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AN ANALYSIS OF HOUSEHOLD COOKING FUEL CHOICE AND EXPENDITURE IN GHANA

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DECLARATION

Students Declaration

I, Esther Owusu Amponsah, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted either part or whole for another degree elsewhere.

Signature: ……

Date: ……

Supervisors Declaration

I hereby declare that the preparation and the presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

Supervisor's Name: Dr. Anselm Komla Abotsi

Signature: ……

Date: ……

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DEDICATION

I dedicate this work to my parents Mr. & Mrs. Owusu and my brother Dr. Isaac Owusu-Mensah

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ABBREVIATIONS

IEA	International Energy Agency
WHO	World Health Organization
LPG	Liquefied Petroleum Gas
GCMC	Ghana Cylinder Manufacturing Company
GEC	Ghana Energy Commission
GLSS	Ghana Living Standard Survey
GSS	Ghana Statistical Service
NADMO	National Disaster Management Organization
GNFS	Ghana National Fires Service
NABCO	National
YEN	Youth Employment
SDG	Sustainable Development Goal
Mtoe	Million tonnes of oil equivalent
Toe	tonnes of oil equivalent
GDP	Gross Domestic Product
UNEP	United Nations Environment Programme
C02	Carbon dioxide
MDG	Millenium Development Goal
ERP	Economic Recovery Programme
SAP	Structural Adjustment Programme
GPRS	Ghana Poverty Reduction Strategy
GSGDA	Ghana Shared Growth and Development Agenda
ESMAP	Energy Sector Management Assistance Programme

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ABSTRACT

Energy is a critical input in an economy and an increased consumption of it has long been associated with an increase in economic activities and an improvement in well-being. Due to its multiple sources and uses in various sectors of the economy, a complex relationship between energy use and human development has evolved. One aspect of this complex relationship is the increased recognition that a wide range of energy sources used in many countries for various purposes is both unclean and inefficient, with significant environmental consequences. Using the seventh round of the Ghana Living Standard Survey (GLSS) and a survey on households in Techiman, this study assesses the factors that influence households' choice of cooking energy and expenditure on LPG in Ghana. The study employed the energy ladder theory to undertake the investigations. With respect to factors influencing choice of cooking energy, it was observed that education status, area of residency, household size and age of household head were all statistically significant in explaining the adoption of wood, charcoal and electricity in cooking as opposed to LPG by households. Based on the results obtained from a multinomial logistic model, the study confirmed the validity of the energy ladder theory for Ghana. Thus, an increase in household income was found to decrease the adoption of traditional fuels and increase the adoption of modern fuels for cooking. This implies that, lower income household heads are more likely to opt for wood and charcoal as cooking fuel rather than LPG, which was predominantly used by high-income earners. Finally, the study used the double hurdle model to explore factors that influence participation and expenditure decisions in the LPG market by households in the Techiman municipality. The study revealed that area of residence, income, sector of employment, sensitization, affordability, reliability, accessibility and tertiary education significantly affected household LPG usage, education level (basic & secondary), house ownership and marital status did not have significant impact on LPG usage. The study then recommended enhanced income creating opportunities and LPG use educational programmes among others to improve the use of LPG by households.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Energy consumption by households is the amount of energy resources spent by households on various appliances used by the households. The various energy resources include biofuel and waste, kerosene, electricity, gas, petroleum, diesel, and solar. International Energy Agency (IEA, 2014 cited in Danlami, Islam and Applanaidu, 2015). Unlike other consumption goods, energy demand is a derived demand as it is not valued for itself but for what it can do, thus, it is not wanted for its own consumption but rather for the light and heat it provides (Kayode, 2016). The ability of any energy form to do so can be regarded as a function of its energy content and the efficiency conversion embodied in the energy using appliances (Kayode 2016). Interest in satisfying the derived demand for energy comes from the basic goal of maintaining and improving a certain level of human welfare wherever possible. Human-beings use energy for wider purposes, as solid power in production sector, construction, services, industries, transport and communication, and power generation, as well as for consumption sector like cooking, heating, lighting, recreation and entertainment (Kussa, 2016).

It is generally agreed that the household sector is one of the most important energy consumption sector (Wang, Zhang, Yin & Zhang, 2011). For instance, energy consumption of the residential sector accounts for about approximately 30% of the total world energy consumption (Swan & Ugursal, 2008 cited in Danlami *et al.,* 2015).

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Energy consumption pattern by households can be grouped into dimensions such as; cooking, lighting, heating and cooling, as well as transportation purposes. For cooking, the various sources of energy can be; animal dung, plant residues fuel-wood (mostly in developing countries), kerosene, gas and electricity, (Julius, 2013 cited in Danlami *et al.,* 2015). Again for lighting purposes, the various sources of energy mainly include electricity/solar, petroleum/diesel (used for fueling generators), kerosene, candles and traditional lamps as well as firewood, which is normally based on socio-economic status of a household (Barness & Floor, 1996 cited in Danlami *et al.,* 2015). Additionally for the purpose of space heating and cooling, the various energy sources consist of electricity and petroleum/diesel to power generator. For transportation purposes the various energy choice available are; petroleum and diesel for fueling various transport vehicles.

Energy is seen as a precondition for economic growth and development (Ebohon, 1996, Wolde-Rufael, 2006, cited in Kayode, 2016). The reason being that; all sectors in an economy (residential, manufacturing, agriculture, transport as well as services sectors) depend largely on various energy sources in order to function. However, despite that, the essentiality of the various end uses for energy varies significantly from country to country because of differences in climatic conditions, policies, level of economic development and other factors (Bhattacharyya, 2011 cited in Danlami *et al.,* 2015). Energy demand is essential because it affects economy, which in turn affects people‘s lives by way of their income, health, happiness and their ability to meet basic needs such as infrastructure, education and so on. Again, the increased consumption of energy is a signal of an increase in economic activities, and by inference, a country has a high economic ranking if there is a progress in economic development of energy (Kayode, 2016). Energy is extremely involved in each of the

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economic, social and environmental dimensions of human development. It contributes to social development through education and public health, and help meet the basic human need for food, and shelter (Kussa, 2016).

Energy demand in a developing country has important implications for its economy due to the issues of black economy, and growing urbanisation, which exists in such nation (Kayode, 2016). Regardless, many developing countries still face difficulties in providing adequate and modern energy services to their communities, which in turn is expected to improve the standard of living through increased income and employment opportunities (Reddy, 2000; Reddy & Nathan, 2013 cited in Kayode 2016). The primary cooking energy source in most developing countries is fuelwood. More than 2.7 billion people in developing countries depend on traditional biomass, example wood, agricultural residues and animal dung (IEA, 2015 cited in Adusah-Poku and Takeuchi, 2019). The use of traditional biomass for cooking can cause indoor pollution, which is harmful to human health particularly for the elderly, women and children. According to Wolde-Rufael (2005) cited in Kayode (2016), improved access to modern energy would not only improve the standard of living of the substantial majority of sub-Saharan African population but can also boost overall industrial and agricultural development.

World Energy Outlook

Solid fuels and kerosene are used by about 40 percent of the world‘s population, the burning of these fuels has harmful health, economic, and environmental consequences (Van Leeuwen, Evans & Hyseni, 2017). About four million people die every year from the adverse effects of household air pollution. This is mostly predominant in low and middle-income countries (WHO, 2014).

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The use of these fuels also comes with massive economic costs. For instance, household air pollution in low- and middle-income countries caused an estimated $1.52 trillion in economic losses and $94 billion in lost labor income in 2013 (World Bank 2016). Forest depletion and degradation can be as a result of prevalent use of wood fuels for cooking. Hence, there is the need to adopt clean cooking fuels such as LPG for cooking.

In 2014, 3.04 billion people around the world lived without access to clean cooking fuels, a slight increase since 2012 (World Bank 2017). The majority of these people were residents of South and Southwest Asia and Sub-Saharan Africa. The highest deficit though is in Sub-Saharan Africa where only 12 percent of Africans had access to clean cooking fuels and technologies in 2014. The increase since 2012 in the number of people living without access is also mainly driven by Africa, where each year the population expands by 25 million, while access to clean cooking increases by only 4 million (World Bank, 2017).

According to WHO 2016, in order to achieve Sustainable Development Goal 7 (SDG7 (ensuring access to affordable, reliable and sustainable modern energy for all by 2030) will therefore require a massive scale-up in the deployment and adoption of clean and affordable clean cooking solutions. It was in 2014 that the WHO provided indoor air quality guidelines including the types of fuels and technologies that can help lower the byproducts of incomplete combustion to a level that would result in positive health outcomes for those exposed (WHO, 2014). The purpose of these guidelines is to facilitate awareness of the health burden from cooking with solid fuels and to track progress toward increasing the proportion of the population relying primarily on clean fuels and technology.

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Africa Energy Outlook

In recent decades, African energy demand has been driven by the growing needs of North Africa, Nigeria and South Africa (IEA, 2019). In 2018, primary energy demand in Africa was more than 830 million tonnes of oil equivalent (Mtoe). North Africa accounted for 24%, Nigeria accounted for 19%, and South Africa accounted for 16%, which together accounted for almost 60% despite making up only 35% of the population (IEA, 2019). According to IEA 2019, the average energy consumption per person in the world is about 2 tonnes of oil equivalent (toe) which is higher than that of the average energy consumption per person in most African countries and is broadly comparable to India‘s average of 0.7 toe/capita. In 2018, per capita consumption in Sub-Saharan Africa was highest in South Africa at 2.3 toe/capita and in Nigeria at 0.8 toe/capita. Most other Sub-Saharan African countries have per capita consumption of around 0.4 toe/capita and a large part of it consists of the relatively inefficient use of solid biomass (IEA, 2019).

