, gender of the household head, age, education, availability of fuel alternatives and accessibility including cooking utensils as well as the degree of the development of fuel markets and wage labour market (Moses, 2006).

Diagrammatically, Fuel switching and Fuel stacking can be seen as follows.

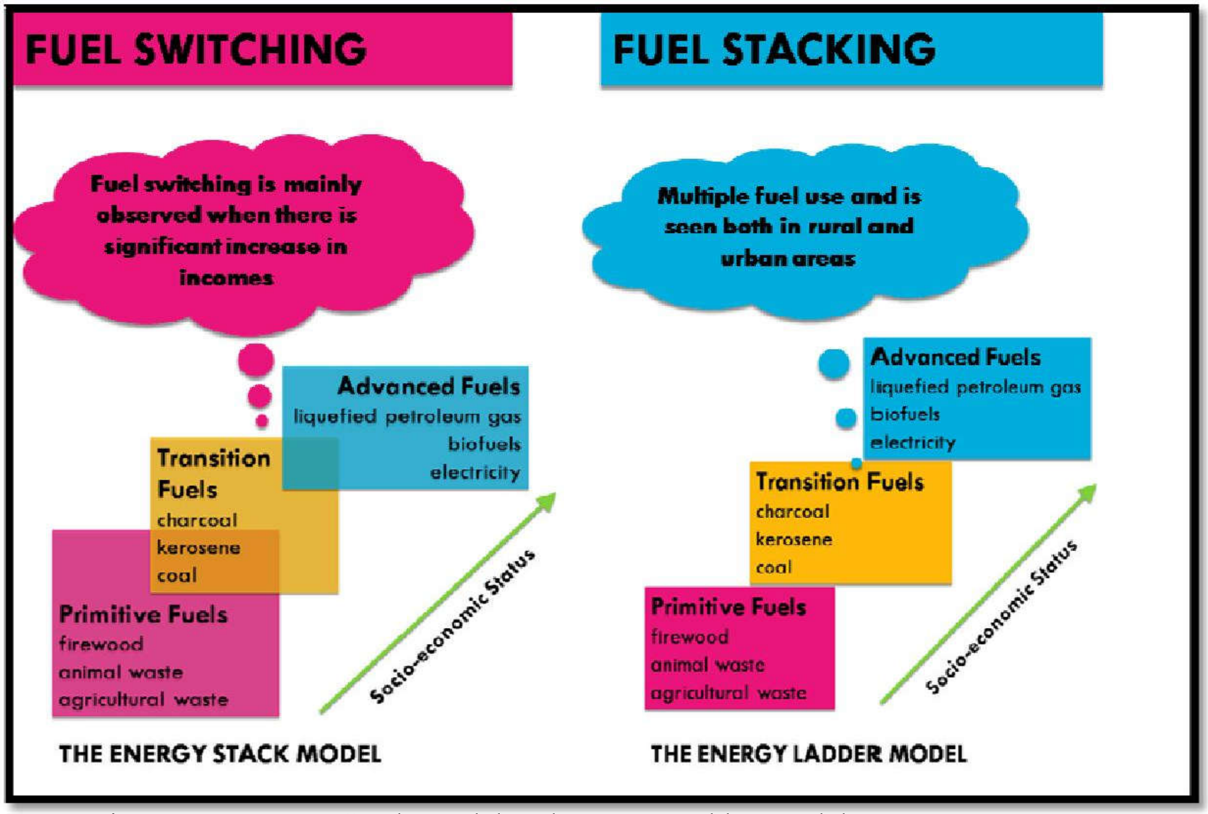


Figure 2.4: Energy Stack Model and Energy Ladder Model
(Source: Sclag & Zuzarte, 2008)

The framework for this study is therefore build around energy ladder and energy stacking model.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter explained the methodology used in the study. It contained the study area, research design, and population of the study, sample and sampling technique, data collection procedure, method of data analysis, model specifications of the three models and measurement of variables used in the study.

3.2 The Study Area

Kano State was among the 12 states created in May 1967 out of the former Northern Region. It formally came into being on April 1, 1968. The state remained intact until August 27,1991when Jigawa State was carved out. It is located in the northwest geo-political zone of Nigeria. It is situated in a semi-arid region located between latitudes 10.30^{o}N to 13^{o}N and longitude 7.40^{o}E and 10.39^{o}E. Kano city is situated at 472.45 metres above sea level. The state is bordered by Jigawa State in the north-east, Katsina State in the north-west and Kaduna State on the southern boundary. It has a total land area of 20,760 square kilometres with 1, 754, 200hectares agricultural and 75,000 hectares forest vegetation and grazing land. The state is noted for its fairly stable climate with relatively minor changes in temperature and humidity.

The projected population of Kano State as of 2016 was 13,076,892 (NBS, 2018).Urban drift from rural areas within Kano, other states in Nigeria as well as North and West Africa has provided a steady stream of migrants adding to Kano's growing population. It is therefore a cosmopolitan melting pot of people. The population density is about 458 persons per square kilometre.

Moreover, Hausa and Fulani are the predominantly Muslims inhabitants of Kano State. Many immigrants mostly Yorubas and Igbos, live in Kano City.

Kano has 44 local governments with an area of 20,479.6 square kilometer. The walled city of Kano, which serves as the state capital is the commercial nerve centre of the State and indeed the whole of northern Nigeria. The Kano Metrropolis comprised Fagge, Gwale, Ungogo, Tarauni,Kumbotso, Kano Muncipal, Nassarawa and Dala Local Governments. The Statealso has three senatorial districts Kano Central which include; Dala, Gwale, Dawakin Kudu, Kura, Gezawa, Tarauni, Fagge, Kano Munincipal ,Garun Mallam, Kumbotso, Madobi, Minjibir, Nassarawa, Ungogo, Warawa. Kano North include; Bichi, Shanono, Bagwai, Danbatta, Makoda, Dawakin Tofa, Gabasawa, Gwarzo, Kabo, Tofa, Rimin Gado, Tsanyawa, Kunchi. Also, Kano South include; Ajingi, Albasu, Bebeji, Bunkure, Doguwa, Garko, Gaya, Karaye, Kibiya, Kiru, Rano, Rogo, Sumaila,Takai, Tudun Wada andWudil .

Historically, Kano State has been a commercial and agricultural state, which is known for the production of groundnuts. The state has over 18, 684 square kilometres of cultivable land and it is the most extensively irrigated state in Nigeria. Kano State is noted for its famous markets and it is the most leading industrial centre in the north.

Giant industrial plants include textile, oil, motor assembly, bicycle assembly and many agro - based industries. Kano City is linked by rail, road, and air to all parts of the country and internationally.

3.3 Research Design

The study employed cross-sectional research design method where data were collected in the selected sample. The cross-section study design provides useful data for simple statistic description and interpretations (Babbie, 1995).

For this study, field survey was carried out to assess the household cooking fuel in Tarauni, Dambatta and Garko Local Government Areas. The field survey employed helped to generate the required data from primary sources using questionnaire. The research instrument was designed to elicit information on household's socio-economic characteristics and the data were used to address the research questions and objectives of the study.

3.4 Population of the Study

According to Sekaran (2003) Population entails entire group of people, events, or things of interest that the researcher wishes to investigate. The population of the study includes all the households that are located in Kano State. Thus, the estimated number of Household in Kano State is 1,603,335 (NBS, 2012) which comprises high, low, and middle income households in the State.

3.5 Sample Size and Sampling Technique

In research investigations involving several hundreds and even thousands of elements, it would be practically impossible to examine every element. Even if it were possible, it would be prohibitive in terms of time, cost, and other human resources. Therefore, the study of a sample rather than the entire population is also sometimes likely to produce more reliable results (Sekaran, 2003).

According to Bartlett, Kotrlik & Higgins (2001) sample size determination is common and usual task for many researchers, in that it affects and influences the accuracy and quality of research.

However, there is no specified percentage of the population set to be accurate for representation. What really matters is the number of the sample size and not a percentage of the study population (Jeff, 2001).

Dillman (2007) provides the following formula for estimating desired sample sizes:

$$n = \frac{(N\text{p})(P)(1-P)}{(N\text{p}-1)(B/C)^2+(P)(1-P)}$$

Where:

*N*s = completed sample size needed (notation often used is *n*)

*N*p = size of population (notation often used is *N*)

p = proportion expected to answer a certain way (50% or 0.5 is most conservative)

B = acceptable level of sampling error (0.05 = ±5%; 0.03 = ±3%)

C = *Z* statistic associate with confidence interval (1.645 = 90% confidence level;

1.960 = 95% confidence level; 2.576 = 99% confidence level)

Therefore, the sample size was calculated as follows;

$$n = \frac{(1{,}603{,}335)(0.5)(1-0.5)}{(1{,}603{,}335-1)(0.05/1.645)^2+(0.5)(1-0.5)}$$

$$n = \frac{(1{,}603{,}335)(0.5)(1-0.5)}{(1{,}603{,}335-1)(0.05/1.645)^2+(0.5)(1-0.5)}$$

$$n = \frac{(1{,}603{,}335)(0.5)(0.5)}{(1{,}603{,}334)(0.0255)^2+(0.5)(0.5)}$$

$$n = \frac{(1{,}603{,}335)(0.25)}{(1{,}603{,}334)(0.0006502)+(0.25)}$$

$$n = \frac{400833.75}{1042.7378}$$

$$n = 384.4$$

$$n = 384$$

Based on the above formulae, a representative sample size of 384 was derived. According to Jeff (2001) since it is not every selected sample that will likely response, there is a need for a researcher to increase the sample size to avoid non response bias.

However, to reduce mistakes in sampling and to take care of non-response rate issue, the sample size was multiplied by two (Hair *et al.,* 2008).Therefore, an approximately a total number of 768 households were used as the sample for the study.

Furthermore, Multi stage cluster sampling technique was employed. In the first stage Kano state was divided in to clusters or groups based on geo-political zonal categorization of the state; Kano central, Kano North and Kano south. In the second stage, three local governments namely; Tarauni, Dambatta and Garko were randomly selected out of each cluster to represent Kano state. Furthermore, the local government areas were categorized into rural and urban with Tarauni from metropolis as urban, Dambatta and Garko as rural. The total numbers of 768 questionnaires were divided into three with the local governments having an equal share of 256. The urban area has a total of 256 and rural area has 512 numbers of households. For the urban area, a total of four (4) wards were selected and for each ward four communities were also selected which makes a total of 16 communities. Also in each community, a total number of 16 households were selected. This gave a total of 16*16 which is equal to 256 households.

Similarly, in the rural area which has a total of 512 numbers of households a total of four (4) wards were selected. Two wards were selected each from Dambatta and Garko. For each ward four communities were also selected which makes a total of 16 communities. Also in each community, a total number of 32 households were selected. This make a total of 32 households *4 communities = 128 per ward. For the four wards 128*4=512 households.

3.6 Data Collection Procedure

A semi structured questionnaire was used in order to accommodate qualitative and quantitative information. Questionnaires are an efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest (Sekaran, 2003).

The questionnaires were personally administered in order to gather information from the respondents. Personally administered questionnaires allow a researcher or a member of the research team to collect all the completed responses within a short period of time and any doubts that the respondents might have on any question could be clarified on the spot (Sekaran, 2003).

Therefore, a total number of 768 questionnaires were administered for Tarauni, Dambatta and Garko Local Government Areas with heads of households or spouse been the targeted respondents.

The questionnaire for this study addressed various issues related to energy usage with their determinants. The administration also involved the help of research assistance who were adequately trained to handle data collection. Part of their role was to actively encourage respondent participation, and to explain the questions if necessary; this was considered important to avoid losing responses due to lack of understanding of the objectives of the research or some aspects of the questionnaire, or due to illiteracy. Among the studies that used questionnaire are; Zaku *et al.* (2015); Oyekale, Dare andOlugbire (2012); Kadiri and Alabi (2014) and Ampitan and Oyerinde (2015), Danlami (2017).

3.7 Method of Data Analysis

To examine the household cooking fuel choice in Kano State Nigeria, Multimonial Logit Model (MNLM) was used. The Multinomial Logit (MNL) framework is mainly used for modeling discrete choices or market shares (McFadden, 1974), but its application has also been considered for consumer budget shares (Theil, 1969) or cost shares (Considine & Mount, 1984). MNLM permits the analysis of decisions across more than two categories in the dependent variable; hence it becomes possible to determine choice probabilities for the different energy use for cooking. On the contrary, the binary probit or logit models are limited to a maximum of two choice categories (Maddala, 1983). Since the publication of McFadden's (1974) seminal article numerous generalizations of the standard multinomial Logit model have then been introduced in the literature (Train,2003; Ackerberg *et al.,* 2007), increasing the supply of models and inference procedures available for applied works.

The choice of the model was based on its ability to perform better with discrete choice studies (McFadden, 1974 and Judge*et al.,* 1985) and it is simple to compute than its counterpart, the multinomial probit model (Hassan &Nhemachena, 2008).

Previous studies on household energy use have been undertaken using MNLM Examples of these studies are; Pundu and Fraser (2003); Heltberg (2005); Ouedraogo (2006); Ogwumike, Ozughalu and Abiona (2014), Mekonnem and Kohlin (2008); Udoffia and Thompson (2015); Nnaji, Ukwueze and Chukwu (2012); Pundo and Fraser (2006); Reddy (1995); Danlami (2017).

More so, to determine the factors that affect firewood consumption in Kano State, OLS Model was used since the dependent variable is quantitative. According to Madala (1992), linear regressions are important to analyse data when the dependent variable is continuous. The least squares method has been used in a wide range of economic relationship with fairly satisfactory result (Koutsoyannis, 1977 cited in Danlami, 2014). More so, despite the improvement of computational equipment and of statistical information which facilitated the use of other more elaborate econometric techniques, OLS is still one of the most commonly employed methods in estimating relationships in econometric models.

Among study that used OLS model are Lee (2013); Barnes *et al.* (2011); Maurice, Umar and Zubairu (2015); Jamasb and Meier (2010) and Navajas(2007).

In addition, to determine the factors that affect charcoal consumption in Kano State, Tobit model was used. Tobit model estimation was conducted toutilise both zero and non-zero values of the dependent variable in order to take into account the significantnumber of zero observations. This model has been widely utilised in studies ofhousehold behaviour (Lee, 2013; Song *et al.,* 2012; Jingchao & Kotani, 2012; and Danlami, 2016).

3.8 Model Specification

3.8.1 Theoretical Specification of Multinomial Logit Model

The multinomial logit model was used toidentify households' energy choices. This model is used when dependent variable is nominal and it comprises more than two categories. In the multnomial logit model, one category of dependent variable is selected as comparison category. Assuming that dependent y derives from j nominal outcome, categories are numbered from 1 to J. Let the likelihood of observing outcome m on the basis of variable given x is$Pr\ (Y_i{=}m|x_i)$

Drawing from Long and Freese (2001) the MNLM can be formally written as;

$$ln\,\Omega_{m|b}(x) = ln\frac{Pr(y=m|x)}{Pr(y=b|x)} = x\beta_{m|b} \text{For } m= 1 \text{ toJ} \quad \text{...(3.1)}$$

Where;

b is the base category which is also referred to as the comparison group. Since$ln\,\Omega_{b|b}\quad(x) = ln\ 1 = 0$, it must hold that $\beta_{b|b}$=0. That is, the log odds of an outcome compared to itself is always0, and thus the effects of any independent variables must also be 0. These J equations can be solved to compute the predicted probabilities:

$$Pr(y=m|x) = \frac{exp(x\beta_{m|b})}{\sum_{j=1}^{J} exp(x\beta_{j|b})} \quad \text{.........(3.2)}$$

While the predicted probability will be the same regardless of the base category b. suppose there are three outcomes and estimate the model with outcome 1 as the base category. The probability equations would be

$$Pr(y=m|x) = \frac{exp(x\beta_{m|1})}{\sum_{j=1}^{J} exp(x\beta_{j|1})} \quad \text{.........(3.3)}$$

One would obtain estimates $\hat{\beta}_{2|1}$ and $\hat{\beta}_{3|1}$, where $\hat{\beta}_{1|1} = 0$.If the model is set up with base category 2, the equations would be

$$Pr(y=m|x) = \frac{exp(x\beta_{m|2})}{\sum_{j=1}^{J} exp(x\beta_{j|2})} \quad \text{.........(3.4)}$$

And would obtain $\hat{\beta}_{1|2}$and$\hat{\beta}_{3|2}$, where$\hat{\beta}_{2|2}$= 0. While the estimated parameters are different,they are only different parameterizations that provide the same predicted probabilities.