The rate of growth in energy demand in Sub-Saharan Africa has slightly slowed in recent years and remains lower as compared to its GDP growth rate. From 2000 to 2010, energy demand increased at an annual average rate of 3%, but this slowed to 2.5% between 2010 and 2018, with very noticeable variations. Countries such as the DR Congo (Africa‘s fourth most populous country) saw their primary energy demand more than double between 2000 and 2018, whereas others such as Côte d‘Ivoire, Ghana and Mozambique have witnessed an increase in demand of around half (IEA, 2019). Even though there is a smaller increase in the demand, it does not necessarily mean that energy services did not grow at the same rate. For instance in the case of Côte d‘Ivoire, the push towards LPG for cooking has resulted in a decline in solid biomass use, and this has produced large efficiency gains.

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Traditional biomass is used mostly for cooking in Africa, but is also used in industry. It is by far the most widely used energy source across Africa, with the exception of North Africa, where oil and gas dominate, and South Africa, where the energy mix is coal-heavy. In Sub-Saharan Africa, bioenergy‘s share in the overall energy mix has barely changed over the last 25 years, and it continues to dominate the primary energy mix, accounting for 60% of total energy use in the region (if South Africa is excluded, this share increases to almost three-quarters). There is no other region in the world that relies so heavily on bioenergy (IEA, 2019).

Fossil fuels represent almost 40% of the overall energy mix in Sub-Saharan Africa and more than half of the African energy mix. Oil demand stands at almost four million barrels per day (mb/d). The transport sector accounts for most oil use (60%), but diesel is also consumed for back-up generators, kerosene or LPG within households for lighting and cooking and a variety of oil products are used by industry. Natural gas overtook coal as the third fuel in the African energy mix in 2015. Today, natural gas accounts for 16% of that mix, with nearly 160 billion cubic metres (bcm) consumed each year: almost 80% of this is consumed in North Africa and over 10% in Nigeria. Coal now accounts for 13% of the primary energy mix (compared with around a quarter globally), with consumption of almost 160 Mtce. South Africa accounts for the overwhelming majority of the continent‘s coal consumption, where it is used for power generation, industrial processes, transport (after coal-to-liquid conversion), and household heating (IEA, 2019).

Access to modern energy is a central pillar of efforts to reduce poverty and support economic growth in Sub-Saharan Africa. Modern household energy services have two components: first, access to clean cooking facilities, where progress remains slow, with around 900 million people without access today; second, access to electricity,

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where there has been strong progress in several countries over the past decade but almost 600 million people in Sub-Saharan Africa remain without access (IEA,2019). Beyond households, gaining access to modern energy services is also essential for businesses, farmers and community buildings.

The IEA defines a household as having energy access when it has reliable and affordable access to both clean cooking facilities and electricity, which is enough to supply a basic bundle of energy services initially, and with the level of service capable of growing over time (IEA, 2019). This basic bundle of electricity services should encompass, at a minimum, several lightbulbs, phone charging, a radio and potentially a fan or television. Access to clean cooking facilities means access to (and primary use of) modern fuels and technologies, including natural gas, liquefied petroleum gas (LPG), electricity, bioethanol and biogas, or improved biomass cook stoves which deliver significant improvements compared with basic biomass cook stoves and three-stone fires traditionally used in some developing countries. This definition of energy access serves as a benchmark to measure progress towards Sustainable Development Goal (SDG) 7.

IEA 2019 establishes that lack of access to clean cooking remains very acute in Sub-Saharan Africa with access increasing only slightly from 15% in 2015 to 17% in 2018. Progress has been registered in a handful of countries. For instance, West Africa has made the fastest progress since 2010, with almost 3 million people gaining access each year, followed by East Africa with nearly 1.5 million people per year. The number of people without access exceeded 900 million in 2018 as population growth outpaced efforts to provide access. Sub-Saharan Africa is the only region where the number of those without access continues to rise significantly, highlighting the urgent need for action. Almost 500,000 premature deaths per year are related to household

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air pollution from the lack of access to clean cooking facilities, with women and children the most affected. Lack of access to clean fuels is also one of the most significant contributors in low-income countries to women‘s workloads, and poses a barrier to the economic advancement of women. It leads to women collecting and carrying loads of wood that weigh as much as 25-50 kg, which can also damage their health (UNEP, 2017).

Several governments, including Ghana, Cameroon and Kenya, are promoting LPG as a better alternative, largely in urban areas. Ghana has been promoting LPG since 1989 and 24% of the population relied on LPG in 2018; as of December 2017, the government had distributed LPG cookstoves to 150,000 households in 108 districts under the LPG Promotion Programme launched in 2017. In other countries, for example Nigeria, LPG uptake primarily displaces kerosene. Clean cooking has only increased by 0.7 percentage point since 2013 in rural sub-Saharan Africa, in part because supply chains for cleaner fuels lack the necessary scale to reach many rural communities.

In Africa, solid biomass remains the largest source of energy used by households (in energy-equivalent terms) and is often burned as fuel in a traditional manner in inefficient and polluting cook stoves, using very basic technologies often with no chimney or one that operates poorly. This so-called ―traditional use” of solid biomass is not sustainable and is associated with a range of damaging impacts to health and well-being.

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Ghana Energy Outlook

Ghana's population over the years has been on the increase with strides in economic growth, however, the same cannot be said of the energy situation (Essah, 2011). Statistics show that marginal increase has been seen in energy supply as compared to the burgeoning population growth (Essah, 2011). It is estimated that 55% of Ghana's capacity to generate electricity is attributed to hydro-based sources; Akosombo (1,020 MW), Kpong (160MW) and Bui (400MW) (Ghana Energy Commission, 2015). The remaining percentage of the energy supply is derived from thermal based plants in which the operation is based on using fuel sources such as natural gas and oil and converts energy stored in them into electrical energy (Ghana Energy Commission, 2015).

It is projected that almost 50% of Ghana's population do not have access to grid-electricity and that about 90% of those who do not have access to LPG for cooking rely on traditional fuels such as firewood and charcoal as alternatives (Kemausuor, Obeng, Brew-Hammond & Duker, 2011). Lack of access to these modern and cleaner energy sources has been attributed to factors including but not limited to income and supply-side constraints (Mensah & Adu, 2013). This indicates that most households depend heavily on traditional energy sources such as wood fuels to meet their energy demand. The impact of continual exploitation of forest and burning of wood fuel by households and industries on environmental degradation continues to engage decision makers at the local, national, regional and international levels. Carbon dioxide (CO2) emissions from primary fuel consumption by the residential sector accounted for about 18% of global CO2 emissions in 2008 (IEA, 2010). According to Energy Comission 2003, it is estimated that about 80% of Ghanaian households depend heavily on wood fuels for cooking. The overreliance on traditional fuels as a key

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energy source by Ghanaian households is among the main drivers of the rapid depletion of Ghana's forest cover which stands at about 2% loss per annum (Amoah, 2016). Incessant depletion of the forest to meet primary energy consumption is likely to derail efforts at ensuring environmental sustainability and inhibit Ghana's attainment of Millennium Development (MDG) Goal 7 (Mensah & Adu, 2013).

Cooking and heating with solid fuels often generates high levels of indoor smoke, a complex mix of health-damaging pollutants. The main problem with the use of solid fuels is products of incomplete combustion, including carbon monoxide, sulphur dioxide, and other toxic elements. This increases the risk of acute respiratory illness, pneumonia, chronic obstructive lung disease, cancer, and possibly tuberculosis, low birth weight, cataracts, and asthma among others (GSS, 2011 cited in Amoah 2016). It is in recognition of adverse effects of the use of traditional fuels that the United Nations has been advocating for intensification of programs/policy initiatives that encourage a switch from traditional energy sources to an enhanced access and utilization of modern and cleaner fuels like LPG (Mensah & Adu, 2013).

According to Duku, Gu, and Hagan 2011, Ghana's energy demand in recent years has increased significantly due to population increase (average growth rate of 2% per annum) and rapid urban growth (average growth of 4% for the period 1980-2013). Unfortunately, this increasing demand for energy is much more pronounced in the consumption of wood fuel, with wood, charcoal the main choice (Duku *et al.,* 2011).

What is disturbing though is the rather low use of LPG, which is cleaner, portable, and efficient with multiple uses. The trend however, is changing with deliberate government efforts aimed at reducing heavy reliance on biomass use.

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Government Initiatives

Until the oil crisis in 1973, most governments did not give too much attention to the use of energy, as it appeared that there was plenty of fossil fuel and the future of energy in general looked bright. However, the oil crisis decreased confidence about the future and many people became more aware of the environmental impact connected with the demand and supply of energy. Some countries experienced severe inflation, recession, stagnation and huge balance deficits due to the increase in oil prices during the oil crisis in 1973/1974. Consequently, energy policy became an important issue for both industrialised and developing countries (Kayode, 2016).

Successive governments in Ghana have implemented various policies aimed at boosting economic growth and poverty reduction. Policies implemented include inter alia the Economic Recovery Programme (ERP) and Structural Adjustment Programme (SAP) in the 1980s and early 1990s, Ghana Poverty Reduction Strategy (GPRS I, 2003-2006), Growth and Poverty Reduction Strategy (GPRS II, 2006-2009) and the Ghana Shared Growth and Development Agenda (GSGDA, 2010-2013). The energy sector was duly given priority in these development policies including actions to ensure sustainable energy use to reduce the impact on the environment, improve access to modern energy sources such as LPG and making energy products affordable for most Ghanaians.

For example, in 1989, the Ministry of Energy embarked on a program to promote the use of liquefied petroleum gas (LPG) as part of the government‘s efforts to reduce deforestation in the country from the overreliance on wood fuels. The promotion targeted households, public catering facilities and small-scale food sellers. As a promotional strategy, 14.5kg and 5kg LPG cylinders were distributed freely to the public. Consumers either were given free cylinders on request or were given cylinders

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filled with gas, but they were required to pay for the cost of the gas only Ghana Energy Commission (GEC, 2012). Furthermore, to enhance fast distribution and delivery of LPG to consumers, the Ministry of Energy purchased and assigned pick-up trucks provided with 50 cylinders each to registered private individuals to retail LPG. These trucks operated –door-to-door" service to enhance accessibility and bring LPG closer to consumers conveniently. The promotional program was extended to educational institutions, hospitals and prisons, which benefitted from free plant and equipment installations. The LPG Fund was created with a levy placed on LPG purchases to fund the purchase and maintenance of cylinders, LPG tanks and kitchen equipment for institutions. Besides, the LPG Fund was used to finance the local component of the cost of constructing the Ghana Cylinder Manufacturing Company (GCMC) factory in Accra (GEC, 2012).

These initiatives were successful, increasing the annual consumption of LPG from 5,000 tonnes in 1990 to 34,000 tonnes in 1994. Annual LPG consumption grew from 45,000 tonnes in 2000 to 220,000 tonnes in 2009 but dropped to 178,000 tonnes in 2010 due to a long shutdown of the Tema Oil Refinery (GEC, 2012).

According to GEC 2012, in 2006, an estimated 9.5% of Ghanaian households used LPG as the main source of fuel for cooking (GEC, 2012). The demand for LPG grown considerably averaging over 40% between 2000 and 2010. The existing infrastructure at Tema Oil Refinery was inadequate to meet the demand at that time. The Tema oil refinery was the only LPG production facility in the country and had daily production rate of 200-250 tonnes/day. This is a fraction of the daily demand of the country of about 1,000 tonnes. The refinery had a storage capacity of 6,300 metric tonnes, which was insufficient for the growing demand for the product by both commercial and

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domestic users. The situation resulted in intermittent severe shortages of LPG in the country. This led to some households going back to the use of charcoal or at least using it as a back-up fuel for cooking (GEC, 2012). The purpose of the LPG program was defeated when taxicabs and other commercial vehicles started patronizing LPG as a fuel for their cars and the levy was scrapped in February 1998 (GEC, 2012). Commercial vehicle drivers found LPG to be cheaper compared to other transport fuels due to higher price differential between LPG and gasoline. This price differential was mainly because of the subsidy component on LPG in the price build-up, which was designed for domestic users with the primary objective of helping households meet their demand at an affordable price (GEC, 2012). In 1994, the Road Traffic use of LPG Regulations, 1994, LI 1592 was passed to regulate the use of LPG as fuel in vehicles. The enforcement of LI 1592 was ineffective leading to the blatant abuse of the LPG subsidy by commercial vehicles (GEC, 2012).

Most second cycle schools, hospitals and prisons that embraced the LPG programme also went back to the use of charcoal and firewood for cooking because of supply difficulties. In 2006, the Household Energy Project also supported 22 schools to convert their kitchens to the use of LPG. After 6 months of use, the schools abandoned LPG because they found LPG more expensive than firewood (GEC, 2012).

Ghana has implemented an LPG promotion programme since 1989. The experiences gained and the problem of demand outstripping supply provides a strong basis for developing a new LPG strategy and policy towards the realization of the dual Government policy objective to increase LPG access to households and public institutions and ensure supply reliability (GEC, 2012).

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Growing demand and widespread awareness and acceptance of LPG as a clean cooking fuel by the Ghanaian household and commercial sectors is a major strength but there are also considerable challenges. The National Energy Policy of 2010 indicates that the Government intends to increase the use of LPG by households as main cooking fuel to 50% of the population by 2015. The Energy Sector Strategy and Development Plan 2010, indicates that this will be achieved through the development of LPG infrastructure and pricing incentives to encourage distributors to expand their operations to especially the rural and deprived areas. However, GEC had to revise the projection of access of households to LPG because 50% of households' use of LPG was not achievable by 2015 and the more realistic target for that year would be 18%, therefore households access to LPG in 2020 would be about 24%. However, with some comprehensive interventions 50% households' access to LPG may be achievable in 2020 (Energy Commission, 2012).

In the Energy Sector Strategy and Development Plan, Government spelt out its intention to implement the following measures to support and accelerate the supply and use of LPG:

1) Speed up the establishment of a Natural Gas Processing Plant to produce LPG from the associated gas to be produced from the Jubilee Oil and Gas Field.
2) Re-capitalise Ghana Cylinder Manufacturing Company (GCMC) to expand production capacity with the production of cylinders focused on small sized cylinders that will be portable and affordable to households in rural communities.
3) Construct LPG storage and supply infrastructure in all regional and district capitals in the long term, and to develop district capital LPG infrastructure in the medium term

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4) Increase the marketers/distribution margin on a sustainable and predictable manner for LPG.

These measures remain largely unimplemented with the exception of the first one where the Ghana National Gas Company (Ghana Gas) has been established to build and operate a Natural Gas Processing Plant in the Western Region (GEC, 2012). Again, The Rural Promotion Program began in November 2013 to facilitate access by providing households with 6kg LPG cylinders, stoves and accessories. The Ministry of Petroleum implemented this program and in 2016, 25,690 households were catered for (Global LPG Partnership, 2018). Now, considering the important role of energy in the economic lives of households, there is the need to undertake a study that focuses on household energy consumption patterns and the factors which influence households cooking energy choices.

1.2 Problem Statement

In Ghana, energy consumption pattern which is similar to most developing countries exceeds the available supply. A key challenge to Ghana‘s energy sector is inadequate access to modern and clean energy services such as liquefied petroleum gas (LPG) and hydro/solar-based electricity. It is estimated that almost 50% of Ghana‘s population do not have access to grid-electricity and that about 90% of those who do not have access to LPG for cooking rely on biomass (i.e. firewood and charcoal) as alternatives (Kemausuor et al., 2011). A survey conducted by the Ghana Statistical Service in 2013 shows that 22.3% of households use LPG as primary cooking fuel. The overreliance on biomass as a key energy source by Ghanaian households is among the main drivers of the rapid depletion of Ghana‘s forest cover which stands at about 2% loss per annum (GSS, 2012).

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In recognition of the adverse impact of continued use of primary energy sources such as biomass on health and climate change that the Government of Ghana initiated the National LPG Promotion Policy in 2014 with the goal of ensuring that at least 50% of Ghanaians have access to safe and environmentally friendly LPG for cooking (domestic and commercial) and increased industrial usage by 2020. Unfortunately, as at 2018, about 24.5% of the Ghanaian population were using LPG as cooking fuel whiles more than twice that percentage were still relying on wood fuels, kerosene and so on (Global LPG Partnership, 2018). Hence, there the need to investigate and investigate the reasons that make households opt for other sources of energy instead of LPG and the factors that influence households‘ expenditure on LPG.

Obviously, there are many studies on this issue. An example is a study conducted by Adusah-Poku and Takeuchi (2019), this study used GLSS6 data and employed the double hurdle model to look at factors that affect participation and expenditure decisions in the LPG and charcoal market. This study did not look at the other sources of fuel such as wood, electricity, kerosene and many more. In addition, GSS has embarked on a new research collecting data on households for the seventh round (GLSS7) and hence may have some new insights into factors that affect choice of cooking fuel in the country hence the need to make some investigations using the new data acquired. Furthermore, aside looking at the whole country, it is also better to consider some prominent areas of the country singularly and there is the need to introduce some factors such as affordability, accessibility and sensitization in analyzing LPG participation decision. This current study seeks to handle all these shortcomings.

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1.3 Research Objectives

The general objective of the study is to analyse the determinants of household choice of cooking energy in Ghana and the factors that influence households' expenditure on LPG.

Specifically, the study seeks to;

i. Examine the socio-economic determinants of cooking energy choice among households in Ghana.
ii. Examine whether the choice for cooking energy is mainly subject to the impact of changes in the income of households as portrayed in the energy ladder theory.
iii. Examine the factors that influence LPG usage and expenditure levels among households.

1.4 Research Questions

i. What socio-economic factors influence the choice of cooking energy among households in Ghana?
ii. How applicable is the energy ladder theory in the Ghanaian context?
iii. What factors explain households' decision to use LPG and expenditure levels?

1.5 Significance of the Study

Researchers have been exploring various dimensions of household energy use in order to design and implement strategies to provide secure access to energy services, facilitate the transition to modern fuels, wipe out energy poverty, address environmental concerns and fix greenhouse gas emissions source. In order to achieve development through energy; we require better knowledge of factors that influence households decision related to their energy choice and expenditure for cooking.

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As this study seeks to examine the factors that influence household energy choice for cooking, it would provide useful findings that can guide the design and implementation of more effective strategies to boost the use of clean and efficient energy sources among households in Ghana.

In addition, since studies on household energy consumption are limited in Ghana, the present study will contribute to literature on energy choice and expenditure by providing a comprehensive analysis of household energy choice and expenditure in Ghana.

Furthermore, as the country strives to ensure that 50 percent of households in the country use LPG as the main cooking energy by 2020 GEC (2012), findings of this study would be important in achieving this goal. The reason being that, after achieving all the objectives for this study, the researcher can inform literature on factors that influence households' decision to opt for other sources of cooking fuel instead of LPG and make some policy recommendations.

1.6 Scope of the Study

For the purpose of this study, the subject matter is assessment of the factors that influence household energy choice for cooking and expenditure on LPG.