3.8.2 Empirical Specification of the Multinomial Logit Model

To examine the pattern of household cooking fuel choice in Kano State Nigeria, Multimonial Logit Model (MNLM) was used.MNLM permits the analysis of decisions across more than two categories in the dependent variable. It was used to determine the extent to which variables affect energy use for cooking.

Danlami, Applanaidu and Islam (2018) in their study on the analysis of household cooking fuel choice in Bauchi State Nigeria used Multinomial logit model as follows;

$$P\ (Y_i=j) = \frac{exp(\alpha_{ij}W_i)}{\sum_{j=0}^{m} exp\ (\alpha_{ij}W_i)} = \propto_i + \beta_1 GND_i + \beta_2 AGE_i + \beta_3 HHS_i + \beta_4 LOC_i + \beta_5 NRM_i + \beta_6 HES_i + \beta_7 PFW_i + \beta_8 NCF_i + \beta_9 HAP_i + \beta_{10} HOS_i + \beta_{11} EDU_i + \beta_{12} INC_i + \beta_{13} DSHR_i + \varepsilon_i \ldots\ldots\ldots (3.5)$$

Where: j takes the values 0, 1 or 2 representing the various fuel source categories i.e. firewood, Kerosene, electricity or gas.

$P(Y_i = j)$= the probability of choosing one of the fuel sources instead of the based category variable. The based (referenced) category is firewood and i = is the individual household

GND_i = Gender of the household head i

AGE_i = Age of the household head i

HHS_i= Size of the household i

LOC_i = home location of the household i

NRM_i = number of rooms in the home of household i

HES_i = hours of electricity available per week for household i

PFW_i = unit price of firewood per bundle

NCFi = similarity with the neighbours main fuel source

HAP_i = number of home appliances own by household i

HOS_i = homeownership of household i

EDU_i = years of formal education of the head of household i

INC_i= monthly income of the head of household i

DSHRi = Size of the dwelling of the household i

Therefore, in order to estimate household cooking fuel choice in Kano state, the model of Danlami, Applanaidu and Islam (2018) has been modified as follows;

$$ln\frac{p(y_{ij}=m)}{p(y_{ij}=1)} = \propto_m + \beta_{m1} loc_i + \beta_{m2} gender_i + \beta_{m3} age_i + \beta_{m4} mstatus_i + \beta_{m5} educ2_i + \beta_{m6} hhsize_i + \beta_{m7} employer_i + \beta_{m8} income_i + \beta_{m9} hownshp_i + \beta_{m10} dwellshre_i + \beta_{m11} Ic\_loc_i + \beta_{m12} gen\_lgic_i + \varepsilon_{im} \ldots\ldots (3.6)$$

Where

'm' represent categories as; 'non-solid fuels' (kerosene, gas and electricity), 'solid fuels' (Charcoal, sawdust, cornstalkand firewood), and 'mixed' (mix of solid and nonsolidfuels). The reference category is solid fuels.

loc = household location

gender= gender of household head

age= age of household head

mstatus= marital status of household head

educ2 = educational level of household head

hhsize= household size

employer = employment sector of household head

income= income earn by the house head

hownshp= home ownership

dwellshre= dwelling share

Ic_loc = interaction variable income and location of household

gen_lgic = interaction variable gender and log of income.

3.9 Diagnostic Test for MultinomialLogit Regression

The Independence of Irrelevant Alternatives (IIA) test is very useful when using the MNLM.

3.9.1 Independence of Irrelevant Alternatives (IIA) Tests

A stringent assumption of multinomial logit models is that outcome categories for the model have the property of independence of irrelevant alternatives (IIA). Stated simply, this assumption requires that the inclusion or exclusion of categories does not affect the relative risks associated with the regressors in the remaining categories (Williams, 2016).

McFadden(1974)wrote that the multinomial logit models should only be used in cases where the outcome categories ‘‘can plausibly be assumed to be distinct and weighed independently in the eyes of each decision maker. ‘Train (1990) argued that an assumption of IIA in multinomial logit model is not as restrictive as it first sees.

A number of tests have been developed to test for the IIA assumption. Hausman and McFadden (1984) proposed a Hausman type test and McFadden *et al* (1976) proposed an approximate likelihood ratio test that was further improved by Small and Hsiao (1985).

The Hausman test involves estimating a restricted model by excluding one of the categories and comparing these estimates with the unrestricted full model. Significant values of H ($p<0.05$) indicate that the IIA assumption has been violated.

The Small and Hsiao (1985) test statistic is computed by dividing the sample randomly into two subsamples, S1 and S2, of about equal size. The unrestricted model is then run on each of these samples and a weighted average of the coefficients is computed. Next a restricted sample is created from the second sub sample by eliminating all cases with a chosen value of the dependent variable. The model is then run on this restricted sample.

Again significant values of SH ($p < 0.05$) indicate that the IIA assumption has been violated.

3.10 OLS Regression of Household Firewood Consumption

In order to answer the second objective the OLS method is use since the dependent variable is quantitative.

3.10.1TheoreticalSpecification of Household Firewood Consumption

The OLS model shows the relationship between the dependent and independent variables which is linear in its parameters. Estimation based on OLS technique is guided by the assumptions of zero mean of the error variable; $E(U)=0$ Zero covariability or relationship between the random error and explanatory variable (i.e.$Cov(X_j, U)=0$, homoscedasticity of the variance of the error term and absence of perfect multicollinearity among the independent variables (Danlami, 2014).

These can be expressed as:

$Y = \beta_0+\beta_1X_1+\beta_2X_2+\ldots\ldots\ldots+\beta_kX_k+U$……………………………………………………… (3.7)

Where Y is the dependent variable and $X_1, X_2, \ldots\ldots\ldots X_k$ are the independent variables

Which has an observable random scalars i.e, they can be observed in a random sample of the population.U is the unobservable random disturbance or error term, while $\beta_0,\beta_1,\beta_2 \ldots\ldots\ldots \beta_k$ are the parameters to be estimated.

3.10.2 Empirical Specifications of Household Firewood Consumption

To determine the factors that affect firewood consumption in Kano state, OLS method was applied.Maurice, Umar andZubairu (2015)used OLSRegression analysis in determining the factors influencing fuelwood consumption in some selected local government areas of Taraba State.

The explicit form of the model is presented as:

$Y_i = \infty_0 + \beta_1X_1 + \beta_2X_2 + \ldots\ldots + \beta_9X_9 + e_i$…………………………...(3.8)

Where;

Y_i = Expenditure on firewood (₦/ month)

X_i= Age (years)

X_2 = Marital status (Dummy where 1 = married and 0 = otherwise)

X_3 = Gender (male = 1 and female =2)

X_4 = Family size (measured by number of people in a household)

X_5= Educational level (measured by years of formal schooling)

X_6= Monthly income (₦)

X_7= Labour on fuel wood collection (mandays)

X_8= Cost of fuel wood per Kg (₦)

X_9= Cost of alternative fuel (kerosene ₦/ litre)

αo, β_1 - β_8 were parameters estimated

e_i= Error term

Following Maurice, Umar and Zubairu (2015) the model is adopted and modified in this study as:

$$Lgfwdexp = \beta_0 + \beta_1 loc_i + \beta_2 gender_i + \beta_3 age_i + \beta_4 mstatus_i + \beta_5 educ2_i + \beta_6 hhsize_i + \beta_7 employer_i + \beta_8 income_i + \beta_9 hownshp_i + \beta_{10} hmnature_i + \beta_{11} ic\_loc_i + \varepsilon_i \text{..........} \quad (3..9)$$

Where;

Lgfwdexp = log of firewood expenditure

loc= household location

gender= gender of household head

age = age of household head

mstatus= marital status of household head

educ2 = educational level of household head

hhsize = household size

employer= employment sector of household head

income= income earn by the house head,

hownshp = home ownership

hmnature = home nature

ic_loc =interaction of income and location of household head.

3.11 OLS Regression Diagnostic Tests

By the Gauss-Markov theorem, the OLS estimator is efficient among linear unbiased estimators if the linear regression model errors are zero-mean independent and homoscedastic. Therefore after estimating the OLS regression model, the following Post-estimation tests were carried out.

3.11.1 ModelMisspecification Tests

The term “model misspecification” in its broadest sense means that one or more of the assumptions made on the data generating process is incorrect.Misspecifications lead to inconsistency of the least-squares estimator and loss of identifiability of parameters of interest.The least-squares estimator may nonetheless continue to have a meaningful interpretation, only one different from that intended under the assumption of a correctly specified model. The most serious consequence of a model misspecification is inconsistent estimation of the regression parameters (Cameron & Trivedi, 2005).

The command to test model specification is ‘linktest.’ The significance of _hatsq should be check. The null hypothesis is that there is no specification error. If the p-value of _hatsq is not significant then we fail to reject the null and conclude that our model is correctly specified (Torres-Reyna, 2007).

3.11.2 Heteroscedasticity Test

One of the important assumptions of the classical linear regression model is that the variance of each disturbance term U_i, conditional on the chosen values of the explanatory variables, is a constant number equal to σ^2. This is the assumption of homosscedasticity, or equal (homo) spread (scedasticity), that is, equal variance. Symbolically,

$E\ (u_i^2) = \sigma^2 \quad i = 1, 2 \ldots n$

When the conditional variance of Y_i increases as X increases., the variances of Y_i are not the same. Hence, there is heteroscedasticity.

Symbolically,

$E\ (u_i^2) = \sigma_i^2$

The subscript of σ^2, which reminds us that the conditional variances of u_i (= conditional variances of Y_I) are no longer constant.

The general assumption of heteroskedastic errors is made because empirically this is often the case for cross-section regression. Heteroskedastic errors are pervasive in micro econometrics. The consequence of heteroskedasticity is that OLS standard errors are incorrect. The failure of homoskedasticity in the standard regression model, leads to the OLS estimator being inefficient though it is still a consistent estimator. This can be readily corrected and guarded against by routinely using heteroskedasticity robust standard errors (Gujarati, 2004).

The test is performed by using the estat hettest post estimation command. The simplest version is theBreusch-Pagan/Cook-Weisberg test to be conducted to ascertain the constancy of random variance.

3.11.3 Multicollinearity Test

The term multicollinearity is due to Ragnar Frisch. Originally it meant the existence of a "perfect," or exact, linear relationship among some or all explanatory variables of a regression model. For the k-variable regression involving explanatory variableX_1, X_2, . . . , X_K *(where* $X_1 = 1$ for all observations to allow for the intercept term), an exact linear relationship is said to exist if the following condition is satisfied:

$$\lambda_1 X_1 + \lambda_2 X_2 + \dots \lambda_K X_K = 0 \quad (3.10)$$

Where, λ_1 , λ_2 ,……… λ_k are constants such that not all of them are zero simultaneously. Therefore, the term multicollinearity is used in a broader sense to include the case of perfect multicollinearity, as shown by equation (3.10), as well as the case where the *X*variables are intercorrelated but not perfectly so, as follows:

$$\lambda_1 X_1 + \lambda_2 X_2 + \dots \lambda_K X_K + v_i = 0 \quad (3.11)$$

Where v_i is a stochastic error term.

If multicollinearity is perfect in the sense of (3.10), the regression coefficients of the Xvariables are indeterminate and their standard errors are infinite. If multicollinearity is less than perfect, as in (3.11), the regression coefficients, although determinate, possess large standard errors (in relation to the coefficients themselves), which means the coefficients cannot be estimated with great precision or accuracy (Gujarati, 2004).

The variance inflation factor (VIF) test is to be conducted to examine the extent of the association among the independent variables. It provides an index that measures how much the variance of an estimated regression coefficient is increased because of collinearity. A VIF of 1means that there is no high correlation among the independents variables and hence β coefficient is not inflated at all while VIFs exceeding 10 are signs of serious multicollinearity requiring correction.

3.11.4 Normality Test

This is one of the assumptions of OLS. The random variable μ is assumed to have a normal distribution. Symbiotically we may write. $u \sim N(0, o_u^2)$which reads: $u$is normally distributed around zero mean and constant (finite) variance o_u^2.

The assumption of normality is necessary for conducting the statistical tests of significance of the parameter estimates and for constructing confidence intervals. If this assumption is violated, the estimates $\hbar_o$ and $\hbar_1$ are still unbiased and best but we cannot assess their statistical reliability by the classical test of significance (t, F, etc) because the letter are based on normal distributions.

3.12 Tobit Model for charcoal consumption

Tobit model estimation was conducted to utilise both zero and non-zero values of the dependent variable (log of charcoal quantity) in order to take into account the significant number of zero observations. This model has been widely utilised in applied microeconometric studies (Brehanu & Fufa, 2008; Amemiya, 1984) and studies of household behaviour (Lee, 2013; Song *et al.,* 2012; Jingchao & Kotani, 2012).

3.12.1 Theoretical specification of charcoal consumption

Tobit model is usually estimated using a method of maximum likelihood estimation. The log likelihood function for Tobit model can be expressed as follows;

$$LL_{Tobit} = \sum_0 \ln\left[I - \delta\left(\frac{\beta_i x_i}{\sigma i}\right)\right] + \sum_+ \ln\left[\frac{1}{б i}\,\phi\left(\frac{y_i \beta_i x_i}{б_i}\right)\right] \ldots\ldots.(3.12)$$

where "0" indicates the total sum of the zero observations in the sample (i.e. $y_i=0$), "+" represents the total over the positive observations (i.e. $y_i>0$), δ stands for the standard normal random variable cumulative distribution function (cdf) and φ represents the standard probability normal density function (pdf). Maximisation of the above likelihood function with respect to σ and β will give the maximum likelihood estimates of these parameters. In this model, the observed charcoal consumption *(Y)* of a household takes "0" or a positive value. The relationship between the censored variable *(y)* and the independent variables can be expressed by the Tobit model, where it is assumed that the observed endogenous variables Y_i for observations *i=1, 2, 3… n* satisfy the following;

$$Y_I = \max(Y_i^*, O) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(3.13)$$

Where

yi* is a latent variables generated using linear regression model:

$$Y_i^* = \beta' X_i + \varepsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(3.14)$$

Where, X_j is the vector of regressor variables. The model error ε_j is assumed to be normally distributed with zero mean and constant variance *(iid~N(0; δ2))*. The observed Value of Yi is censored below 0, that is, as is shown below:

$$Y_i = \begin{bmatrix} Y_i^* & if\ Y_i^* > 0 \\ 0 & if\ Y_i^* \leq 0 \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.15)$$

In this model, households consumes charcoal only when the latent variable Y^*takes a positive value, and the actual consumption $Y=Y^*$. Otherwise, the household does not use charcoal and therefore $Y=0$.