The study employs the seventh round of the Ghana Living Standards Survey (GLSS7), a nationwide household survey designed to generate information on living conditions in the country. The GLSS7 collected detailed information from households, including their demographic characteristics, education, health, employment and time use, migration and tourism, housing conditions, household agriculture, and access to financial services and asset ownership. The survey also

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collected information on households‘ perception of governance, peace and security in the country.

The study also employs primary data, which covers the capital town of the Bono East region, Techiman to be precise. Techiman was considered appropriate because, the main source of fuel for cooking is charcoal, which is used by 46.9 percent of households, wood is the second most used cooking fuel accounting for 32.7 percent and LPG is used by 10.6 percent of households (GSS, 2014).

1.7 Organization of the Study

This thesis is divided into five chapters. The first chapter, consists of background of the study followed by the problem statement, objectives of the study, the research questions, significance of the study and organisation of the study. The second chapter involves review of relevant literature both theoretical and empirical while the third chapter presents the research methodology. It entails, the study area, study design, sources of data, target population, sample size, sampling procedure and data collection techniques. The chapter also discusses data processing and analysis methods. The fourth chapter deals with data presentation and analysis. The final chapter presents with the summary of findings, conclusions, recommendation, limitations of the study and suggestions for further research.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Introduction

In order to have a fair idea on theories and empirical evidence relating to household energy choice and expenditure, there is the need to review existing literature. This chapter reviewed both theoretical and empirical literature on energy choice and expenditure.

2.1 Theoretical Literature

This study reviewed three theories that explain energy transition and expenditure among households. These theories are: energy ladder theory, energy stacking theory and the two stage budgeting theory.

2.1.1 The energy ladder theory

The idea of the energy ladder started to emerge in parallel to the fuel-wood crisis in the 1970s-1980s (Toole, 2015). The energy ladder theory shows a hierarchical relationship between households‘ rise in economic status and the various choice of energy sources used in cooking and heating.

The energy ladder model assumes households to impersonate the behaviour of a utility maximising neoclassical consumer, which implies that they will move to more sophisticated energy carriers as their income increases, maximizing their utility (Hosier & Dowd, 1987). Fuel switching is a central concept in the energy transition process, referring to the displacement of one fuel by another. A move up to a new fuel is simultaneously a move away from the fuel used before (Heltberg, 2005). The fuels on the energy ladder are ordered according to households preferences based on

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physical characteristics, including cleanliness, ease of use, cooking speed, and efficiency (Hiemstra-van der Horst & Hovorka, 2008). According to consumer theory, when a household's income increases, that household tend to purchase more superior goods than inferior goods since superior goods have a positive relationship with income whereas inferior goods have a negative relationship. Following from the above, energy researchers then linked consumer economic theory with energy, emphasising that households act as if they were consumers, who try to maximize their energy utilities according to their economic status. Therefore, when a household income rises, that household begins to consume different types of energy that are located in the higher-ranked rungs of the ladder.

Higher ranked fuels are usually more efficient and costly, but require less input of labour and produce less pollution per unit of fuel (Masera, Saatkamp & Kammen, 2000). The energy ladder also assumes that more expensive technologies are locally and internationally perceived to signify higher status. Families desire to move up the energy ladder not just to achieve greater fuel efficiency or less direct pollution exposure but also to demonstrate an increase in socioeconomic status (Masera *h*2000). The energy ladder model portrays wood as an inferior economic good, thus the fuel for the poor. This shows a strong correlation between income and fuel choice. Cross-country comparisons reveal a positive correlation between economic growth and modern fuel uptake, indicating that as a country progresses through the industrialization process, its reliance on petroleum and electricity increases and the importance of biomass decreases (Hosier & Dowd, 1987).

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Energy use patterns of the rich and poor are certainly not identical. The per capita modern fuel consumption among high-income households is far greater than that of low-income households (van der Kroon, Brouwer & Beukering, 2011),

There are various types of how the rungs of the ladder were divided and constructed in different literatures and theories.

For example, Hosier and Dowd (1987) presented a five-rung ladder, which is ordered ascendingly as follows;

1. Gathered fuelwood
2. Purchased fuelwood
3. Transition fuels
4. Kerosene
5. Electricity

Again, Reddy (1995) designed a six-rung ladder, representing the following ascending order;

1. Dung/waste.
2. Fuelwood.
3. Charcoal.
4. Kerosene.
5. LPG.
6. Electricity

In a more general sense, the fuel types occupying the ladder can be shown as; biomass → kerosene → LPG → electricity in ascending order.

According to the World Health Organization, over three billion people worldwide are at the lower rungs of the ladder, depending on biomass fuels, crop waste, dung, wood, leaves, and coal to meet their energy needs and a large number of such are in Africa

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and Asia. However, with a rise in income households are expected to switch to higher quality fuel choices. With increasing disposable income and changes in lifestyle, households tend to move from the cheapest and least convenient fuels (wood fuels) to more convenient and usually more expensive ones (Dzioubinski & Chipman, 1999). Moving up the ladder to higher quality fuel will among other benefits help decrease the air pollution within the household and subsequently translate to an improvement in the health of the household. This is because the reduction of air pollution within the household has the positive impact on the potential to have a direct effect on the respiratory system of the household. As such, there will be an increase in productivity with household adults missing fewer days of work and children missing fewer days of school (Kayode, 2016).

The energy ladder theory also implies that the differences in the pattern of energy use in households vary with their economic status. Each step of the ladder relates to different and more sophisticated energy carriers. This relates to the basic assumption of the energy ladder model in that it is inferred that households are faced with an arrangement of energy supply choices in order of increasing technological sophistication. Thus, households have a disposition of energy supply choices ranging from traditional fuels such as crop waste, dung waste, fuel wood to electricity. The step to which households climb up the ladder depends on household income and the level of substitution affected by the preferences of consumers for modern fuel.

The energy ladder theory is closely related with urbanisation and according to Montgomery (2008), urbanisation and its associated changes in energy use and consumption patterns are a dominant force for land use change. The shift from rural to urban areas is generally accompanied by reduced reliance on traditional energy sources.

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There are three steps in the energy ladder model;

1. The general reliance on biomass in the form of wood, dung and agricultural residues.
2. The use of transition fuels for instance switching to fuels such as kerosene and coal.
3. The third phase is the adoption of fuels such as LPG, natural gas, electricity or other ‗clean' sources of energy (Heltberg, 2004).

Households at lower levels of income and development tend to be at the lower rungs of the energy ladder, using fuels that are cheap and locally available but not very clean nor efficient (Hosier and Dowd, 1987). According to van der Kroon et al., (2011), at the macro level, energy consumption increases with development and accompanies higher reliance on modern fuels. Cross-country comparisons also reveal a positive correlation between economic growth and modern fuel uptake, suggesting that as a country progresses through the industrialisation process, its reliance on petroleum and electricity increases and the importance of biomass decreases (Kroon et al., 2011). More so, other factors that may influence the choice of fuels in households have been considered, given that income alone is not sufficient to determine the household consumption of a particular energy type (Heltberg, 2003). The choice of fuel for a particular use will depend on other issues not only on the price of the fuel or the income of the household but also on the availability of the fuel and the prices of the substitutes, the appliances and the efficiency of the fuel used.

As explained above the energy ladder theory is used to describe the way in which households will move up the ladder to more sophisticated fuels as their economic status improves. Empirical studies have also confirmed the relation between income and fuel choice (Gupta & Kohlin, 2006; Farsi, Filipini, & Pachauri, 2007).

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However, some empirical evidence suggests that the linkages between fuel choice and income level are rarely as strong as assumed by the energy ladder. Both Arnold et al (2006) and Cooke et al. (2008) cited in Kroon et al (2011) note that many estimated income elasticities of demand for fuel wood are insignificant, very low or even positive.

Studies in developing countries have shown that fuel wood can be an essential energy source for both urban and rural households at all levels of income (Brouwer & Falcon, 2004; Hiemstra-van der Horst & Hovorka, 2008). In the study carried out reassessing the energy ladder in household energy use in Maun, Botswana, Hiemstra-van der Horst and Hovorka (2008), it was shown that consumers do not follow the energy ladder model. They do not simply switch from one fuel to another as their income improves. Instead, they use multiple energy sources because the different fuels that they use are not completely inter–substitutable. In fact, the results of the survey indicated that despite the nearly universal use of commercial alternatives, fuelwood was chosen by households across the income spectrum as a strategic energy source important for particular applications.

According to Leach (1992), the energy ladder theory is strongly dependent on urban size and, within cities, on household income, since the main constraints on the transition are poor access to modern fuels and the high cost of appliances for using them. The energy ladder theory portrays wood as an inferior economic good, suggesting that it is a fuel for households with a lower income. Thus implying a strong correlation between income and fuel choice.

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A study conducted by Hosier and Dowd (1987) on energy ladder hypothesis in Zimbabwe, using the Multinomial Logit model discovered that contrary to the assumptions of energy ladder, households do not move away from the lower rung of the energy ladder to a sophisticated form of energy as their economic status improves. Rather, a large number of other factors such as the particular household characteristics and environment are important in determining household fuel choice. In the Tanzanian cities of Dares Salaam and Mbeya, Hosier and Kipyonda (1993) found that neither fuelwood consumption nor the percentage of households using fuelwood varied significantly by income category.

A study conducted by Odihi (2003) on deforestation in Nigeria, observed that fuelwood was preferred over other energy forms by –all members of the different classes". He further noted that there were other factors such as availability, affordability and provision of alternative energy source that contributed to the decision of a consumer to shift to another form of energy and that such decision was not solely based on the income level.