3.12.2 Empirical Specification of Household Charcoal Consumption

To assess the determinants of charcoal consumption in Kano State Tobit model was used.

Lee (2013) inthe study on household energy mix in Uganda employedtobit model. The econometric model estimated for the tobit model is of the form:

$$InY_{ij}^x = \alpha_j + \beta_{1j}Urban_i + \beta_2 HH_i + \beta_{3J}Edu_i + \beta_{4j}Edu2_i + \beta_{5j}In(ExpPPi) + \beta_{6j}PrivW_i + \beta_{7J}PubW_i + \beta_{8J}P_{ki} + \beta_{9j}P_{fi} +_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3.16)}$$

$Y_{ij=}0\ IfY^x \leq_{ij}$

$Y_{ij=}Y_{ij}^x If Y_{ij}^x > 0$

Where;

The dependent variable (Y_{ij}) is the consumption of household i of energy type j,

Where

j = {electricity, kerosene, firewood, charcoal}. For electricity, kerosene, and firewood, consumption units are kilowatt-hours, liters, and bundles, respectively. Charcoal consumption is in terms of expenditure due to data limitations.

Dummies for urban residence (Urban), private water connection *(PrivW),* and public water source *(PubW)* are included.

Household size (HH) refers to number of people per household.

Edu = greatest number of years of education any member of the household has received

ExpPP = expenditure per capital.

The variables *Pk* and *Pf* denote fuel prices for kerosene per liter and firewood per bundle, respectively.

Following Lee (2013), the empirical estimate of the Tobit model used in this study to estimate the quantity of charcoal is presented in the following equation

$$lgcqtity = \beta_0 + \beta_1 age_i + \beta_2 mstatus_i + \beta_3 hhsize_i + \beta_4 employer_i + \beta_5 income_i + \beta_6 hownshp_i + \beta_7 dwellshre_i + \beta_8 educ2_i + \beta_9 loc_i + \beta_{10} age\_gen_i + \varepsilon_i \ldots\ldots\ldots \quad (3.17)$$

Where

lgcqtity is log of charcoal quantity

age= age of household head

mstatus= marital status of household head

hhsize = household size

employer= employment sector

income = monthly income of household head (₦)

hownshp = home ownership

dwellshre = dwelling share

educ2 = educational status of household head

loc= interaction variable location of household

age_gen= interaction variableage and gender of household head.

3.13DefinitionsandMeasurement of Variables

Dependent Variable

The dependent variable for the multinomial logit model (*Cfu*) is a multi-categorical variable and it represents the fuel chosen by household. In order to analyse fuel use by household using multinomial logit model, the consumers were grouped into three categories according to the fuel use by the household. Household whose fuel is only solid; fuel wood, charcoal, sawdust, animal dung, dried cornstalk takes the value =0.

Household whose fuel is only non-solid; kerosene, electricity, gas, and this takes the value =2

A mixture of these (when households reported both solid and non-solid fuels as their main fuel) =1.

In order to analyse firewood consumption, the dependent variable for OLS model is log of firewood expenditure *(lgfwexp)*in which the amount spend on firewood in ₦ value.

The dependent variable for tobit model which was used to analyse charcoal consumption is charcoal quantity *(lgcqtity)*which is measured in. bowl. Firewood and charcoal is in terms of expenditure and quantity respectively due to Data limitations.

Independent Variables

Location (loc): this is the Geographical location of the respondents. It is a binary variableittakes on the value of 1 if the respondent resides in rural areas of Dambatta and Garko local government and 0 if the respondent resides in Tarauni Local Government which is in urban area.The majority of the households in urban areas used multiple sources of energy for cooking which was different to the rural areas where most household used single source of cooking energy (Desalu, 2012) This observation is in contrast to a study of (Desai, Mehta & Smith, 2011) in rural areas where most of the household reported the use of multiple sources of energy The expectation of the study is for the households in the rural areas to use more of solid fuels than households in urban areas.

Age of household head (Age): This variable represents the age of the household head measured in an interval scale. The age of the household head was found to be negatively related to the use of clean fuel (Nlom and Karimov, 2014; Suliman, 2010). On the other hand, Danlami *et al.* (2017) found this relationship to be positive. Also, the expectations for the study is for older household heads to consume more of solid fuels.

Education level of house head (Edu2)

This explains the head of household knowledge, awareness and experience. This variable has an ordered multi categorical nature i.e. beginning from informal educational background to primary, secondary, tertiary and post tertiary education. However for easy measurement and incorporation into the model, number of years spent by respondents in acquiring formal education was used to assess their educational background thereby making it a continuous variable. The education level of house head is coded as 0 = no formal education, 6 = Primary, 12 = Secondary, 14 = Diploma, 16 = Degree, 18 = Post graduate or Masters, Others = 21.Education had negative influence on the kerosene usage (Kwakwa &Wiafe, 2013). These results contradict the findings by (Mekonnen & Kohlin, 2009; Heltberg, 2003) that households associated with higher education were more likely to use electricity and kerosene than wood and charcoal as cooking energy.

Household heads that are more educated are expected to adopt modern energy.

Household size or Family size (Hhsze)

This is a continuous variable. It is the total members in the family.The positive association between household size and Solid fuel use was discovered by (Desalu, 2012; Ouedraogo, 2006; Njong & Johannes, 2011). In contrast, households with more members consumed more electricity and kerosene, but wood and charcoal consumption did not depend on family size (Mekonnen & Köhlin, 2008). When the number of family members is large household are expected to use unclean fuel.

Income (Inc): This includes every form of income; salaries and wages, retirement income, investment gains etc earn monthly and measured in ₦ (Naira). It is a continuous variable measured on an interval scale. Households with higher income has lower probability of using firewood (Kwakwa & Wiafe, 2013; Nnaji, Ukwueze & Chukwu, .2012) .Studies by Davis 1998 and Campbell *et al.,* 2003 also found the use of electricity and LPG for cooking in low income households. The households are expected to use modern energy with increase in income of the household heads.

Marital Status (Mstatus): This variable is a dichotomous variable coded as 1 for a married household and 0 for single. Household headed by married individual use more of modern energy (Danlami et al., 2016).Households headed by married individuals are expected to use less of solid fuels and more of modern fuels or non-solid fuels.

Employer: This is an unordered categorical variable coded as 0 = Self-employed, 1 = Private Company, 2= Local government, 3 = State government, 4 = Federal government, 5 = others. It is the expectation of the study that people in white-collar jobs adopt cleaner fuel, while those in blue-collar jobs adopt firewood and other traditional fuels. Empirical studies conducted by Eakins (2013), Özcan *et al.* (2013) and Heltberg (2005) have similar findings.

Home ownership (hownshp): This variable is unordered categorical variable coded from 0 to 5. 0 =Self owned house, 1 =Rented house, 2 =Dwelling provided by employer, 3 = Free dwelling, 4 =others. Household that live in owned adopt clean cooking fuel sources thannon selfownedhouses (Laureti & Secondi, 2012). Household head who live in non self owned houses are expected to use unclean or solid fuels.

Dwelling share: This refers to more than one household living in the same building. It is coded from 0 to 1. For 0 as those Households who do not share dwelling with others and 1 =Households who share dwelling with others.Households who share dwelling with others adopt modern energy (Couture et al, 2012). Households that share dwelling with others also are expected to adopt modern fuels.

Home nature: This variable represent nature of houses coded from 0 to 5.Traditional or mud houses = 0, Single Detached =1, Semi detached =2, Row houses =3, Flat in duplex =3, Apartment, Others= 5. Households that live in detached houses adopt modern energy (Eakins, 2013).Household heads that live in traditional houses are expected to use unclean fuels.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Summary of Descriptive Statistics of the Variables

This section provides a summary of the study variables and the way of their construction along with their means, standard deviations, minimums and maximum values. Table4.1 exhibits the values of the summary statistics.

Table 4.1: Descriptive Statistics of Variables

Variable	Mean	SD	Min	Max
Location	-	-	0	1
Gender	-	-	0	1
Age	45.41	10.37	20	60
Marital status	-	-	0	1
Education	2.38	1.54	0	6
Household size	6.59	3.98	1	30
Employer	-	1.44	0	5
Income	43829.34	23369.98	10000	80000
Home ownership	-	.81	0	4
Dwellshre	-	-	0	1
Home nature	-	1.19	0	6

Source: *Author's computation using Stata 14*

Table 4.1 above shows the descriptive statistics of variables. The mean, minimum and maximum values give information on the descriptive nature of the variables. The table shows the value of location as 0 and 1 with the minimum as urban and maximum as rural areas. Similarly, the minimum value of gender is 0 and maximum value is 1 which denotes female and male respectively. The table also shows that the average age of the household head is approximately

45years with an average income of N43, 829. A typical family in Kano State has an average number of 7 members under a single head with minimum and maximum values of 1 and 30 members respectively. More so, the average years of school experience of the head of household is approximately 3 years representing schooling experience up to Primary school level. The minimum and maximum values for home nature are 0 and 6 respectively. These denote single houses and other types of houses.

4.2 Socio-Economic Characteristics of Households in Kano State

Socio-economic characteristics is an economic and sociological combination of total measure of a person's economic and social position relative to others, based on experience, sex, age, marital status, household size and education(Maurice *et al.,*2015). These characteristics as they relate to the respondents are presented in Table 4.2

Table 4.2: Socio Economic Characteristics of Energy Consumers in Kano State

Characteristics	Freq	Percent	Cum
Location			
Urban	242	31.84	31.84
Rural	518	68.16	100
Gender			
Female	77	10.13	10.13
Male	683	89.87	100.00
Age			
Below 20	4	0.53	0.53
20-29	54	7.14	7.67
30-39	180	23.81	31.48
40-49	231	30.56	62.04
50-59	203	26.85	88.89
60 above	84	11.11	100.00
Education			
Non formal	154	20.59	20.59
Primary School	56	7.49	28.07
Secondary School	138	18.45	46.52
Diploma/NCE	182	24.33	70.86
Degree/HND	189	25.27	96.12
Post Graduate	26	3.48	99.60
Others	3	0.40	100.00
Household size			
1-5	402	53.67	53.67
6-10	248	33.11	86.78
11-15	72	9.61	96.40
16-20	21	2.8	99.20
21 and above	6	0.80	100
Employer			
Self Employed	364	49.73	49.73
Private Company	56	7.65	57.38
Local Government	87	11.89	69.26
State Government	194	26.50	95.77
Federal Government	20	2.73	98.50
Other	11	1.50	100.00
Income			
Below 10000	56	7.90	7.90
10000-19999	103	14.53	22.43
20000-39999	175	24.68	47.11
40000-59999	174	24.54	71.65
60000-79999	106	14.95	86.60
80000 Above	95	13.40	100.00

Source: *Author's computation using Stata 14*

4.2.1 Location of Household: Table4.2 above shows that 68.16 percent of the respondents are from rural area while 31.84 percent are from urban area .This shows that majority of the respondents are from the rural area. This is because the three local government areas namely; Tarauni, Dambatta and Garko which were selected to represent Kano state based on geo-political zonal categorization of the state were further categorized into rural and urban with Tarauni from metropolis as urban, Dambatta and Garko as rural areas. Therefore, two local government areas made up the rural area and constitute the majority.

4.2.2 Gender of the Respondents: the study sample comprised of both male headed and female headed households. Male headed constitutes the majority. Male constitute 89.87 percent while female constitute 10.13 percent. This could be attributed to the culture of the people in the study area in which male occupy the position of the household head. Except in some areas where females function as household's head either as widows or divorcees.

4.2.3 Age of the Respondents: Age is an important criterion in accessing the socio-economic effects of household energy. Examining household heads age distribution, the study shows that most of the respondents are within the age interval of 40-49 years of which 30.56 percent of the respondents fall within the interval followed by 50-59 years of which 26.85 percent of the respondents fall within the interval.23.81 percent fall within 30-39 years, 11.11 percent are within the age of 60 and above. More so, 7.14 percent are within the age of 20-29 years and 0.53 percent is below 20 years of age. Therefore, most of the respondents are within the age interval of 40-49 years because adult people are more likely to engage in energy issues than dependent age group

4.2.4 Household Size: More often, the family size of respondents determines the quantity of energy to be consumed in a house usually large family are expected to cook several times in a day, hence demand for energy. Households which have majority number of family members fall within 1-5 members which constitute 53.67 percent of the respondents. This is followed by 33.11 percent of the respondents which have 6-10 members,9.61 percent of the respondents have 11-15 members,2.8percent have 16-20 members and only 0.80 percent of the respondents have 21 and above members.

4.2.5 Marital Status of the Respondents: The result of the study also shows that 86.81 percent of the respondents are married and 13.19 percent are single. This indicates that majority of the respondents are married. Married couple shoulder many responsibilities and participate actively in different economic activities including cooking.

4.2.6 Educational Status of the Respondents: Educational status sometimes reflects the energy utilization pattern of people. As to the educational status of the household heads 20.59 percent have no formal education while 7.49 percent and 18.45 percent have primary school and secondary school respectively. Also, 24.33 percent have Diploma or NCE and 25.27 percent have Degree or HND. Nevertheless, 3.48 percent have post graduate and only 0.40 percent constitute others. Majority of the respondents therefore have formal education looking at the level of development even in the rural areas.

4.2.7 Employer: The employer of the respondent is more likely to show how much the purchasing power a household has, as it is believed to improve the income of the household. The result obtained in the table indicated that most of the respondents 49.73 percent are self employed while 11.89 percent, 26.50 percent 2.73 percent, and 7.65 are working with the local government, State government, federal government and private sector respectively. Only 1.50 percent is working as voluntary workers which constitute other sector. Therefore, majority of the respondents are self employed due to the fact that most of the respondents are from the rural area whose main occupation is farming and produce mostly for consumption as well as sale.

4.2.8 Income of the Respondents: Income refers to earnings received by household and social status in the community. The result of the study also shows that most of the respondents 24.68 percent earned between 20,000 to 39,999 and 24.54 percent earned between 40,000 to 59, 999.similarly, 14.95 percent of the household heads monthly income is between 60,000 to 79,999 and 14.52 percent monthly income is between 10,000 to 19,999 while 13.40 percent monthly income is between ₦80,000 and above. Only 7.90 percent of the respondent's monthly income is below ₦10,000. This indicates that monthly earning of the respondents majority of who are living in rural areas of the state is relatively not high. This can be as a result of the nature of economic activities which consist mainly of primary economic production.

4.3 Dwelling Characteristics of Households

Dwelling characteristics refers to the structure and state of the building and weather it is occupied by the owner or not. The Dwelling characteristics include dwelling share, home ownership and home nature.

Table 4.3:Dwelling Characteristics of Respondents

Characteristics	Frequency	Percentage	Cum
Dwelling share			
No	464	67.64	67.64
Yes	222	32.36	100
Home ownership			
Self owned dwell	590	78.88	78.88
Rented dwelling	106	14.17	93.05
Dwelling provided by employer	13	1.74	94.79
Free Dwelling	29	3.88	98.66
Other	10	1.34	100
Home nature			
Traditional/Mud house	150 280	19.89	19.89
Single Detached House	148 140	37.14	57.03
Semi Detached House	27	19.63	76.66
Row House	6	18.57	95.23
Flat In Duplex		3.58	98.81
Apartment in Building	3	0.80	99.60
Others		0.40	100.00

Source: *Author's computation using Stata 14*

Table 4.3 above shows the dwelling characteristics of the respondents. These include; dwelling share, home ownership and home nature.