Similarly, Campbell, Vermeulen, Mangono and Mabugu (2003), conducted two questionnaire surveys of fuel use by low-income households in four small towns in Zimbabwe and discovered that –even the poorest households used electricity if they had a connection" which, in some towns included –almost 100 per cent of households in all income groups". They also established that fuel prices were not a significant variable in explaining households' choices of main fuel, but rather household incomes were significant. This means that the ability to afford fuels was not the sole reason for the difference in household choice across the income spectrum.

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Masera et al. (2000) used a four year data set obtained from a survey to evaluate the energy ladder model in a village in Mexico and noted a pattern of household accumulation of energy options. This is contrary to the "energy ladder" model that suggests that increasing affluence brings about a progression of consumers from traditional biomass fuels to more advanced and less polluting fuels. It was also pointed out from the study that families desire to move up the energy ladder was not just to achieve greater fuel efficiency or less direct pollution exposure, but also to demonstrate an increase in socioeconomic status".

Farsi, Filippini, and Pachauri (2007), in modelling fuel choices and patterns of cooking fuel use in urban Indian households showed that although insufficient income is one of the main factors that deters households from using cleaner fuels, several socio-demographic factors such as education and sex of the head of the household are also important in determining household fuel choice. However, the above-described observations indicate that the characterization of wood energy as the "fuel of the poor" is an oversimplification (Hiemstra-van der Horst & Hovorka, 2008). It also indicates that a broader spectrum of influential factors besides income should be considered.

2.1.1.1 Evaluation of the energy ladder theory

The energy ladder theory although noted mainly for its ability to explain the income dependency of fuel choices, has been criticised as being insufficient to represent actual energy consumption dynamics (Foster, 2000). This is due to the complexities of switching process as economic aspects are linked with social and cultural issues. Below are certain assumptions the energy ladder theory is based on;

1. Economic factors determine energy consumption;
2. Unidirectional movement in energy consumption;

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3. Linear progression of energy consumption;
4. Movement due to improvement in the economic status;
5. Energy consumption depends on fuel preferences.

From the first assumption, economic factors such as income is used to determine and influence the consumption of energy and although the energy ladder theory suggests that consumption of modern fuels are caused by increase in incomes, other factors such as social and cultural factors may also influence consumers‘ behaviour pattern. From the second assumption, the theory also assumes that the movement to different forms of energy is unidirectional and that it is usually as a result of improved economic circumstances.

The process in energy ladder model should be seen as a process resulting from the interaction of various factors that tend to pull households towards the use of modern fuel and away from biofuel (Masera *et al.,* 2000). It is possible though for there to be a downward movement on the ladder if for instance there is an increase in the cost of the sophisticated fuel or if there is a drop in the household income. The model portrays linear progression of energy consumption, which shows the dynamics of energy consumption as a simple linear progression from inferior fuels like crop residue to sophisticated fuel like LPG.

This is not usually the case in a developing country, as households tend to use several forms of energy at the same time depending on a number of factors. For example, they can use electricity for lighting and charcoal for cooking family meals. Findings by Masera et al (2000) on a study done in Mexico confirms that energy consumption for most households will involve the partial adoption of several fuels at the same time

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and consumers will not necessarily choose a fuel in order to completely abandon the previous one used.

Barnes and Floor (1996) stated that the model leaves little room for multiple fuel use. Meanwhile, such behaviour aids the families to avail the benefit of the different energy fuels at their disposal. The energy ladder model also assumes that the same path is used for going up and down the ladder. This indicates that movement by households or societies to better fuels is due to improving economic circumstances and the ability to purchase the appliances that can be used which may be costly financially. Chambwera (2004) established that the energy ladder model assumes that, although households behave in a manner consistent with neoclassical theory of consumer behaviour, the model is flawed as in the assumption that households move to more sophisticated energy carriers as incomes increase without being specific on the status of abandoned fuels. The final assumption is that, energy consumption depends on fuel preferences. Thus, consumers are assumed to regard some fuels better than others and this is seen as they move up the energy ladder. On the contrary, households tend to keep fuels for preferred uses and at the same time continue to use other fuels. This enables the spread of risk that may be associated with the one form of energy in terms of its availability, reliability and costs.

The energy ladder model has a strong emphasis on the role of income in determining the choice of fuel and hypotheses that as households gain socio-economic status, they tend to move away from technologies that are cheaper and start using modern technologies (Masera et al., 2000). As indicated above, the energy ladder theory relies on the microeconomic theory of rational choice. It assumes that all forms of fuel (traditional to modern) are available, that there is a universal set of fuel preferences,

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and that households will choose to move up the ladder as soon as they can afford to do so.

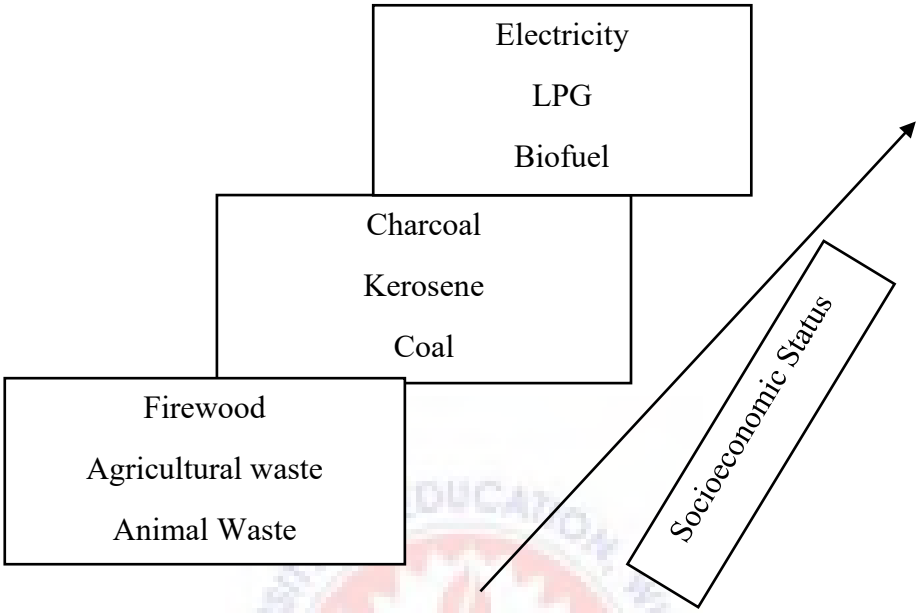

Figure 1: Energy ladder model

Source: Authors compilation

2.1.2 Energy stacking theory

The energy ladder theory has not been able to account for the fact that households may be using several fuels but in different proportions at any point in time. Several studies concerning households‘ choice for cooking fuels conducted throughout the globe have disproved its applicability claiming that the observed behaviour of households of the developing economies conforms to fuel stacking rather than fuel switching as postulated by the energy ladder model (Sengupta, 2013 cited in Kayode, 2016).

According to the ‗Fuel-Stacking‘ theory, with increasing income, households do not fully switch to different fuel types, they rather use an energy mix, thus, households depend on multiple fuels in their energy-use, using higher proportions of superior

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fuels in mixture with inferiors ones. Other factors can affect the fuel-switching behaviour of households that the energy ladder hypothesis did not include.

Some of these factors include; price changes, preferences, taste, reliability of supply, cooking and consumption habits, availability of technology, education, household composition and further cultural or habitual factors (Mekonnen, Gebreegziabher, Kassie & Köln, 2009).

Therefore, many factors influence households in taking decisions on any kind of fuel switching. This process of switching does not happen as a series of simple disconnected steps but rather intertwined and connected. Accordingly, the fuel-switching process is not unidirectional, and households can both use fuels that are more advanced for certain purposes, in combination with more traditional ones for other purposes of the household.

The propensity though is for energy mix composition to change over the years due to the rate of demographic growth, changes in consumption behaviour and the rate of economic growth, which may result in changes in energy needs. Households also tend to use different fuels for various tasks. They do so in order to cater for periods when particular fuels are unavailable. Like in the case of the energy mix for a country, the energy mix for households will be dependent on a number of factors such as the availability of the different fuels, the price of the fuels, income of the household and characteristics of the household.

As disposable income is a constraint for most households in developing countries, it implies that the households will determine how much of its income will be spent on energy and will determine the amount to be spent on each of the fuels and likewise the quantity of such fuels. Households adopt new fuels and technologies that serve as

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partial, rather than perfect substitutes for more traditional ones as income increases (Elias & Victor, 2005 cited in Kroon et al., 2011). With increasing income, the household can afford to purchase a variety of appliances, each of which requires a specific energy source. This leads to a more diversified energy demand including modern energy sources. For basic energy needs households will continue to use biomass fuels and add fuels to accommodate the needs for their changing lifestyle (Hiemstra-van der Horst & Hovorka, 2008).

A growing body of empirical studies on household energy use show that energy transition does not occur as a series of simple, discrete steps; instead, multiple fuel use is more common (Karakezi & Majoro, 2002; Martins, 2005; Arnold et al., 2006 cited in Kroon et al., 2011).

Kebede, Bekele, and Kedir (2002) confirmed this by establishing that location of households in addition to income levels, the infrastructure in different urban centres, availability of fuels, climate and other characteristics that vary across the urban centres explain some of the variations in the energy demand of households and hence causing households to use multiple fuels. Thus, instead of moving up the ladder step by step as income rises, households choose different fuels. They may choose a combination of high-cost and low cost fuels, depending on their budgets, preferences, and needs (Mekonnen & Köhlin, 2009).

Soussan et al (1988) cited in Masera et al (2000) implied that the energy ladder model only provides a limited view of reality in households and that the issue of multiple fuel use constitutes the rule rather than the exception in many urban and rural areas of developing countries. Masera et al. (2000) also reported that households follow a multiple fuel approach or fuel stacking process as opposed to simple linear

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progression depicted in the energy ladder model. The composition of the energy mix depends on the availability of usable resources on its territory or the possibility of importing these, the extent and nature of energy needs to be met, the economic, social, environmental and geopolitical context and the political choices resulting from the above.

Couture, Garcia and Reynaud (2012) studied the profile of households in France with regards to wood as a potential source of energy. They modelled the use of wood as the main source of heating energy, combined with others (fuel, electricity, gas) or as a back-up energy source and discovered the choice of the energy mix by household determines the consumption level of each type of energy. The decision to use a certain type of energy is determined by other several factors including energy prices, income and some characteristics of households such as the profession of the head of the household.

Masera et al (2000) further suggest that there is no such thing as fuel switching, and propose a multiple fuel model. Instead of switching fuels, households choose to consume a portfolio of energy options at different points along the energy ladder. The fuel portfolio of households can represent a combination of fuels from both lower and upper levels of the ladder. They also found in their study that it is unusual for households to make a complete fuel switch from one technology to another; rather they begin to use an additional technology without abandoning the old one. For example, households in Jaracuaro in Mexico add cooking fuels such as LPG and stove types, but rarely abandon fuel wood completely.

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Davis (1998) cited in Kroon et al (2011) argues that fuel stacking is inherent to the poor's livelihood strategies. Irregular and variable income flows of households (derived from agricultural work or informal selling of goods) prohibit the regular consumption of modern energy. Therefore, specific budget strategies are applied in order to maximize fuel security. In addition, fuel-stacking behaviour is observed due to fuel supply problems (Masera et al., 2000). The supply of modern fuels fluctuates and the reliability of supply channels is low. Therefore, households must have one or two fuels that can be used as backups in the event that their primary fuels are temporarily unavailable (Hosier & Kipyonda, 1993). Again, fluctuations of commercial energy prices might make the preferred fuel temporarily unaffordable (Hosier & Kipyonda, 1993). Finally, culture and traditions also play a role in constraining a complete transition to modern fuels. Traditional methods of cooking are often rooted in local cultures preventing the use of modern fuels (Masera et al., 2000). Thus, multiple fuel use patterns in households are the result of complex interactions between economic, social and cultural factors (Masera et al., 2000: 2004). The inverted U shape found by Masera et al (2000: 2004) for the number of fuels used for cooking in urban areas implies that during the development process the uptake of modern fuels shows a fuel stacking pattern but at the top end several traditional fuels are displaced indicating fuel switching. This may be an indication that fuel stacking is a transient phenomenon rather than a linear and continuous process.

There are different combinations of fuels that make up the total energy consumption of the various households and correspondingly, the energy mix model presents the different expenditure on the different fuels. This combination may change from time to time for the different households depending on the income and other determinants of energy. Thus, this model has the advantage of allowing consumption and

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expenditure of energy in real terms. The model also allows changes in energy consumption to be estimated if or when there are changes to household circumstances. This enables the estimation of demand for both total energy and individual fuels.

2.1.2.1 Assumptions for using energy stacking model

In using the energy mix model, the following assumptions are made:

1. All households use a combination of different fuels/ energy use equipment over a period of time.
2. Energy is a compound commodity and comprises the different sources of energy such as kerosene, liquefied petroleum gas, electricity and firewood.
3. Households also allocate part of their income or expenditure to energy and further decide on how much of this expenditure will be put towards the different sources of energy.

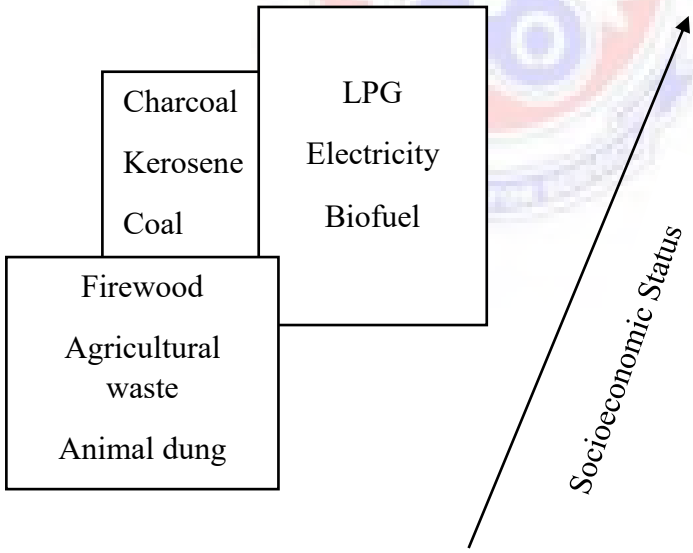

Figure 2: Energy stacking model

Source: Authors compilation

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2.1.3 Two stage budgeting theory

This theory maintains that households engage in a two-stage process in their consumption decisions. The first stage entails the allocation of income by households to various categories of goods such as food, clothing, energy, and others. In the second stage, with constraints imposed by income and other predisposing factors, households maximise utility with each category (Eakins, 2013). The priority of households in assigning any expenditure to the different energy sources combination is to ensure that they have maximum utility. A household expenditure may consist of three main categories namely: Food expenditure, clothing expenditure, shelter expenditure, energy expenditure and other goods. The energy expenditure is further broken into the expenditure associated with the different forms of energy: wood fuels, kerosene, LPG and electricity. Thus, households allocate total expenditure first to broad groups of goods, based on price index for each group and then further allocate expenditure within each of these groups based on group individual prices and group expenditures. By so doing, the household decision process is made easy since one broad cost allocation method can be considered at a time. Like other countries, energy consumption among households in Ghana follows the two-stage budgeting process in the sense that residential energy consumers in the country constantly have to take economic decisions to allocate their family budget between both segments of energy and non-energy goods, without necessarily being conscious of this theoretical process. Therefore, this study will rely on the two-stage budgeting model proposed by Baker, Blundell and Micklewright (1989) who indicate that disaggregate fuel expenditures depend on relative fuel prices and other household level factors as well as weakly separable preferences between fuel and non-fuel goods. Unlike Baker et al., this study

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will however use income and other household factors due to the absence of reliable information on fuel prices in the dataset employed for the analysis.

2.1.3.1 Assumptions of the two stage budgeting theory

This theory maintains that households engage in a two-stage process in their consumption decisions.

- The first stage entails the allocation of income by households to various categories of goods such as food, clothing, energy, and others.
- In the second stage, with constraints imposed by income and other predisposing factors, households maximise utility with each category (Eakins, 2013).

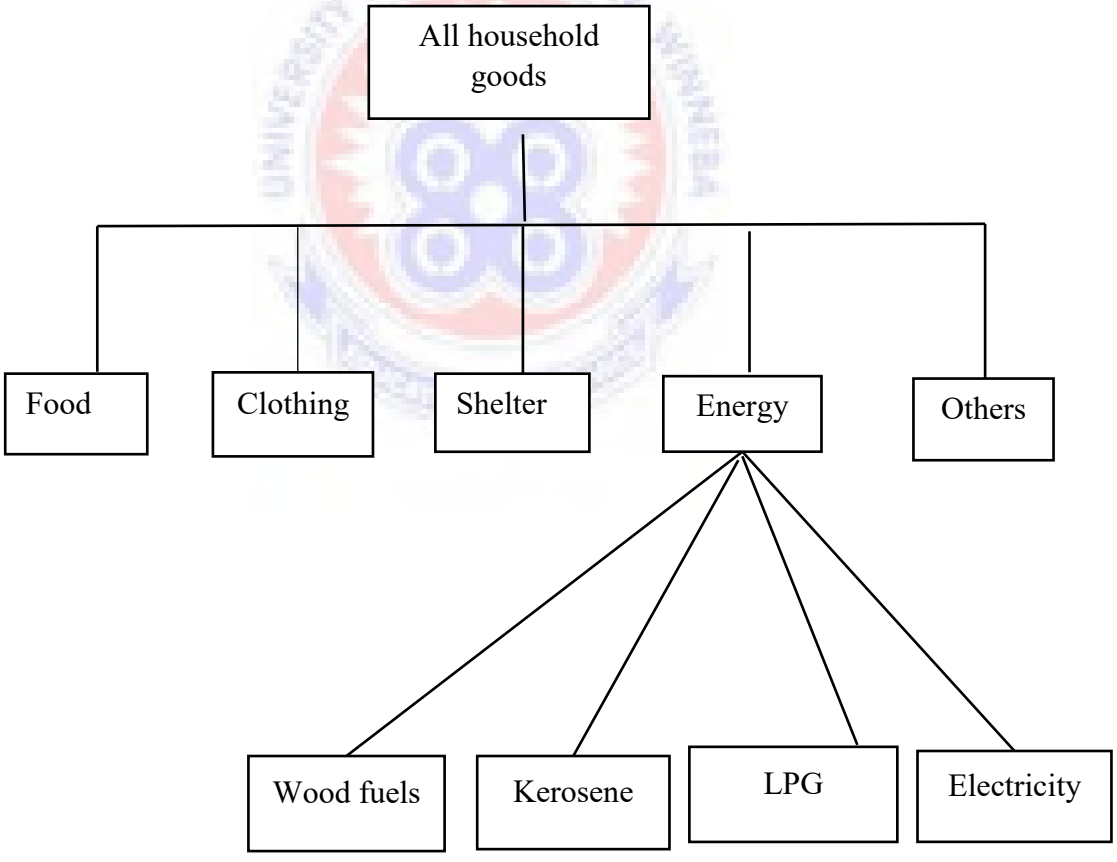

Figure 3: Two stage budgeting model

Source: Authors compilation

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With reference to the theoretical review above, the researcher adopted the energy ladder theory, energy tacking theory, the two stage budgeting theory and employed multinomial logit model to analyse factors that influence choice of cooking fuel in Ghana.