4.3.1 Dwelling Share: In both the rural and urban areas of Kano State dwelling share plays an important role in energy consumption. Table 4.3 shows that 67.64 percent of the respondents share dwelling with other households while 32.36 percent do not share dwelling with other households.

4.3.2 Home ownership

There is also some influence of house ownership towards the choice of household cooking fuel use. Table4.3 above shows that 78.88 percent of the respondents live in self owned houses, 14.17 percent live in rented houses and 1.74 percent live in dwelling provided by their employer.

Similarly, 3.88 percent of the respondents live in free dwelling and only 1.34 percent lives in other types of home ownership. This means that majority of the respondents live in self owned houses.

4.3.3 Home Nature: Table 4.3 above also shows that approximately 20 percent of the respondents live in traditional or mud houses and 37.14 percent of the respondents live in single detached houses. The table also shows that 19.63 percent, 18.57 percent, 3.58 and 0.80 percent of the respondents live in semidetached houses. Row houses, flat in duplex, apartment in building and other types of houses. From the result therefore majority of the respondents live in single detached houses.

4.4 Household Energy Use

The different aspects of household cooking fuel consumption and the respondents' awareness of the effects of modern energy on the environment are illustrated in Table 4.4 below.

Table 4.4: Households Cooking Fuel Sources and Consumption

Characteristics	Frequency	%	Cumulative frequency
Cooking fuel type			
Solid	464	61.21	61.21
Mixed	182	24.01	85.22
Non Solid	112	14.78	100
Firewood use			
No	159	21.06	21.06
Yes	596	78.94	100
Fire wood source			
Purchased firewood	471	78.89	78.89
Collected firewood	123	20.6	99.50
Others	3	0.50	100
Awareness on effects of fuel			
No	70	9.38	9.38
Yes	676	90.62	100
Modern fuel challenge			
Higher cost of initial installation	77	10.29	10.29
Higher price	243	32.49	42.78
Far Distance to the place of purchase	83	11.10	53.88
Shock	86	11.50	65.37
Flame	241	32.22	97.59
Others	18	2.41	100

Source: *Author's computation using Stata 14*

Table 4.4 above gives the summary of household energy consumption for cooking.

4.4.1 Cooking fuel type: The cooking fuel types found in the study areas were firewood, charcoal, sawdust, cornstalk, kerosene, gas and Electricity. Households fuel choice therefore, were categorized into three namely; solid, non solid and mixed of solid and non solid. Solid fuels include traditional fuels such as firewood,charcoal,sawdust and cornstalk.Non solid fuels are modern and clean energy. These include; kerosene, gas and Electricity The result of the study shows that 61.21 percent of the respondents use solid fuel, 24.01 percent of the respondents use mixed fuel and 14.78 percent use non solid fuel. This indicates that majority of the respondents use solid fuels. Solid fuels are available at little or no cost. Similarly, some households find it difficult to change their consumption when they are used to certain commodity.

4.4.2 Firewood Usage: In the sample data, majority of the respondents use solid fuels for cooking and firewood is the most used cooking fuel among the solid fuels type in Kano State with 78.94 percent usage while 21.06 percent use other types of energy for cooking. This indicates that despite the availability of other solid fuels most of the households use firewood for cooking.

4.4.3 Firewood Source: From table 4.4 above, among the firewood users 78.89 percent purchased firewood, 20.60 percent collected the firewood from their farmland and 0.50 percent got the firewood free from people.

4.4.4 Awareness of the effects of energy source for cooking on the environment

On the awareness of the effects of energy source for cooking on the environment table 4 shows 90.62 percent of the respondents are aware of the effects associated with energy source and only 9.38 percent of the respondents are unaware of the effects associated with energy source on the environment.

4.4.5 Modern fuel challenge

On the challenges faced for using modern or clean energy table 4 above shows that 10.29 percent of the respondents associate the problems with high cost of initial installation, 32.49 percent of the respondents associate it with high prices and 11.10 percent associate it with far distance to place of purchase. Other challenges include shock of which 11.50 percent associate the problem of using modern energy, 32.22 percent associate it to flame and 2.41 percent with other problems

4.5 Correlation Analysis

A correlation analysis was conducted in order to explore the nature of the relationship that exists among variables used in this study. Correlation measures a strength and direction of a relationship between variables. The value of correlation coefficient usuallyranges between 0 to 1. A correlation value of 0.7 indicates high correlation among variables. Table 5 shows the correlation values for variables in Multinomial model. A negative value indicates negative relationship between variables and a positive value indicates positive relationship between variables.

Table 4.5: Correlation analysis of Variables Used in Multinomial Logit Model

	Cfu	Loc	Gen	Age	Mst	edu	Hsz	Emp	Inc	Hsp	dsh	Ic_loc	Gen_loc
Cfu	1.00												
Loc	-0.39	1.00											
Gen	-0.02	0.21	1.00										
Age	-0.05	-0.24	-0.06	1.00									
Mst	0.01	0.19	0.65	0.01	1.00								
Edu	0.40	-0.41	0.03	-0.16	-0.08	1.00							
Hsz	-0.17	0.08	0.05	0.51	0.10	-0.21	1.00						
Emp	0.21	0.02	-0.09	-0.12	-0.05	0.45	-0.08	1.00					
Inc	0.47	-0.24	0.16	0.27	0.19	0.35	0.12	0.29	1.00				
Hsp	0.04	0.01	-.002	-0.13	-0.01	0.13	-0.14	0.06	-0.05	1.00			
Dsh	0.06	0.01	0.01	-0.09	-0.03	-0.04	-0.03	-0.08	-0.21	0.21	1.00		
Ic_loc	-0.07	0.72	0.19	-0.03	0.21	-0.13	0.16	0.23	0.38	-0.02	-0.06	1.00	
gen_loc	0.07	0.14	0.98	-0.01	0.66	0.07	0.07	-0.03	0.32	-0.01	-0.01	0.25	1.00

Source: *Author's computation using Stata 14.*

Note: Cfu stands for fuel use, Loc stands for location, Gen stands for gender category of the household head, Age stands for age of household head, Mst for marital status, Edu stands for education of house head, Hsz stands for household size, Emp stands for employer of household head, Inc for income of household head, Hsp for home ownership, Dsh for dwelling share , Ic_loc stand for income and location ,gen_loc for gender and location.

Table 4.5 shows no strong relationship among the variables. Table 4.5 also shows weak and negative relationship between location and fuel use, fuel use and gender, age and fuel use, location and age, gender and age, location and education, age and education, marital status and education, fuel use and household size, marital status and household size, employer and gender, age and employer, marital status and employer. Similarly, the relationship between household size and employer, location and income, gender and home ownership, age and home ownership, age and home ownership, marital status and home ownership, household size and home ownership, Income and home ownership, age and dwelling share, marital status and dwelling share, education and dwelling share, household size and dwelling share, employer, income with dwelling share were also found to be weak and negative. Similarly, negative and weak relationship was found among interaction variables income – location with fuel use, age, education, home ownership and dwelling share. Moreover weak and negative relationship was found between an interaction variable gender-location with gender, home ownership and dwelling share.

In addition, positive and weak relationship was found among location and gender, fuel use and marital status, location and marital status, age and marital status. Also, table 4.5 above shows weak and positive relationship between fuel use and education, gender and education location and household size, gender and household size, age and household size, marital status and household size, income and fuel use, income and gender, income and age, income and marital status, income and education, income and household size, income and employer, employer and fuel use, employer and location, employer and education, home ownership and fuel use, location and home ownership, education and home ownership, employer and home ownership, fuel use and dwelling share, location and dwelling share, gender and dwelling share, location and dwelling share. Positive relationship was found between interaction variables income-location and gender, income-location and marital status, income-location and household size, income-location and employer, income-location and income, Positive relationship was found between interaction variables gender-location and fuel use, gender-location and location, gender-location and household size, gender-location and employer, gender-location and dwelling share.

Moreover, positive and strong relationship was found between gender and marital status, interaction variable income-location and location, gender-location and gender, gender-location and marital status.

There is an absence of high multicollinearity among the variables. Therefore, all variables were included in the estimation of household fuel choice model.

4.6 Determinants of Household Cooking Fuel Choice in Kano State

Multinomial Logit estimate of the determinants of households' choice between solids, non-solids, and a mixture of solids and non solids fuels are presented in Table 4.6 and solids fuels are the omitted category (base outcome), with which the estimated coefficient are compared. The estimated odd ratios are also presented in Table 4.7.

Table 4.6: The Estimated Coefficients of Multinomial Logit Model

Variables	Mixture of solid and non solid fuels	Non solid fuels
Loc	-1.6948***	-1.9846*
	(.6280)	(1.2003)
Gender	-2.4283	-5.2667
	(5.6384)	(9.8087)
Age	-.0212	-.0711**
	(.0145)	(.0241)
Marital status	.5115	.4909
	(.5147)	(.8003)
Educ2	.0277	.2364**
	(.0274)	(.0978)
Household size	-.0983***	-.1415*
	(.0374)	(.0742)
Employer		
Private Company	.9168	2.1545***
	(.5929)	(.7024)
Local government	.2799	-.0884
	(.3577)	(.6030)
State Government	.2433	-.1727
	(.3089)	(.3843)
Federal Government	1.1974	1.8322*
	(.9083)	(.9340)
Others	.1337	-11.7219***
	(1.0848)	(1.3532)
Income	.00002	.00004**
	(.00001)	(.00002)
Home ownership		
Rented	-.6055	.1775
	(.3859)	(.4354)
Dwelling by employer	.2823	1.6648
	(.7066)	(1.0776)
Free Dwelling	-1.8931**	-.3244
	(.8094)	(.8058)
Others	-.0962	-12.7736***
	(.9457)	(.8361)
Dwellshre	-.2902	.1667
	(.2701)	(.3584)
Income_ location	.00002*	6.35e-06
	(.00001)	(.00002)
Gender_income	.2155	.3907
	(.5447)	(.9131)
Cons	.0460	-1.5575
	(1.0285)	(1.5827)
Pseudo R^2= 0.27		
Wald chi2(50) = 1320.07***		

Source: *Author's computation using Stata 14.*

Note: Robust standard error in parenthesis.* ** *** denotes statistical significance at 10% 5% 1% levels respectively.

Table 4.7: Odd ratio of the Estimated MNLM

Variables	Mixture of solid and non solid fuels	Non solid fuels
Loc	.1836***	.1374*
	(.1153)	(.1650)
Gender	.0882	.0052
	(.4972)	(.0506)
Age	.9791	.9314**
	(.0142)	(.0224)
Marital status	1.668	1.6337
	(.8584)	(1.3075)
Educ2	1.0281	1.2667**
	(.0282)	(.1239)
Household size	.9063***	.8681*
	(.0339)	(.0644)
Employer		
Private Company	2.5012	8.6234***
	(1.4830)	(6.0576)
Local government	1.3231	.9153
	(.4732)	(.5519)
State government	1.2754	.8413
	(.3939)	(.3233)
Federal government	3.3113	6.2477*
	(3.0077)	(5.8354)
Others	1.1431	8.11e-06***
	(1.2401)	(.00001)
Income	1.0000	1.0000**
	(.00001)	(.00002)
Home ownership		
Rented	.5458	1.1943
	(.2106)	(.5200)
Dwelling by employer	1.3261	5.2848
	(.9371)	(5.6948)
Free Dwelling	.1506**	.7229
	(.1219)	(.5826)
Others	.9083	2.83e-06 ***
	(.8589)	(2.37e-06)
Dwellshre	.7481	1.1814
	(.2020)	(.4234)
Ic_loc	1.0000*	1.0000
	(.00001)	(.00002)
gender_ income	1.2405	1.4779
	(.6756)	(1.3495)
Cons	1.0471	.2107
	(1.0770)	(.3334)
Pseudo R^2 = 0.2687		
Wald chi2(38)=1320.07***		

Source: *Author's computation using Stata 14.*

Note: Standard errors in parenthesis.* ** *** denotes statistical significance at 10% 5% and 1% respectively

The table above shows that the overall model is significant at 1 percent with P Value of 0.0000 and the Pseudo R^2 is about 29%.

Based on the result of the multinomial logit model, the significant variables are explained below.

4.6.1 Location

This variable represents Location of the household. It takes a binary value, coded as 1 if the household lives in the rural area, 0 otherwise. The variable was found to be statistically significant at 1% and 10%. The result shows negative relationships with mixed fuels and non solid fuels. Households in the rural areas have lower multinomial log-odds of using mixed fuels and non solid fuels compared with solid fuels than the households in urban areas by about 1.7 and 2 units respectively. This is because clean cooking fuel facilities are available in more urban areas than in rural areas. The households in the urban areas are also more economically stronger to afford the cost of using a modern cooking fuel source than households in rural areas this is in line with the a priori expectations and supports the findings of other previous studies (Ogwumike *et al.,* 2014; Hosier and Dowd, 1987; Danlami *et al.,* 2017; Suliman, 2010). In addition, the estimated odd ratio of location variable indicates that household that live in rural areas have lower odd of adopting mixed of solid and non solid fuel by about 0.82 times lower compared to solid fuels. Similarly, theestimated odd ratio of location also indicates that household who live in rural areas have lower odd of adopting non solid fuel by about 0.86 times lower compared to solid fuels.

4.6.2 Age of the Household Head

This variable represents the age of the household head measured by number of years. The age of the Household head was found to be statistically significant at 5 percent level. The result shows negative relationship between the variable with non solid fuels as well as mixed fuels. A one-year increase in the age of the household head decreases the multinomial log odd of using mixed fuels and non solid fuels by about 0.02 and 0.07 units when all other variables are held constant. As the household head becomes older the odds of adopting modern cooking fuel source reduces. This finding conforms to a priori expectations because when people use a commodity for a long period of time, they find it difficult to change the pattern of their consumption when they become older. Similarly, Households adopt solid fuels when the head is older. This finding conforms to the findings of previous studies (Nlom &Karimov, 2014; Mensah & Adu, 2013; Suliman, 2010; Danlami*et al,* 2016).Based on the estimated result ofodd ratio, age variable indicates that an increase in the age of household head have lower odd of adopting mixed of solid and non solid fuel by about 0.02 units times lower compared to solid fuels. Similarly, an increase in the age of household head have lower odd of adopting non solid fuel by about 0.07 units times lower compared to solid fuels.

4.6.3 Educational Level of Household Head (Educ2)

These variable represent the Educational level of Household head .The variable was found to be statistically significant at 5 percent level. The Level of education of the household head has a positive relationship with non solid fuel adoption and mixed fuels. The higher educated is the household head, the more he realises the negative impact of solid fuels and therefore the less it will be adopted. A one-year increase in the level of education of the Household head therefore, increase the multinomial log odds of using mixed fuels and non solid fuels compared to solid fuels by about 0.03 and 0.24 percent. This finding conforms to the a priori expectation because when the household head is more educated, he will be more aware about the negative effects of using solid cooking fuel and will likely use more of non solid fuels. Furthermore, the more educated the household head is, the more economically stronger the household may be, and themore the household can afford to use clean, modern cooking fuel. This corresponds to the findings of (Maryam, 2011; Danlami *et al.,* 2017). The estimated odd ratio indicated that every additional year of education of household head increases the odd of adopting mixed of solid and non solid fuel by about 0.03 times higher compared to solid fuels .Similarly, an additional year of education of household head increases the odd of adopting non solid by about 0.27 times higher compared to solid fuels These findings conform to the findings of other previous studies (Oyekale *et al.,* 2012; Suliman, 2010).