2.2 Empirical Literature

An analysis of the pattern and determinant of household energy choice, demand and consumption have been the focus of previous studies with different tools of econometric analysis, depending on the scope of the dimension of household energy covered by a study. Below are some empirical evidence using different econometric methods.

A study conducted by Lee (2013) which used Ordinary Least Square (OLS) regression to assess determinants of household electricity consumption. Variables like; temperature, electric water heater, electric clothes dryer, dish washer, number in house, family income, age of respondents, nature of employment, municipality of residence, expenditure per capita, private water connection, price of kerosene, age of household head, gas price, were found to be positively significant related to the household consumption of electricity. While factors such as; electricity price, temperature change, second and third quarter period of the year, pleasure of wood consumption, household perception of wood consumption, time when the dwelling was built, level of education of the household head, public water source and fire wood price were found to have a negative relationship with the amount of household consumption of electricity.

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Adetunji, Adesiyan and Sanusi (2007) investigated the pattern of energy consumption in Osogbo Local Government Area of Osun State, Nigeria. They used Ordinary Least Square regression method in the analysis. The empirical results showed that household income and size are statistically significant while household occupation, age and level of education are not statistically significant to consumption pattern.

Osiolo (2009) used the same OLS method to examine the determinants of fuel wood expenditure in Kenya. In his findings, only age of the household head and the level of the education of the household head had positive significant relationship with household fuel wood expenditure.

However, using OLS as a tool of analysis gives the study a very limited scope. OLS model will only permit analysing one source of household energy in a single model. In addition, with the use of OLS model, no estimation can be made for the determinants of household energy choice decision.

Some studies also used Multi-nomial Logit model to analyse household energy choice decision. The most frequent categories use by such studies for the dependent variables include; biomass fuel, kerosene, electricity and liquefied petroleum gas.

For instance, Song, Aguilar, Shifley, and Goerndt (2012) found variables such as; age of the household head, household size, number of years the house was built and area of residence (rural) to have a positive relationship with to use firewood consumption whiles high income had a negative relationship with firewood consumption in rural areas.

Couture, Garcia, and Reynaud (2012) indicated that income and age of household head have a negative relationship with wood consumption whiles dwelling ownership and household size have a positive relationship with wood consumption rather than

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non-wood consumption. This implies that, the higher the income of a household, the lower the probability of wood consumption and the older the household head, the lower the probability of wood consumption. In addition, households with larger sizes have a higher probability of consuming wood.

Furthermore, Laureti and Secondi (2012) found income, higher education level and dwelling ownership (owners) to have a positive relationship with the probability of choosing gas whereas year of dwelling construction had a negative effect on the probability of choosing gas. This shows that higher income households, households with higher education and dwelling owners are more likely to use gas.

Ouedraogo (2006) analysed household energy cooking preference in urban Ouagadougou, the capital city of Burkina Faso by using a multinomial logit model. He tried to identify different variables like household size, age, sex, level of education, marital status, religion, owning of refrigerator, electric meter, owning of dwelling, etc. for household energy demand. From his findings, family size and consumption of energy had positive relationship. Household with old age heads used more traditional energy than modern energy and households headed by females were more likely to use firewood than male-headed households were. Households with less educational level used more traditional energy than the modern ones. The households' heads that were married preferred to use firewood and kerosene than charcoal as compared to not married household heads. Since they require more alternative energy mixes for cooking and baking to feed their members. Besides, owning refrigerator had a negative impact on consumption of energy or cooking frequencies. Own electric meter also had a negative impact on consumption of other energy type except

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electricity and owning of dwelling had a positive affect the consumption of firewood than any others fuels.

In Cameroon, Njong and Johannes (2011) studied the domestic cooking energy choice. They employed multinomial logit model to investigate the social and demographical determinants of household cooking choice. Their results showed that, level of education, ownership of housing unit, nature of dwelling unit and distance of household from urban city are key factors that determine cooking fuel choice in Cameroon. The study also showed that firewood is the major cooking fuel in Cameroon.

Nnaji, Ukwueze, and Chukwu (2012) analysed the determinants of household energy choices for cooking in Enugu state, Nigeria. They used Multinomial logit model to identify the main determinants of energy for cooking as well as sociological and economic variables influencing major energy sources in the area. From their findings, households‘ total income, the level of education of women, age of women, occupation n of women and existence of internal cooking facilities were important factors that determine household cooking fuel choice.

Alem, Beyene, Köhlin and Mekonnen (2016) analysed households‘ fuel choice in urban Ethiopia by using random effect multinomial logit analysis. In their study, they used panel data and tried to categorize the energy sources in three types. Solid for biomass, clean for modern and mix for both types of energy. Several factors were considered for the choice of these different energy categories in urban households in Ethiopia. Among these, fuel prices were important determinant of fuel choice. As the price of firewood increased, the demand for solid and mixed fuels decreased. Thus, there is the tendency of households to shift to clean fuel sources, such as, electricity

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and kerosene, when firewood price rose. They also examined the higher per capita expenditure (which is a proxy for per capita income) with the consumption of that energy in its category and found that there was a positive association with considering energy ladder hypotheses. Furthermore, the level of household head education was a strong determinant for fuel switching. Households head with high education level have large probability of using clean fuel sources and small chance of using solid fuels such as firewood and charcoal.

Ogwumike, Ozughalu and Abiona (2014) studied the determinant of energy use in Nigeria. They employed multinomial logit model. The study grouped households by expenditure rather than income. The study revealed that, percentage of household using firewood in cooking declines as expenditure level increases while the percentage of households using kerosene as main source of cooking increases with rise in household expenditure level. Again, increase in the households' expenditure class, increases the percentage of household using LPG and electricity as main source of cooking.

Adeyemi and Adereleye (2016) examined the determinants of household choice of cooking energy in Ondo State, Nigeria. They employed Multinomial logit model for the analysis. Regarding the determinants, the study identified that income has a positive and significant influence on cooking energy choice. This shows that households‘ are more likely to move away from the use of firewood and switch to modern energy sources as income improves. Household size showed a negative influence for kerosene and gas, showing that the use of kerosene and gas declines with increase in the number of family members. The study revealed that, ownership of housing unit has a negative influence for both kerosene and gas, suggesting that

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owners of dwelling unit are less likely to switch to wood fuel alternatives. Education level was positively related to cooking energy choice for kerosene and gas. This indicates that education improves the awareness of the health hazards associated with use of firewood. Household with more education is more likely to switch to modern fuel sources.

Furthermore, Bello (2011) examined the impact of wealth distribution on energy consumption in Nigeria, a case study of Gombe state. He employed multinomial logit model and found that household income, household size and level of education determine the choice of energy consumption in Gombe state.

Mekonnen and Kohlin (2009) used multinomial logit model to analyse the determinants of household fuel choice in major cities in Ethiopia. From their findings, households in the urban areas had tendency to increase the number of fuels as their income rose instead of completely switching from consumption of traditional fuels such as firewood to modern ones such as kerosene and electricity. They found that households with old age heads were more likely to use firewood and kerosene than charcoal and electricity. Households headed by females were more likely to use firewood than charcoal while charcoal consumption was higher in male-headed households. They also tried to link the level of education with using of energy and found that the household heads with the high level of education in secondary or post-secondary schools had high probability of consuming clean fuels (kerosene and electricity) than firewood and charcoal. The differences in conclusions arrived by these studies can be attributed to the fact that they were carried out in different environment using different data. This shows that energy consumption behaviour of

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households varies from one region to another and not all factors are equally important in determining energy consumption in different areas and regions.

In addition, Karimov and Nlom (2014), Eakins (2013) and Mensah and Adu (2013) used ordered logit/probit models to examine the factors that influence household energy choice to cleaner source. Variables such as; income, firewood price, education level of household head, share of dwelling with other people, urban household, access to Liquefied Petroleum Gas (LPG) were found to have a positive relationship with the probability of adopting more cleaner energy. While other variables, such as; electricity price, price of kerosene, age of the household head, household size, gender (male) of the household head, and access to fire wood, have negative effect on the probability of the use of clean and efficient fuels.

The major limitation of these studies is that they are based on the assumption that the various household energy choice categories are in an ordered ranking manner, whereby in real life situation, the various categories are not an ordered based choice.

Kojima, Bacon and Zhou (2011) examined the factors influencing household decisions to use LPG and the quantity consumed per person in six developing countries (Guatemala, India, Indonesia, Kenya, Pakistan and Sri Lanka). The significance of household characteristics such as urban residence and household size differs from country to country. They find household expenditure and LPG price to be positively and negatively related to the quantity of LPG consumption respectively.

Leach (1992) analysed household energy demand in different South Asian countries like Indonesia, Malaysia, Sri Lanka and Colombo and India. The finding of his study indicated that the price of LPG was relatively expensive compared to kerosene and it was the second most important factor after equipment cost. Other factors like family

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size, local cooking practices were affecting the energy consumption. This study also examined the speed and extent of fuel switching along the energy ladder models with estimating several factors like physical access, equipment costs, income and relative fuel prices. The findings indicated that, the appliance cost hindered households from switching upwards to modern energy. For example, in Sri Lanka and Colombo, the LPG appliance cost equal to at least one month‘s income for 70% of households and three months‘ income for poorest households.