4.6.4 Household Size (HHSIZE)

This represent the number of a household members (i.e. household size).Household size was found to be significant at 1 and 10 percent level .The result of the study shows negative relationship between household size with mixed fuels and non solid fuels. An increase in family size by one person keeping other factors constant decreases the multinomial log odds of using mixed fuels and non solid fuels by 0.10 and 0.14 percent. This conforms to the a priori expectation and supports the findings of other previous studies (Couture *et al.,* 2012; Maryam, 2011; Danlami*et al.,* 2017; Özcan *et al.,* 2013; Laureti & Secondi, 2012). This is because when the number of family members that depend on a single person with a constant income level increases, the household head finds it more difficult to afford higher costly modern sources of cooking fuel. Furthermore, the estimated odd ratio of this variable show that an increase in the size of the household by one individual will lead to lower odd of adopting mixed fuels and non solid fuels by about 0.09 and 0.13 units' lower times compared to solid fuels.

4.6.5 Employer

The variable was found to be significant at 1 and 10 percent. The result of the study shows positive relationship between private company with mixed fuels and non solid fuels. Household head working in private company uses more of mixed fuel and non solid fuels by about 0.9 and 2.2 percent more than self employed. The estimated odd ratio of this variable show that household head that work in private company have higher odd of adopting mixed fuels by about 1.5 and non solid fuels by about 7.6 times higher compared to solid fuels.

More so, those working with federal government have higher multinomial log odds of using mixed and non solid by 1.2 and 1.8 percent. The result of the estimated odd ratio of this variable have shown higher odd of adopting mixed fuels by about 2.3 times higher and also non solid fuels by about 5.3 percent times higher. An increase in the number of those working with other sectors such as voluntary workers increase the multinomial log odds of using mixed fuels by about 0.13 percent and decrease the multinomial log odds of using non solid fuels by 11.7 percent. This conform to a priori expectations and in line with findings of previous studies of Eakins(2013) Ozcan *et al.,*(2013) and Heltberg (2005) whom proved that those in white collar jobs (executives, entrepreneurs) tend to adopt modern clean fuels, while those in blue collar jobs (such as farming and trading) tend to adopt firewood and other biomassfuels. Similarly, the estimated odd ratio of this variable have shown higher odd of using mixed fuels by about 1.14 times higher compared to non solid fuels .In addition, the estimated result show that household head who are voluntary workers have lower odd of adopting non solid fuels by about 1.00 times lower compared to solid fuels.

4.6.6 Income

This variable represents the total monthly income of the household measured in Naira. The findings of the study show the coefficient of this variable as significant at 5 percent. Based on the estimated result of the multinomial logit model, income is positively related to mixed fuels and non solid fuels. The result shows that an increase in income of the household head by ₦1000 lead to an increase in the multinomial log-odds of using mixed fuels and non solid fuels compared with solid fuels by about 0.02 and 0.04 units respectively. This tally with the a priori expectations and also supports the assertion of both energy ladder hypothesis and the energy stacking model. When income increases, households use more of non solid or switch to using cleaner fuel. This is also in line with the findings of other previous studies (Link *et al.,* 2011; Heltberg, 2003; Danlami, 2017), it also shows that households switch or generally used more fuel types as their incomes increased, instead of (completely) switching to another fuel type. Such behavior is associated with the fact that while households were more likely to afford to buy additional cooking stoves if new fuel types required them, there were also various other reasons to do so, including preferences for a particular fuel type used for a particular type of food, for a particular time or occasion, for convenience, or due to uncertainty about the supply of a fuel type. Moreover, the estimated odd ratio of this variable show that, a ₦1000 increase in income will lead to an increase in the odd of adopting mixed fuels by about 0.02 times higher compared to solid fuels .In addition, an increase in income by ₦1000 lead to an increase in the odd of adopting non solid fuels by 0.04 times higher compared to solid fuels .This is also in line with the findings of (Danlami*et al.,* 2017).

4.6.7 Home Ownership

Home ownership which is also one of the indicators of the economic status of households affects their decision on the type of cooking fuel sources toadopt. This variable is categorical ranges from 0 to 5 namely; self owned house, rented, Dwelling provided by employer, free dwelling and other types of ownership. Negative relationship was found between non self owned houses and non solid and mixed fuels. This conforms to apriori expectation and in line with findings of (Couture *et al.,* 2012; Laureti & Secondi, 2012) who found that those who live in an owned house adopt clean cooking fuel sources than non self owned houses. In this study, free dwelling was found to be significant at 5 percent and has negative relationship with both mixed fuels and non solid fuels. The result indicates that free dwelling houses have lower multinomial log-odds of using mixed fuels and non solid fuels compared with solid fuels by about 1.9 units and 0.3 units respectively. Furthermore, the estimated result of odd ratio of this variable show that, household head that live in free dwelling have lower odd of adopting mixed fuels by about 0.85 times lower compared to solid fuels. Also, the estimated result of odd ratio of this variable show that, household head that live in free dwelling have lower odd of adopting non solid fuels by about 0.28 times lower compared to solid fuels

Moreover, the result of the study indicates that other type of non self owned houses such as inherited houses have lower multinomial log-odds of using mixed fuels and non solid fuels compared with solid fuels by 0.10 units and 12.8 units. This is because those living in inherited houses may not be economically strong to adopt more of modern or non solid fuel. Based on the estimated result of odd ratio, the estimated result indicates that household head that live in other types of houses such as inherited houses has lower odd of adopting mixed fuels and non solid fuels by about 0.09 and 1.00 times lower compared to solid fuels .

4.6.8 Income and Location (Ic_loc)

These variables represent income of household head and location of household. The variable is statistically significant at 10 Percent and has positive relationship with mixed fuels and non solid fuels. The results of the study shows that an increase in the income of the household head that live in rural area by ₦1000 lead to an increase in the multinomial log-odds of using mixed fuels and non solid fuels compared with solid fuels by about 0.02 units and 0.006units respectively. The result of the estimated odd ratio of this variable shows that an increase in income of household head that live in rural area lead to an increase in the odd of adopting mixed fuels by about 0.00002 times higher compared to solid fuels. Similarly, an increase in income of household head that live in rural area lead to an increase in the odd of adopting non solid fuels by about 0.00006 times higher compared to solid fuels.

4.7 Post-estimation test

Post-estimation test was conducted to examine the validity of the estimated MNLM .Table 4.8 below show the result of the test.

Table 4.8 IIA Test based on SUEST Method

Categories	$\chi 2$ test statistic	p-value	Evidence
Solid fuels	0.00	1.0000	For H0
Mixed of solid and solid fuels	0.00	1.0000	For H0
Non solid	0.00	1.0000	For H0

Source: *Author's computation using Stata 14*

Ho: Difference in coefficients not systematic.

Based on the result of the IIA test, we do not reject the null hypothesis of difference in coefficients not systematic which is the requirement for meeting the IIA assumption. Therefore, the model was found valid.

4.8 Correlation analysis of OLS model

The OLS method was applied in order to assess firewood expenditure.

Table 4.9 Correlation Matrix for LOGFWEXP

	Lfe	Loc	Gen	Age	Mst	Edu	Hsz	Emp	Inc	Hsp	Hnt	ic_loc
Lfe	1.00											
Loc	0.01	1.00										
Gen	0.003	0.21	1.00									
Age	0.17	-0.24	-0.06	1.00								
Mst	0.01	0.19	0.65	-0.01	1.00							
Edu	-.004	-0.41	0.03	-0.16	0.08	1.00						
Hsz	0.28	0.08	0.05	0.51	0.10	-0.21	1.00					
Emp	0.02	0.02	-0.09	-0.12	-0.05	0.45	-0.08	1.00				
Inc	0.14	-0.24	0.16	0.27	0.19	0.35	0.12	0.29	1.00			
Hsp	-0.07	0.01	-.002	-0.13	-0.01	0.13	-0.14	0.06	-0.05	1.00		
Hnt	0.04	-0.15	0.03	.0004	-0.01	0.10	0.01	0.02	0.11	0.12	1.00	
ic_loc	0.07	0.72	0.19	-0.03	0.21	-0.13	0.17	0.23	0.38	-0.02	-0.10	1.00

Note: Lfe stands for log of firewood expenditure, Loc stands for location, Gen stands for gender category of the household head, Age stands for age of household head, Mst for marital status, Edu stands for education of house head, Hsz stands for household size, Emp stands for employer of household head, Inc for income of household head, Hsp for home ownership, Hnt for home nature, ic_loc stand for income and location

(Source: Author's computation using Stata 14).

The correlation matrix for firewood expenditure is reported in the table above. The coefficients with positive signs indicate positive relationships while those with negative signs indicate negative relationships. Table4.9 shows strong and positive relationship between an interaction variable income and location with location. Firewood expenditure has a weak and positive relationship with gender, age, marital status, household size, employer, income, home nature. Positive relationship was found between education and gender, marital status, employer, home ownership, home nature. Table 4.9 also shows positive correlation between household size and location, gender and household size, age and household size, marital status and household size, home nature and household size, household size and income, employer and income, home ownership and income, employer and home ownership, home nature and gender, age and home nature, An interaction variable income and location has a positive relationship with firewood expenditure, gender, marital status, household size, employer, income.

More so, negative and weak relationship was found between location and age, age and marital status, education and firewood expenditure, education and location, education and age, household size and education, employer and age, marital status and employer, employer and household size, income and location, home ownership and gender, home ownership and age, home ownership and location, home ownership and marital status, home ownership and location An interaction variable of income and location has negative and weak relationship with age ,education ,home ownership, home nature.

4.9 Determinants of Household expenditure on firewood

In order to assess the determinants of household expenditure on firewood in Kano state, OLS method was employed. Table 4.10 below shows OLS estimation of firewood expenditure.

Table 4.10: OLS ESTIMATION FOR FIREWOOD CONSUMPTION

Variables	Coefficient	T ratio	P Values
Location	.4067551***	2.94	0.003
	(.1384)		
Gender	-.1775339	-1.56	0.120
	(.1141)		
Age	.005538*	1.65	0.100
	(.0034)		
Marital status	.0185567	0.17	0.862
	(.1068)		
educ2	.0084306	1.41	0.161
	(.0060)		
Home size	.0347822***	4.46	0.000
	(.0078)		
Employer			
Private company	-.095085	-0.61	0.543
	(.1561)		
Local Government	.0029297	0.03	0.980
	(.1142)		
State Government	.0979305	0.99	0.323
	(.0989)		
Federal Government	-.1357502	-0.58	0.563
	(.2343)		
Others	-.3074231***	-2.80	0.005
	(.1098)		
Income	8.22e-06***	3.49	0.001
	(2.36e-06)		
Home ownership			
Rented	-.1515251	-1.73	0.085
	(.0878)		
Dwelling provided by employer	-.1449779	-0.65	0.513
Free Dwelling	(.2214)		
	.0359287	0.33	0.738
Others	(.1074)		
	-.1036001	-0.49	0.625
	(.2116)		
Home nature			
Single Detached	-.1395282	-1.81	0.071
	(.0770)		
Semi Detached	-.1168573	-1.32	0.188
	(.0886)		
Row House	-.0043386	-0.05	0.961
	(.0892)		
Flat in Duplex	.0620242	0.43	0.669
	(.1451)		
Apartment in Building	.4768794***	2.71	0.007
	(.1759)		
Others	.160736	0.32	0.749
	(.5016)		
Income _Location	-7.42e-06**	-2.48	0.014
	(3.00e-06)		
Cons	7.27536	32.44	0.000
	(.2243)		
R^2= 0.13			

Source: *Author's computation using Stata 14*

Note:Standard error in parenthesis.* ** *** denotes statistical significance at 10% 5% 1% respectively.

From the above table, the result of the OLS model shows approximately 13% variations in the dependent variable are accounted for by the independent variables. More so, the overall model is significant at 1 percent with P value of 0.0000.

The important determinants of Firewood expenditure are:

4.9.1 Location

The location of the home in which the households live have an impact on energy consumption for cooking. The variable is statistically significant at 1 percent level. The result of the study shows positive relationship between location and firewood expenditure. For every one percent increase in the number of household that live in rural areas compared to urban areas, we expect 41 percent increase in firewood expenditure holding other variables constant. The households that are located in urban areas therefore, tend to adopt cleaner energy than their rural counterparts. This is because clean cooking fuel facilities are available in more urban areas than in rural areas. This is in line with previous studies and was proved to be true by previous studies such as (Eakins, 2013; Ozcan *et al.,* 2013; Mensah & Audu. 2013).

4.9.2 Age of Household Head

The age of the household head is statistically significant at 10 percent level. The age of the head of household exerts a positive effect on firewood consumption. Aone year increase in the age of the household head increase firewood expenditure by 5.5 percent. This finding conforms to a priori expectationsbecause when people use a commodity for a long period of time, they find it difficult to change thepattern of their consumption when they become older. It is also in line with the past studies like (Abebaw, 2007; Nnaji*et al.,* 2012; Ganchimeg &Havrland, 2011; Onoja, 2012).

4.9.3 Household Size

Household size also affects the household's decision on the type of cooking fuel to adopt. The coefficient of household size is statistically significant at 5 percent with respect to the use of firewood. Household size positively influences expenditure on firewood. An increase in the size of household by I individual increases firewood expenditure by 3.5 percent ofcooking fuel. The positive relationship between household size and household expenditure on firewood can be explained by the increased availability of family labor to collect firewood and the greater demand for energy in larger households. These findings conform to a priori expectations and supports results from past studies on household energy use (Jingchao & Kotani, 2011; Laureti & Secondi, 2012, Mensah &Adu, 2013: Ozcan*et al.,* 2013; Danlami*et al.,* 2017).

4.9.4 Income of Household Head

Income has a positive relationship with firewood expenditure and was found to be statistically significant at 5 percent level. A ₦1000 increase in income of household head increase firewood expenditure by 0.82 percent. The positive coefficients of the income may indicate that firewood may not be abandoned for a long period until household income reaches a considerable high level. This assertion conforms to a priori expectations and was supported by past studies (Lee, 2013; Nlom & Karimov, 2014; Oyekale& Olugbire, 2012).

4.9.5 Employer

This variable is statistically significant at 1 percent and was found to be negatively related with firewood expenditure. A 1 percent increase in the number of household heads that work in other types of employment sector such as voluntary organization decrease firewood expenditure by about 31 percent. This is in line with expectation of the study. Voluntary workers are flexible and can do more work and earn more income. Therefore, adopt clean energy.

4.9.6 Home Ownership

Home ownership is statistically significant at 10 percent. The result of the study shows negative relationship between rented house and firewood expenditure. A one percent increase in the number of household head who live in rented house decrease firewood expenditure by 15 percent. This conforms to a priori expectations. If the main household dwelling unit is rented, the household is more likely to use firewood alternatives. Such houses are likely to be rented and tenants must adhere to landlord occupancy rules. One disadvantage of firewood (which makes it less preferred in rented houses) is that it produces smoke that can stain walls and roofs.

4.9.7 Home Nature

The nature of building exerts some influence on energy consumption. The findings of the study show the variable as statistical significant at 10 percent. The estimated result shows negative relationship between single detached house and firewood expenditure. A one percent increase in the number of household head who live in single detached house decrease firewood expenditure by 14 percent. This conform to a priori expectations and in line with previous studies of (Eakins, 2013; Laureti &Secondi, 2012: Ozcan *et al.,* 2013) who empirically found that living in detached house has positive significant relationship with the adoption of gas, electricity and liquid fuel. More so, living in apartment has positive significant relationship with firewood expenditure. A one percent increase in the number of household head who live in apartment increase firewood expenditure by 48 percent.

4.9.8 Income Location

This variable is significant at 5 percent and has negative relationship with firewood expenditure. An increase in income of household head that live in rural area decreases firewood expenditure by 0.74 percent. This tally with a priori expectation, that is, as income increases, households switch to using cleaner fuel. This supports the assertion of both energy ladder hypothesis and the energy stacking model. And also is in line with the findings of other previous studies (Link *et al.,* 2011; Heltberg, 2003; Danlami *et al.,* 2017).

4.10Diagnostic Test for OLS Model

4.10.1 Joint Test of Significance

The overall test statistic F-value of 34.54 in the model indicates that the estimated model is statistically significant at 1% with p-value of 0.000.Therefore, low P. value indicates joint significance of regressors.

4.10.2 Heteroskedasticity

One consequence of heteroskedasticity is that default OLS standard errors are incorrect.

This can be readily corrected and guarded against by routinely using heteroskedasticity robuststandard errors. In this case, robust estimates are obtained and have taken care of heteroskedasticity.

4.10.3 Test of Omitted Variable

Ramsey RESET test using powers of the fitted values of lgfwdexp

Ho: model has no omitted variables

F(3, 452) = 0.07

Prob > F = 0.9758

The null hypothesis is that the model does not have omitted variables bias. The result of the test shows the P-value is higher than the usual threshold of 0.05(95% significance) so we do not reject the null hypothesis and conclude that we do not need more variables.

4.10.4 Specification Error Test

The table below shows specification error test.

Table 4.11 Specification error Test

Lgfwdexp	Coef	T	P>|t|
_hat	.4295 (5.9197)	0.07	0.942
_hatsq	.0351 (.3639)	0.10	0.923
_cons	2.3179 (24.0646)	0.10	0.923

Source: *Author's computation using Stata 14*

The null hypothesis is that there is no specification error. The result shows the P-value of hatsq is not significant therefore; we do not reject the null hypothesis and conclude that the model is correctly specified and free from specification bias.

4.10.5 Multicollinearity

In this case the variance inflation factor "VIF" test was conducted to examined the extent to which the association among the independent variables. The table below shows "VIF" and "1/VIF" results.

Table 4.12 MulticollinearityTest

VARIABLE	VIF	1/VIF
Location	6.92	0.145
Gender	1.94	0.516
Age	1.92	0.521
Marital status	1.91	0.524
educ2	2.01	0.499
Household size	1.53	0.653
Employer		
Private company	1.18	0.849
Local Government	1.68	0.594
State Government	1.80	0.555
Federal Government	1.14	0.873
Others	1.11	0.902
Income	4.73	0.211
Home ownership		
Rented	1.25	0.799
Dwelling By Employer	1.03	0.974
Free Dwelling	1.06	0.947
Others	1.10	0.910
Home nature		
Single Detached House	1.99	0.502
Semi Detached House	1.72	0.581
Row House	1.65	0.605
Flat in Duplex	1.25	0.801
Apartment	1.06	0.947
Others	1.05	0.950
Income Location	7.66	0.131
Mean VIF	2.12	

Source: *Author's computation using Stata 14*

Based on the result of the VIF test of variable multicollinearity, the VIF test indicates that the variables have low VIF. These indicated that multicollinerity was not a serious issue based on the fact that the variance inflation factor (VIF) values for each of the variables was less than 10. Hence, the coefficients are not inflated at all and all the variables are retained for further analysis.

4.10.6 Cameron and Trivedi's Decomposition of IM-test

Cameron and Trivedi's Decomposition of IM-test composition test includes test foe heteroskedasticity as well as skewness and kurtosis tests for normal distribution. Skewness is used to indicate the shape of distribution of data while kurtosis indicates the flatness or peakedness of the frequency distribution curve and measure the tail or outliers of the distribution.

Table 4.13: Cameron and Trivedi's Decomposition of IM-test

Source	chi2	Df	P
Heteroskedasticity	63.64	174	1.0000
Skewness	9.80	23	0.9924
Kurtosis	0.97	1	0.3246
Total	74.42	198	1.000

Source: *Author's computation using Stata 14*

H_0: Homoscedasticity and normality.

The result of theCameron and Trivedi's Decomposition of IM-test as shown in Table 4.13 shows a high Pvalue. This means that skewness and kurtosis as well as heteroskedasticity are not problems. Therefore,the null hypothesis of homoscedasticity and normality is not rejected.

4.11 Correlation analysis of Tobit model

Many households do not use charcoal, meaning zero values for charcoal consumption. Thus, Tobit regression method was applied. The following table shows correlation of the tobit model.

Table 4.14 Correlation MatrixFor Quantity Of Charcoal

	Lcqtity	age	Msta	Hsize	emplo	inc	Hwnshp	dwshre	educ2	loc	age_gen
lcqtity	1.000										
Age	0.031	1.000									
msta	-0.127	-0.012	1.000								
hsize	0.147	0.511	0.100	1.000							
emplo	0.161	-0.117	-0.047	-0.084	1.000						
Inc	0.138	0.269	0.190	0.124	0.293	1.000					
hwnshp	-0.039	-0.127	-0.013	-0.140	0.061	-0.048	1.000				
dwshre	-0.155	-0.094	-0.028	-0.034	-0.078	-0.211	0.209	1.000			
educ2	0.012	-0.157	0.076	-0.209	0.445	0.345	0.130	-0.038	1.000		
Loc	0.060	-0.235	0.187	0.078	0.018	-0.240	0.009	0.011	-0.406	1.000	
age_gen	0.013	0.518	0.568	0.336	-0.125	0.311	-0.056	-0.032	-0.057	0.052	1.000

Source: *Author's computation using Stata 14*

note: Lcqtity stand for log of charcoal quantity, Age stands for age of household, Msta for marital status, Hsize stands for household size, Emplo stands for employer of household head, Inc for income of household head, Hwnshp for home ownership, Dwshre for dwelling share, Edu2 stands for education of house head, Loc stands for location, age_gen stands for interaction variable of age and gender.

The correlation matrix for charcoal consumption is reported in the table above. Positive signs indicate positive relationships and a negative sign indicates negative relationships. A correlation value of 0.7 indicates high correlation among variables. From table 4.14, positive relationship was found between quantity of charcoal and household size, employer, education, location, income. The relationship was also positive between age and household size, income, location and charcoal quantity, location and marital status, location and household size, home ownership and location, dwelling share and location, home ownership and employment, dwelling share and home ownership. Similarly, education was found to have positive relationship with quantity of charcoal, marital status, employer, income and home ownership. The interaction variable of gender and age has positive relationship with quantity of charcoal, age, marital status, household size, location and income. The relationship was also negative between charcoal quantity and marital status, age and marital status, employer and age, marital status and employer, employer and household size, quantity of charcoal and home ownership, age and home ownership, marital status and home ownership, household size and home ownership, income and home ownership. Table 4.14 also shows negative relationship between dwelling share and quantity of charcoal, age, marital status, household size. In addition, the relationship was found negative between employer and income, education and age, household size, dwelling share. Moreover, the relationship is negative for location and age, location and income, location and education. An interaction variable of age and gender is found to be negative with employer, home ownership, dwelling share, education. Therefore, the table indicatedno sign of serious muliticollinearity issues among the regressors and all variables are included in the model.

4.12 Household Charcoal Consumption in Kano State

The table below also shows the estimated tobit model of charcoal consumption in Kano state.

Table 4.15: Tobit Model for intensity of charcoal use in Kano State

VARIABLES	COEFFICIENT	T RATIO	P>|t|
Age	-.0208** (.0095)	-2.18	0.031
Mstatus	-.8457** (.3221)	-2.63	0.010
Hhsize	.0528** (.0213)	2.48	0.014
Employer			
Private Company	.0189 (.3095)	0.06	0.951
Local government	-.3831 (.2579)	-1.49	0.140
State Government	.3708** (.1990)	1.86	0.065
Federal Government	.4438** (.2443)	1.82	0.072
Income	-1.43e-06 (4.42e-06)	-0.32	0.747
Hownshp			
Rented	.0210 (.2045)	0.10	0.918
Dwelling by employer	-.9526*** (.2859)	-3.33	0.001
Free Dwelling	.4510*** (.2504)	1.80	0.074
Others	.3756 (.2937)	1.28	0.203
Dwellshre	-.3547** (.1800)	-1.97	0.051
educ2	.0060 (.0188)	0.32	0.748
Loc	.2011 (.2013)	1.00	0.320
age_gen	.0149** (.0066)	2.27	0.025
Cons	3.300*** (.4959)	6.65	0.000
LR chi2(16) =27.17**			
$R^2 = 0.0715$			

Source: *Author's computation using Stata 14* .Note: Standard error in paranthesis.* ** *** denotes statistical significance at 10%,5%and 1 %

The table above shows that the overall model is significant at 5 percent with P value of 0.0396 and Pseudo R^2 of only 7 percent shows approximately 7% variations in the Dependent variable are accounted for by the independent variables.

4.12.1 Age

Age was found to be statistically significant at 5 percent level. The age of the head of household exerts a negative effect on charcoal consumption. A one year increase in the age of household head decreases the quantity of charcoal by 2percent. This is because as time goes on, income level normally increases, enabling the heads of households to afford expensive sources of cooking fuel. This finding is in line with the a priori expectation and also supports the findings of other previous studies (Özcan *et al.,* 2013; Abebaw, 2007).

4.12.2 Marital Status (mstatus)

This variable means the marital status of the household head. This variable is a dichotomous variable coded as 1 for a married household head otherwise 0. The variable was found to be statistically significant at 5 percent level and has a negative relationship with the quantity of charcoal. A household headed by a married individual use less quantity of charcoal by 85 percent. Therefore, has a chance of adopting modern cooking fuel higher than otherwise, all things being equal. This is because individuals get married when economically strong, and being economically strong means the chance of avoiding solid fuels or use of less solid fuels. This conforms to a priori expectation and is in line with the findings of (Danlami *et al.,* 2016).

4.12.3 Household Size

This variable represents the number of individuals per head in the family. In other words, it refers to the size of the family. This variable was found to be statistically significant at the 5% level and was found to have a positive relationship with the quantity of charcoal. When the number of family members is large, the quantity of charcoal increases. This is because it is comparatively affordable to use .charcoal for large family.Thecheapness of charcoal compared to modern or non solid fuels would require that households with large family size use huge amount of it for their activities. A one percent increase in household size, increase the quantity of charcoal by 5percent. This conforms to a priori expectation and is also in line with the findings of previous studies such as Pundo &Fraser (2006).

4.12.4 Home Ownership

Home ownership was found to be statistically significant at 1 percent level .A negative relationship exists between dwelling provided by employer and quantity of charcoal. Charcoal is regarded as unclean fuel. A one percent increase in the number of household that live in dwelling provided by employer, decrease charcoal quantity by 95percent.This is in line with the expectations of the study. Those who live in houses provided by their employers may earn much income which may enable them to buy modern fuels.

Free Dwelling is statistically significant at 10 percent and has Positive relationship with quantity of charcoal. A one percent increase in the number of household that live in free dwelling, increase charcoal quantity by 45 percent. This is in line with the expectations of the study. Those who live in free dwelling may earn less income and modern fuel may not be affordable for them and hence adopt solid fuels.

4.12.5 Dwelling Share

Share of dwellings (i.e. more than one household living in the same building)is one of the factors which also shape the fuel consumptionbehaviour of households. The result of the study shows the dwelling share to be statistically significant at 10 percent level and also found to have negative relationship with charcoal quantity. A one percent increase in dwelling share decrease charcoal quantity by35 percent. This conforms to a priori expectations and in line with findings of Coutureet *al.,* (2012) who found that this factor has a positive relationship with the adoption of modern clean fuel. This can be as a result of influence of one household over another. Fuel choice by one household can influence fuel choice of another household living in the same dwelling.

4.12.6 Employer

This variable is statistically significant at 10 percent .State Government and Federal Government was found to be positively related with quantity of charcoal. Household head who work with federal and state government use more of charcoal. A one percent increase in the number of household head who work with federal and state government, increase charcoal quantity by 44 percent and 37 percent respectively. The positive relationship is in line with a priori expectations and may be true for household heads who earn less.

4.12.7 Age and Gender (Age_Gen)

These variables are statistically significant at 5 percent and are related positively with quantity of charcoal. As the age of male headed household increases the quantity of charcoal increases A one year increase in the age of male headed household increase the quantity of charcoal by 1.5 percent. This finding conforms to a priori expectations because when people use a commodity for a long period of time, they find it difficult to change the pattern of their consumption when they become older. It is also in line with the past studies like (Abebaw, 2007; Nnaji*et al.,* 2012; Ganchimeg &Havrland, 2011; Onoja, 2012).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

This study focused on household energy use and its determinants in Kano State. A field survey was carried out to assess household energy consumption for cooking in three local government areas of Kano State namely;Tarauni, Dambatta and Garko.The three local government areas were selected from the three senatorial zones; Kano central, Kano North and Kano South.The survey was based on structured questionnaire distribution to 768 households out of which 760 were returned.The targeted respondents are heads of household. The study population comprises of low, middle and high income households. Analysis was also carried out with the use of descriptive statistics, multinomial logit, ordinary least square (OLS) and tobitmodel. Descriptive statistics was used to analyze socio economic characteristics of household heads whereas Multinomial Logit, OLS and Tobit regression models were employed for the analysis of the household's fuel choice, household firewood expenditure and household charcoal consumption.

The result of the estimated multinomial logit model of household fuel choice shows the factors that significantly affect household energy choice as; location, age, educational level of household head, household size, employer, income, home ownership, interaction variable income and location.

Furthermore, the findings of the study show household that live in rural areas use less of mixed of solid and non solid fuel. An increase in the age of the household head reduces the use of mixed fuels and non solid fuels. The findings of the study show that when the household head is more educated, he will be more aware about the negative effects of using solid cooking fuel and will likely to use more of non solid

Moreover, the findings of the study show negative relationship between household size with mixed fuels and non solid fuels. An increase in family size by one person keeping other factors constant reduces the usage of mixed fuels and non solid fuels Household head working in private company, federal and those working with other sectors such as voluntary workers uses more of mixed fuel and non solid fuels.

When income increases, households use mixed of solid and non solid or switch to using cleaner fuel. Therefore, the findings support that energy use of these households switches from traditional fuels to modern fuels including gas and kerosene along with income growth. During the energy transition, solid fuel is not abandoned as coal, firewood, charcoal and other fuels or non solid fuels are adopted, supporting the "energy stack" model. Hence, people do not necessarily abandon biomass use when their income increases, or when they gain access to modern fuel types.

Furthermore, the findings of the study show that those who live in an owned house adopt clean cooking fuel sources than non self owned houses. The result indicates that those who live in free dwelling houses and other type of non self owned houses such as inherited houses use less of mixed fuels and non solid fuels compared with solid fuels. In addition, an increase in the income of the household head that live in rural area lead to an increase in the multinomial log-odds of using mixed fuels and non solid fuels compared with solid fuels.

The result of the study revealed that different factors significantly affect household expenditure on firewood. These include; location, age, household size, employer, income, home ownership, home nature, interaction variable Income and location.

The result of the OLS model shows positive relationship between location and firewood expenditure. The households that are located in urban areas therefore, tend to adopt cleaner or non solid energy than their rural counterparts. These means those who live in rural area uses more of traditional or solid fuels more than those living in urban area. The age of the head of household exerts a positive effect on firewood consumption. An increase in the age of the household head increase firewood expenditure.

The findings show Household size and income positively influences expenditure on firewoodan increase in income of the household head also increases firewood expenditure.Similarly, an increase in household size increases firewood expenditure.

Household heads that live in rented houses and single detached houses spend less on firewood. More so, living in apartment has positive significant relationship with firewood expenditure. An increase in the number of household head who live in apartment increases firewood expenditure. The interaction variable income and location show negative relationship. An increase in income of household head that live in rural area decreases firewood expenditure.

In order to determine household consumption on charcoal, tobit model was used. The result of the tobit model shows age of the household head, marital status, household size, employer, home ownership, Dwelling share, interaction variables age and gender as significant.

The finding of the study shows that the age of the head of household exerts a negative effect on charcoal consumption. An increase in the age of household head decreases the quantity of charcoal. A household headed by a married individual use less quantity of charcoal. Therefore, has a chance of adopting modern cooking fuel higher than otherwise,

More so, when the number of family members is large, the quantity of charcoal increases. This is because comparatively affordable to use .charcoal for large family because the cheapness of charcoal compared to modern or non solid fuels would require that households with large family size use huge amount of it for their activities.

Also, the findings of the study shows that an increase in the number of households that live in free dwelling increase quantity of charcoal. Negative relationships exist between dwelling provided by employer and quantity of charcoal. Similarly, the relationship between dwelling share and quantity of charcoal was negative. Those who share dwelling with others uses less quantity of charcoal.

In addition, as the age of male headed household increases the quantity of charcoal increases. Household head who work with federal and state government use more of charcoal than self-employed.

5.2 Conclusions

In rural areas, traditional fuels such as firewood, charcoal and cornstalk constitute a major portion of energy consumption. The rural dwellers whose needs are often basic depend to a large extent on the traditional sources of energy for their domestic energy requirements while the majority of the urban dwellers depend on traditional energy sources and modern fuels. Majority of the households in urban areas used multiple sources of energy for cooking which was different to the rural areas where most household used single source of cooking energy.By using the concept of energy ladder and fuel stacking, the study examines the differences in the pattern of energy use in households based on the economic status of the households.

Firewood is the most used cooking fuel in Kano State. Among the firewood users, majority of them purchased the firewood use for cooking. The fact that a household chooses one or more of energy sources is a function of interaction of so many factors which consists of socio economic, demographic characteristics of households.

5.3 Recommendations

In line with the findings of the study, the following recommendations are made to improve the situation, Income was found to be an important factor in energy choice for cooking. Therefore the state government as the immediate to the people should embark on policies and programmes aimed at increasing income of individuals .For instance; employment generations through establishment of more facilities especially in rural areas for easy access by the people at the grass root, empowerment and skills development by organizing entrepreneurship programmes for people to have skills in the production of goods and services. This will increase the level of income and modern energy will be more affordable by the households thereby reducing the use of traditional or unclean fuels.

The local communities under their village leaders are also the immediate managers of the forest resources .A by –law at village level should be made to ensure that all wood fuel using households use improved stoves. The improved fuel woodstove will require the state and local government subsidies as most people will not be able to afford them. These should aim at helping those below the poverty line particularly rural communities. Robust mechanisms also should be put in place to minimize the potential for corruption.

The State, Local government as well as nongovernmental organizations (NGO) should engage in enlightening the people through campaign and workshops on the consequences of using firewood. The state government should also provide enabling environment for the people in the form of adequate electricity, good roads and credit facilities. This will reduce the use of unclean energy.

5.4 Contributions of the Study

The study made a number of contributions. It has contributed to the existing literature on household energy consumption by conducting an analysis of households' cooking fuel choice in Kano State, household firewood expenditure and household charcoal consumption. To the knowledge of the researcher, no empirical investigation has gone into the factors that underlie household cooking energy in both urban and rural areas of Kano State. The study therefore incorporates both rural and urban households in order to derive a more comprehensive understanding of the current household cooking energy across regions. The study also used household micro data set for Kano State to test the validity of fuel stacking model and the energy ladder hypothesis.

Previous studies does not use interaction variables and their effects on household energy consumption. The study therefore, made use of interaction variables in the three models of multinomial logit model. OLSand Tobit model. In the multinomial logit model, the interaction variables used are; income and location (Inc_loc) and Gender and log of income (gen_lgic). Income and location were found to be positive and significant. Also, in the OLS model the interaction variables income and location (Inc_loc) was found to be negative and significant. In the tobit model, age and gender (age_gen) were found to be positive and significant.

5.5 Areas of Further Research

There are other important variables that the study did not cover. For example, unit costs of cooking equipment were not captured. These and other factors could shed further light on the key factors influencing choice of fuel and household energy consumption for cooking. Furthermore, the influence of time dimension may have significant impact on cooking fuel choice and consumption which need to be investigated by future studies. Lastly, this study only analysed cooking aspect of household fuel consumption in Kano State, other dimensions of household energy such as; lighting and cooling need to be considered by future studies.

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APPENDIX I

QUESTIONNAIRE ON HOUSEHOLD ENERGY USE

My Name is **Hadiza Nasir Iro**, PhD Economics Student at Bayero University Kano State Nigeria. I am conducting a Research on the "Pattern of Household energy use in rural and urban areas of Kano State. The research is meant for academic purpose. Kindly respond to the questions below with as much transparency as possible. The responses will be strictly confidential and only be use for the purpose of this study.

Thank you for your time and cooperation.

INSTRUCTIONS

Please tick in the box which corresponds to your choice and fill in the blank where necessary

LOCAL GOVERNMENT: TARAUNI [ ] DAMBATTA [ ] GARKO [ ]

SECTION A: DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENT

1. Gender of the Household head

(a) Male [ ] (b) Female [ ]

2. Age of the Household head

(a) Less than 20 [ ] (b) 20- 29 [ ]

(c) 30 - 39 [ ] (d) 40 - 49 [ ]

(e) 50 – 59 [ ] (f) 60 above [ ]

3. Marital status

(a) Married [ ] (b) Single [ ]

(c) Divorced [ ] (d) Separated [ ]

(e)Widowed [ ]

(f)Others please specify____

4. Level of Education

(a) Non formal education/Qur`anic school [ ] (b) Primary school[ ]

(c) Secondary school [ ] (d) Nce/Diploma [ ]

(e)HND/Degree [ ] (f) Post Graduate [ ]

(g) Others please specify______________________________

5. Size of the household members (Including the Head)

____

6. Main Occupation of the respondent

(a) Unemployed [ ] (b) Farmer [ ]

(c) Teacher [ ] (d) Banker [ ]

(e)Labourer [ ] (f) Medical Practioner [ ]

(g) Businessman [ ]

(h)Others (please Specify) ______________________________

7. Who is your employer job?

(a)Federal Government [ ] (b) State Government [ ]

(c) Local Government [ ] (d) Private Sector [ ]

(e) Self Employed [ ]

(f) others (please Specify) ______________________________

8. **How much do you earn per month?**

(a) Below 10000 [ ] (b) 10000 – 19,999 [ ]

(c) 20,000–39,999 [ ] (d) 40,000 – 59,999 [ ]

(e) 60,000 – 79,999 [ ] (f) 80,000 and above [ ]

9. Were you engaged in a second job?

(a)Yes [ ] (b) No [ ]

10. If yes, how much do you earn per month for the second job?

(a) Below 10000 [ ] (b) 10001 – 19,999 [ ]

(c) 20,000–39,999 [ ] (d) 40,000 – 59,999 [ ]

(e) 60,000 – 79,999 [ ] (f) 80,000 and above [ ]

11. What is the Total estimated Monthly Expenditure of Household?

SECTION B:DWELLING CHARACTERISTICS

1. **We are living in:**

(a) Self owned dwelling [ ] (b)Rented dwelling [ ]

(c)Dwelling provided by employer (d) free dwelling but owned by another non household member [ ]

(e) Others specify____

2. Does your household lives with another household in the same building

(a)Yes [ ]

(b) No [ ]

3 Nature of your Dwelling

(a) Traditional home made of mud**[ ]** **(b)** Single detached house [ ]

(c) Semi detached house [ ] **(d)** Row house [ ]

(e) Apartment or flat in a duplex [ ]**(f)** Apartment in a building [ ]

(g)Single attached house [ ] (h) Others Specify............

SECTION C: HOUSEHOLD ENERGY CONSUMPTION DATA

1. Which cooking fuel(s) do you consume? Choose as many as applicable.

(a) Kerosene [ ] (b) Electricity [ ]

(c) Firewood [ ] (d) Dried cornstalk [ ]

(e) Charcoal [ ] (f) Gas [ ]

(g))Sawdust [ ] (h) Animal dung [ ]

(I) Coal [ ] (j) Others (please Specify)____________________

2. What is your main source of cooking fuel?(Tick only one option)

(a) Kerosene [ ] (b) Electricity [ ]

(c) Firewood [ ] (d) Dried cornstalk [ ]

(e) Charcoal [ ] (f) Gas [ ]

(g))Sawdust [ ] (h) Animal dung [ ]

(I) Coal [ ] (j) Others (please Specify)_..

3. Choose the Second Alternative of Cooking Fuel Source (Tick only one option)

(a) Kerosene [ ] (b) Electricity [ ]

(c) Firewood [ ] (d) Dried cornstalk [ ]

(e) Charcoal [ ] (f) Gas [ ]

(g))Sawdust [ ] (h) Animal dung [ ]

(I) Coal [ ] (j) Others (please Specify)_..

4. Do you ever collect firewood?

(a)Yes [ ] (b) No [ ]

5. If yes indicate the source of firewood

(a)Purchased firewood [ ] (b) Collected firewood [ ]

(c) Others (please Specify)____

6. What is the estimated total value of the firewood you used in a month whether gathered or purchased?

(a) N2, 000 below [ ] (b) N2, 001–N10, 000 [ ]

(c) N10, 001–N18, 000 [ ] (d) N18, 001 Above[ ]

7. Do you have electricity working in your dwelling?

(a) Yes [ ] (b) No [ ]

8. What was the total monthly cost for electricity in the household?

(a)Below N2, 000 [ ] (b) N2, 001–N10, 000 [ ]

(c) N10, 001–N18, 000 [ ] (d) N18, 001 Above [ ]

9. If using cooking gas, how much did you pay for it in a month?

(a)Below N2, 000 [ ] (b) N2, 001–N10, 000 [ ]

(c) N10, 001–N18, 000 [ ] (d) N18, 001 Above [ ]

10. If using Charcoal, state the quantity use per month for cooking …………………

11. How much did you pay for the Charcoal in a month?

(a) N2, 000 below [ ] (b) N2, 001–N10, 000 [ ]

(c) N10, 001–N18, 000 [ ] (d) N18, 001 Above [ ]

SECTION C.PROBLEMS AND CHALLENGES FACED IN USING COOKING FUEL

1. Are you aware of the effect of some energy types on the environment?

(a)Yes [ ] (b) No [ ]

2. Indicate the problem of using clean energy in your area.

(a)Higher cost of initial installation [ ] (b) Higher price [ ]

(c)Far Distance to the place of purchase [ ] (d) Risk [ ]

(e) Flame [ ]

(f) Others (please specify)……………………………………….

Thanks for your cooperation

.

APPENDIX II

Multinomial Logit Model of Household Energy Choice for Cooking

```
mlogit cfueltype   loc  gender age mstatus  educ2 hhsize i.employer income  i.hownshp dwellshre ic_loc gen_lgic,r
Iteration 0:   log pseudolikelihood = -583.88076
Iteration 1:   log pseudolikelihood = -452.57195
Iteration 2:   log pseudolikelihood = -432.10943
Iteration 3:   log pseudolikelihood = -427.30386
Iteration 4:   log pseudolikelihood = -426.99941
Iteration 5:   log pseudolikelihood = -426.97158
Iteration 6:   log pseudolikelihood = -426.96672
Iteration 7:   log pseudolikelihood = -426.96562
Iteration 8:   log pseudolikelihood = -426.96535
Iteration 9:   log pseudolikelihood = -426.96529
Iteration 10:  log pseudolikelihood = -426.96528

Multinomial logistic regression               Number of obs     =        596
                                        Wald chi2(38)     =    1320.07
                                        Prob > chi2       =     0.0000
Log pseudolikelihood = -426.96528             Pseudo R2         =     0.2687


------------------------------------------------------------------------------
             |               Robust
cfueltype |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------
1            |
loc |  -1.694788   .6280198    -2.70   0.007    -2.925684   -.4638921
gender |  -2.428334   5.638386    -0.43   0.667    -13.47937    8.622699
age |  -.0211708   .0145361    -1.46   0.145     -.049661    .0073194
mstatus |   .5115029   .5146687     0.99   0.320    -.4972293    1.520235
      educ2 |   .0277067   .0274475     1.01   0.313    -.0260893    .0815028
hhsize |  -.0983352   .0373697    -2.63   0.009    -.1715785   -.0250919
             |
employer |
1  |   .9167776   .5929228     1.55   0.122    -.2453298    2.078885
2  |    .279942   .3576857     0.78   0.434    -.4211091     .980993
3  |   .2432932   .3088637     0.79   0.431    -.3620686     .848655
4  |    1.19735   .9082926     1.32   0.187    -.5828712     2.97757
5  |   .1337349   1.084835     0.12   0.902    -1.992502    2.259972
             |
income |    .000018   .0000148     1.21   0.226    -.0000111    .0000471
             |
hownshp |
1  |   -.605515    .385873    -1.57   0.117    -1.361812    .1507821
2  |    .282277   .7066386     0.40   0.690    -1.102709    1.667263
```

3 | -1.893099 .8094019 -2.34 0.019 -3.479498 -.3067007

4 | -.0962233 .9456911 -0.10 0.919 -1.949744 1.757297

|

dwellshre | -.2901605 .2701167 -1.07 0.283 -.8195794 .2392584

ic_loc | .0000201 .0000105 1.91 0.056 -5.27e-07 .0000407

gen_lgic | .2155185 .5446768 0.40 0.692 -.8520285 1.283065

_cons | .0460543 1.028502 0.04 0.964 -1.969773 2.061881

-------------+--

2 |

loc | -1.984616 1.200279 -1.65 0.098 -4.33712 .3678886

gender | -5.266771 9.808701 -0.54 0.591 -24.49147 13.95793

age | -.0711023 .0240984 -2.95 0.003 -.1183343 -.0238703

mstatus | .4908658 .8003414 0.61 0.540 -1.077775 2.059506

educ2 | .2364466 .0978161 2.42 0.016 .0447306 .4281626

hhsize | -.1414909 .0742219 -1.91 0.057 -.2869631 .0039813

|

employer |

1 | 2.154482 .7024615 3.07 0.002 .7776832 3.531282

2 | -.0884995 .6029866 -0.15 0.883 -1.270332 1.093333

3 | -.1727526 .384308 -0.45 0.653 -.9259825 .5804773

4 | 1.83221 .9340087 1.96 0.050 .001586 3.662833

5 | -11.72187 1.353227 -8.66 0.000 -14.37415 -9.069594

|

income | .0000437 .0000206 2.12 0.034 3.29e-06 .000084

|

hownshp |

1 | .1775416 .4354251 0.41 0.683 -.6758759 1.030959

2 | 1.664829 1.07759 1.54 0.122 -.4472078 3.776866

3 | -.3244438 .8058438 -0.40 0.687 -1.903869 1.254981

4 | -12.77366 .8360932 -15.28 0.000 -14.41238 -11.13495

|

dwellshre | .1667268 .3584146 0.47 0.642 -.5357529 .8692064

ic_loc | 6.35e-06 .0000177 0.36 0.720 -.0000284 .0000411

gen_lgic | .390652 .9131088 0.43 0.669 -1.399008 2.180312

_cons | -1.557486 1.582713 -0.98 0.325 -4.659548 1.544575

Odd Ratio of Estimated Multinomial Logit Model

Mraginal effect

Iteration 0: log pseudolikelihood = -583.88076

Iteration 1: log pseudolikelihood = -452.57195

Iteration 2: log pseudolikelihood = -432.10943

Iteration 3: log pseudolikelihood = -427.30386

Iteration 4: log pseudolikelihood = -426.99941

Iteration 5: log pseudolikelihood = -426.97158

Iteration 6: log pseudolikelihood = -426.96672

Iteration 7: log pseudolikelihood = -426.96562

```
Iteration 8:   log pseudolikelihood = -426.96535
Iteration 9:   log pseudolikelihood = -426.96529
Iteration 10:  log pseudolikelihood = -426.96528
Multinomial logistic regression                 Number of obs     =        596
                                                Wald chi2(38)     =    1320.07
                                                Prob > chi2       =     0.0000
Log pseudolikelihood = -426.96528               Pseudo R2         =     0.2687
------------------------------------------------------------------------------
             |               Robust
   cfueltype |        RRR   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
0            |  (base outcome)
-------------+----------------------------------------------------------------


1            |
loc |   .1836381   .1153284    -2.70   0.007      .053628    .6288314
gender |   .0881836   .4972132    -0.43   0.667     1.40e-06    5556.364
age |   .9790517   .0142316    -1.46   0.145      .951552    1.007346
mstatus |   1.667796   .8583623     0.99   0.320     .6082135      4.5733
       educ2 |   1.028094   .0282186     1.01   0.313     .9742481    1.084916
hhsize |   .9063451   .0338699    -2.63   0.009     .8423342    .9752203
             |
employer |
1  |   2.501217   1.483029     1.55   0.122     .7824464    7.995548
2  |   1.323053   .4732371     0.78   0.434     .6563185    2.667103
3  |   1.275443   .3939379     0.79   0.431     .6962346    2.336502
4  |   3.311329   3.007655     1.32   0.187     .5582931    19.64004
5  |    1.14309   1.240064     0.12   0.902     .1363538    9.582823
             |
income |   1.000018   .0000148     1.21   0.226     .9999889    1.000047
             |
hownshp |
1  |   .5457932   .2106069    -1.57   0.117     .2561961    1.162743
2  |   1.326146   .9371059     0.40   0.690     .3319705    5.297649
3  |   .1506043   .1218994    -2.34   0.019     .0308229    .7358709
4  |   .9082612   .8589345    -0.10   0.919     .1423105    5.796749
             |
dwellshre |   .7481435    .202086    -1.07   0.283     .4406169    1.270307
      ic_loc |    1.00002   .0000105     1.91   0.056     .9999995    1.000041
    gen_lgic |   1.240505   .6756743     0.40   0.692     .4265488    3.607682
       _cons |   1.047131   1.076977     0.04   0.964     .1394886    7.860744
-------------+----------------------------------------------------------------
2            |
loc |   .1374334   .1649585    -1.65   0.098     .0130741    1.444681
gender |   .0051602   .0506153    -0.54   0.591     2.31e-11     1153059
age |   .9313666   .0224445    -2.95   0.003      .888399    .9764123
```

mstatus | 1.63373 1.307542 0.61 0.540 .3403521 7.842096
educ2 | 1.26674 .1239076 2.42 0.016 1.045746 1.534436
hhsize | .8680631 .0644292 -1.91 0.057 .7505395 1.003989
|
employer |
1 | 8.623426 6.057625 3.07 0.002 2.176424 34.16773
2 | .9153036 .5519158 -0.15 0.883 .2807385 2.984203
3 | .8413457 .3233359 -0.45 0.653 .396142 1.786891
4 | 6.247676 5.835384 1.96 0.050 1.001587 38.97159
5 | 8.11e-06 .000011 -8.66 0.000 5.72e-07 .0001151
|
income | 1.000044 .0000206 2.12 0.034 1.000003 1.000084
|
hownshp |
1 | 1.194278 .5200185 0.41 0.683 .5087107 2.803754
2 | 5.28477 5.694814 1.54 0.122 .639411 43.67894
3 | .7229294 .5825682 -0.40 0.687 .1489911 3.507772
4 | 2.83e-06 2.37e-06 -15.28 0.000 5.51e-07 .0000146
|
dwellshre | 1.181431 .4234422 0.47 0.642 .5852285 2.385017
ic_loc | 1.000006 .0000177 0.36 0.720 .9999716 1.000041
gen_lgic | 1.477944 1.349524 0.43 0.669 .2468416 8.849071
_cons | .2106649 .3334222 -0.98 0.325 .0094707 4.685979

Correlation Analysis of Variables Used in Multinomial Logit Model

| cfuelt~e loc gender age mstatus educ2 hhsize
-------------+---
cfueltype | 1.0000
loc | -0.3889 1.0000
gender | -0.0163 0.2104 1.0000
age | -0.0463 -0.2349 -0.0632 1.0000
mstatus | 0.0113 0.1874 0.6505 -0.0118 1.0000
educ2 | 0.3980 -0.4068 0.0275 -0.1570 0.0763 1.0000
hhsize | -0.1724 0.0784 0.0475 0.5108 0.0997 -0.2088 1.0000
employer | 0.2128 0.0175 -0.0932 -0.1166 -0.0470 0.4445 -0.0837
income | 0.4656 -0.2392 0.1583 0.2688 0.1908 0.3449 0.1238
hownshp | 0.0408 0.0087 -0.0018 -0.1270 -0.0125 0.1304 -0.1395
dwellshre | -0.0640 0.0113 0.0127 -0.0939 -0.0282 -0.0386 -0.0343
ic_loc | -0.0682 0.7165 0.1879 -0.0326 0.2114 -0.1313 0.1648
gen_lgic | 0.0677 0.1424 0.9824 -0.0123 0.6635 0.0724 0.0656

| employer income hownshp dwells~e ic_loc gen_lgic
-------------+--
employer | 1.0000
income | 0.2934 1.0000
hownshp | 0.0610 -0.0480 1.0000

dwellshre | -0.0779 -0.2112 0.2087 1.0000
ic_loc | 0.2278 0.3752 -0.0175 -0.0624 1.0000
gen_lgic | -0.0306 0.3248 -0.0129 -0.0125 0.2509 1.0000

OLS Estimation for Firewood Consumption

Linear regression Number of obs = 479
F(23, 455) = 5.43
Prob > F = 0.0000
R-squared = 0.1267
Root MSE = .62139

| Robust
lgfwdexp | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------+--
loc | .4067551 .1384423 2.94 0.003 .1346896 .6788207
gender | -.1775339 .114078 -1.56 0.120 -.401719 .0466512
age | .005538 .0033564 1.65 0.100 -.001058 .012134
mstatus | .0185567 .1068448 0.17 0.862 -.1914137 .2285271
educ2 | .0084306 .0059994 1.41 0.161 -.0033592 .0202205
hhsize | .0347822 .0077953 4.46 0.000 .0194629 .0501015
|
employer |
1 | -.095085 .1560626 -0.61 0.543 -.4017778 .2116079
2 | .0029297 .1141751 0.03 0.980 -.2214462 .2273057
3 | .0979305 .0989103 0.99 0.323 -.0964471 .2923081
4 | -.1357502 .2342651 -0.58 0.563 -.5961259 .3246255
5 | -.3074231 .1098349 -2.80 0.005 -.5232697 -.0915764
|
income | 8.22e-06 2.36e-06 3.49 0.001 3.59e-06 .0000128
|
hownshp |
1 | -.1515251 .0877633 -1.73 0.085 -.3239967 .0209464
2 | -.1449779 .2214359 -0.65 0.513 -.5801419 .2901861
3 | .0359287 .107409 0.33 0.738 -.1751506 .2470079
4 | -.1036001 .2116233 -0.49 0.625 -.5194803 .3122802
|
hmnature |
1 | -.1395282 .0769802 -1.81 0.071 -.2908092 .0117527
2 | -.1168573 .0885917 -1.32 0.188 -.2909571 .0572424
3 | -.0043386 .0891818 -0.05 0.961 -.1795979 .1709207
4 | .0620242 .145113 0.43 0.669 -.2231507 .3471991
5 | .4768794 .1759467 2.71 0.007 .1311104 .8226484
6 | .160736 .5016342 0.32 0.749 -.8250712 1.146543
|
ic_loc | -7.42e-06 3.00e-06 -2.48 0.014 -.0000133 -1.53e-06
_cons | 7.27536 .2242832 32.44 0.000 6.834601 7.716119

Correlation Analysis of OLS Model

	lgfwdexp	loc	gender	age	mstatus	educ2	hhsize
lgfwdexp	1.0000						
loc	0.0126	1.0000					
gender	0.0037	0.2104	1.0000				
age	0.1765	-0.2349	-0.0632	1.0000			
mstatus	0.0144	0.1874	0.6505	-0.0118	1.0000		
educ2	-0.0041	-0.4068	0.0275	-0.1570	0.0763	1.0000	
hhsize	0.2751	0.0784	0.0475	0.5108	0.0997	-0.2088	1.0000
employer	0.0237	0.0175	-0.0932	-0.1166	-0.0470	0.4445	-0.0837
income	0.1423	-0.2392	0.1583	0.2688	0.1908	0.3449	0.1238
hownshp	-0.0702	0.0087	-0.0018	-0.1270	-0.0125	0.1304	-0.1395
hmnature	0.0429	-0.1481	0.0282	0.0004	-0.0126	0.1036	0.0134
ic_loc	0.0766	0.7165	0.1879	-0.0326	0.2114	-0.1313	0.1648

	employer	income	hownshp	hmnature	ic_loc
employer	1.0000				
income	0.2934	1.0000			
hownshp	0.0610	-0.0480	1.0000		
hmnature	0.0168	0.1125	0.1178	1.0000	
ic_loc	0.2278	0.3752	-0.0175	-0.1034	1.0000

Test of Omitted Variables

Ramsey RESET test using powers of the fitted values of lgfwdexp

Ho: model has no omitted variables

F(3, 452) = 0.07

Prob > F = 0.9758

Source	SS	df	MS		
				Number of obs	= 479
				F(2, 476)	= 34.54
Model	25.4932247	2	12.7466124	Prob > F	= 0.0000
Residual	175.682678	476	.369081257	R-squared	= 0.1267
				Adj R-squared	= 0.1231
Total	201.175903	478	.42087009	Root MSE	= .60752

Specification Error Test

lgfwdexp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	.42947	5.919706	0.07	0.942	-11.20252	12.06146
_hatsq	.0350776	.3638828	0.10	0.923	-.6799376	.7500927
_cons	2.317886	24.06457	0.10	0.923	-44.96804	49.60381

Multi Collinearity Test

Variable	VIF	1/VIF
loc	6.92	0.144521
gender	1.94	0.515627
age	1.92	0.520709
mstatus	1.91	0.524167

educ2 | 2.01 0.498635
hhsize | 1.53 0.653431
employer |
1 | 1.18 0.849305
2 | 1.68 0.594111
3 | 1.80 0.554580
4 | 1.14 0.873455
5 | 1.11 0.902439
income | 4.73 0.211471
hownshp |
1 | 1.25 0.798884
2 | 1.03 0.973636
3 | 1.06 0.946781
4 | 1.10 0.910005
hmnature |
1 | 1.99 0.502056
2 | 1.72 0.580973
3 | 1.65 0.604891
4 | 1.25 0.801361
5 | 1.06 0.947493
6 | 1.05 0.950034
ic_loc | 7.66 0.130500
-------------+----------------------
Mean VIF | 2.12

Cameron & Trivedi's decomposition of IM-test

Source | chi2 df p
---------------------+-----------------------------
Heteroskedasticity | 63.64 174 1.0000
Skewness | 9.80 23 0.9924
Kurtosis | 0.97 1 0.3246
---------------------+-----------------------------
Total | 74.42 198 1.0000

Tobit Regression Model

Tobit regression Number of obs = 143
F(15, 127) = .
Prob > F = .
Log pseudolikelihood = -176.30395 Pseudo R2 = 0.0715

| Robust
lgcqtity | Coef. Std. Err. t P>|t| [95% Conf. Interval]
-------------+--
age | -.0208035 .0095225 -2.18 0.031 -.0396468 -.0019601
mstatus | -.8456661 .3221332 -2.63 0.010 -1.48311 -.2082225
hhsize | .05276 .0212775 2.48 0.014 .0106557 .0948644

| employer |
1 | .0188704 .3095089 0.06 0.951 -.5935919 .6313327
2 | -.3830613 .2579393 -1.49 0.140 -.8934765 .1273539
3 | .3708429 .1990257 1.86 0.065 -.022993 .7646788
4 | .4438324 .2443116 1.82 0.072 -.0396161 .9272809
|
income | -1.43e-06 4.42e-06 -0.32 0.747 -.0000102 7.32e-06
|
hownshp |
1 | .0210311 .204531 0.10 0.918 -.3836988 .425761
2 | -.9526127 .2859301 -3.33 0.001 -1.518417 -.3868085
3 | .4510154 .2503946 1.80 0.074 -.0444703 .9465011
4 | .3755985 .2937113 1.28 0.203 -.2056032 .9568001
|
dwellshre | -.3546812 .1799826 -1.97 0.051 -.7108342 .0014718
educ2 | .0060406 .0187717 0.32 0.748 -.0311052 .0431863
loc | .2010911 .2013486 1.00 0.320 -.1973414 .5995236
age_gen | .0148731 .0065568 2.27 0.025 .0018984 .0278478
_cons | 3.300262 .495928 6.65 0.000 2.31891 4.281614
-------------+--
/sigma | .8183493 .0714766 .6769101 .9597885

Obs. summary: 5 left-censored observations at lgcqtity<=0
138 uncensored observations
0 right-censored observations

Correlation Analysis of Tobit Model

| lgcqtity age mstatus hhsize employer income hownshp
-------------+---
lgcqtity | 1.0000
age | 0.0314 1.0000
mstatus | -0.1273 -0.0118 1.0000
hhsize | 0.1470 0.5108 0.0997 1.0000
employer | 0.1607 -0.1166 -0.0470 -0.0837 1.0000
income | 0.1377 0.2688 0.1908 0.1238 0.2934 1.0000
hownshp | -0.0386 -0.1270 -0.0125 -0.1395 0.0610 -0.0480 1.0000
dwellshre | -0.1547 -0.0939 -0.0282 -0.0343 -0.0779 -0.2112 0.2087
educ2 | 0.0115 -0.1570 0.0763 -0.2088 0.4445 0.3449 0.1304
loc | 0.0597 -0.2349 0.1874 0.0784 0.0175 -0.2392 0.0087
age_gen | 0.0125 0.5187 0.5680 0.3363 -0.1254 0.3118 -0.0569
| dwells~e educ2 loc age_gen
-------------+------------------------------------
dwellshre | 1.0000
educ2 | -0.0386 1.0000
loc | 0.0113 -0.4068 1.0000
age_gen | -0.0327 -0.0568 0.0515 1.0000