Hyde, and Kholin (2000) conducted a comprehensive study on the effect of own price of firewood in rural Indian household energy demand. Their work indicated that demand for firewood was negatively related to own price. They also examined the income elasticity of fuel, households‘ consumption pattern and demand for energy in urban areas. They found that, income, family size, education and level of urbanization had positive impact on the uses of firewood. According to them, the households that owned refrigerator consumed less energy (firewood, charcoal, kerosene and LPG) than the household without refrigerator did. The reason behind less consumption of fuels was less cooking frequency due to preserved cooked food in refrigerator for long time.

Kebede, Bekele and Kedir (2002) conducted a study to examine the demand of modern fuels (electricity, LPG and Kerosene) by the urban poor in Ethiopia. They analysed different factors that affected energy demand. They estimated the price and income elasticity of energy by a multivariate analysis. The factors included the budget share of each fuel, price of fuels and household size. From their finding, all fuels had positive income elasticity and the price elasticity of each fuel was negative. They also found that, poor households generally spent more money for energy than rich

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households did and the high-energy costs had a large budgetary implication for the poor, the study also indicated that, the non-poor households spent relatively more on modern energy as compared to traditional energy sources than the poor did.

Energy Sector Management Assistance Program (ESMAP, 2003) studied the Latin American household energy demand. The study found that, energy price, household income and family size affect energy demand in urban areas of Guatemala and Brazil. From their findings, poor households used different fuels simultaneously as their income rose. Households also adopted the multiple fuel strategy for different reasons. First, households often have invested significant capital in traditional technologies (e.g. fire wood burning stoves) and could not have the extra capital to buy new energy appliances, immediately after gaining access to new energy sources. Secondly, modern energy sources were expensive and applied carefully for unique services such as radio, television, refrigerator and many more.

Heltberg (2003) analyzed the household energy demand in eight developing countries (Brazil, Ghana, Guatemala, Indian, Nepal, Nicaragua South Africa and Vietnam,). The researcher found that own price of fuel inversely affected the energy demand (the higher the price of fuel, the lower the demand and vice versa). Income had a positive impact on household fuel switching in the energy ladder. There are large important differences between countries in the cooking fuel mix, between solid and non-solid and within the group of solid fuels. Non-solid fuels were normal goods in these countries households and firewood, animal dung and straw were inferior fuels.

Shittu, Idowu and Otunaiya (2004) studied energy demand among households in Ijebu - Ogun state Nigeria. Ninety households were selected across the six communities and linear logit model was used for the analysis. The study revealed that,

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household income and age of household head have significant influence in determining energy demand while household size and level of education were not significant. The effect of income was positive for kerosene, cooking gas and electricity except firewood. In other words, rise in income increases the demand for a better energy source other than firewood.

Chambwera (2004) conducted research on economic analysis of urban firewood demand in Harare, Zimbabwe. The researcher investigated the demand for energy with energy mix model. He used a multi-stage budgeting approach to estimate the proportion of total household expenditure for energy, food and other goods in the first stage and then estimated proportion of energy budget spent on each types of fuel in the second stage. He considered the Almost Ideal Demand System (AIDS) model for energy demand estimation and used the Probit model to test energy choices of households by classifying them as un-electrified and electrified households. For all households (electrified and un- electrified), total energy expenditure increased proportionally with the increase of total household expenditure. Again, household size, energy appliances owned, price of fuels, income, the number of rooms used by the household and education level of household head were the main determinant factors of energy demand. The study also found that, high level of family head education had a positive impact on using of more modern energy sources than traditional energy ones. The households with large family members used more kinds of fuel.

Gebreegziabher (2007) researched household fuel consumption and resources use in rural –urban Ethiopia in Tigray region. Using the appropriate functional form of energy demand and handled zero expenditure (problem of censored data) by

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employing Heckman‘s two-step estimation. From his findings, electricity and firewood, kerosene and charcoal were substitutes‘ fuels and all fuel types were price inelastic. While, electricity was found to be luxurious (i.e. with expenditure elasticity of greater than one), other energy goods were necessity goods. Family size, age and education of family head were important variables in the household‘s decision to consume a particular energy sources, but the relative importance of each factors varied from one fuel to another.

Gamtessa (2003) examined the energy demand for urban Ethiopia and found that price, income level and availability of different fuel types were the major factors to determine the consumption patterns of urban households. According to him, household size had positive effect on energy demand and it is more pronounced in the use of traditional energy sources. He used the multivariate probit model analysis to estimate the probability of choosing modern and traditional energy sources. From his findings, as household income increases, the probability of choosing modern fuel also rises than the traditional fuel. From the findings, the price elasticity of charcoal, firewood and kerosene consumption were all price elastic.

Onyekuru and Eboh (2011) studied the determinants of cooking energy demand in the rural area of Enugu state. They employed bivariate probit model. The variables included in the study were, household size, occupation, income and level of education of the household heads. The result revealed that, household occupation and level of education have negative relationship with the use of firewood. This implies that educated household head and household with better-paid occupation use less of firewood. The result showed that household income and occupation are positive and statistically significant in determining the choice of cooking energy for kerosene. This

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indicates that households with better-paid jobs in the rural area and higher income households are more likely to switch to more expensive kerosene use.

Getamesay (2011) examined determinants of kerosene and LPG demand in Ethiopia using time series data. Real price of kerosene, real price of LPG, real per capita income and real foreign exchange earnings were found to be significantly affecting demand for kerosene and real price of LPG, real price of kerosene, population growth, level of urbanization and real foreign exchange earnings were the major determinants of demand for LPG. Price elasticity of LPG was inelastic while kerosene was price elastic. The cross price elasticity of LPG and kerosene was positive, then, LPG was substitute fuel for kerosene. The study found the existence of one unique co-integration relation between kerosene and LPG.

Nyembe (2011) using econometric analysis analysed factors determining charcoal consumption by urban households in Zambia. He found that, households with older heads were more likely to use charcoal than electricity. Households headed by females were more likely to use charcoal than electricity consumption. He also linked the level of education and energy types used and found that household head with high education level had higher probability of consuming clean fuel (electricity) than charcoal.

From the findings, household size had a positive effect on charcoal demand. Again, the income elasticity of charcoal and electricity was +0.395. His findings indicated that both energies were necessity goods for urban Zambian households. He also found that households with refrigerator had less consumption of charcoal and electricity than that of households without refrigerators.

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From the above literature, not all factors have equal importance in determining the pattern and behaviour of household energy consumption for different areas due to differences in socio-economic settings, environmental factors, and cultural factors as well as the average level of development in the area. This has led to the arrival of different and inconsistent conclusions in the literature of household energy consumption behavior by researchers. The explanatory variables consistent in the review above in analysing household energy choice decision include; income, prices, demographic factors, household characteristics and energy supply factors.

Previous studies on choice of energy

An analysis of the pattern and determinant of household energy choice, demand and consumption have been the focus of previous studies with different tools of econometric analysis, depending on the scope of the dimension of household energy covered by a study.

Several empirical studies have established the importance of socioeconomic factors, demographic factors, household characteristics and energy supply factors in determining households‘ energy consumption (Hosier and Dowd, 1987; Ouedraogo, 2006; Edwards & Langpap, 2005; Gupta & Kohlin 2006; Nnaji, Ukwenze & Chukwu, 2012; Karimove & Nlom, 2014).

Previous research tends to focus on socioeconomic factors that show obvious differences in households' energy preferences. Some of these factors include; income, employment status and education status of household heads. Effect of income on fuel use is investigated in most studies.

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Most authors specify income as a measure of household earnings but sometimes, households‘ expenditure and wealth are used as proxy for income. Most studies indicate income as the main driver behind the use of modern fuels. For instance, Hosier and Dowd (1987) find that urban households in Zimbabwe tend to move away from wood towards kerosene and electricity as their income rises. Similary, Ouedraogo (2006) observes that, in Burkina Faso, a higher income makes urban households to choose natural gas over kerosene.

Also, in rural Nigeria, Baiyegunhi and Hassan (2014) find that the transition from fuelwood to kerosene, natural gas and electricity occurs along with rising income. When Gupta and Kohlin (2006) used expenditure as proxy for income, they find that in urban India some evidence for an energy transition from fuelwood and kerosene to LPG (Light Petroleum Gas) was largely driven by expenditure levels.

In addition, Lay, Ondraczek and Stoever (2013) show that rising expenditure influences households to choose electricity and solar energy over wood and kerosene. Again, Demurger and Fournier (2011) provide evidence showing that, Chinese rural households respond to rising wealth by substituting coal for firewood.

Moreover, Farsi and Filippini (2007) applied an ordered discrete choice framework to model fuel choices and patterns of cooking fuel use in urban households. The study showed that lack of sufficient income was one of the main factors that retarded households from using cleaner fuels.

A similar study by Vassileva (2012) on characterization of household energy consumption in Sweden established that income is among the factors that influence consumption the most. Also, Adetunji, Adesiyan and Sanusi (2007) investigated the

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pattern of energy consumption in Osogbo Local Government Area of Osun State, Nigeria. The empirical results showed that household income is a significant factor in determining energy consumption.

However, Song, Francisco, Stephen and Michael (2012) indicated that high income had a negative relationship with firewood consumption in rural areas. A similar results by Couture, Garcia and Reynaud (2012) indicated that income of household head have a negative relationship with wood consumption. Also, Laureti and Secondi (2012) found income to have a positive relationship with the probability of choosing gas.

More so, Nnaji et al. (2012) analysed the determinants of household energy choices for cooking in Enugu state, Nigeria. They used Multinomial logit model to identify the main determinants of energy for cooking. From their findings, households‘ total income was an important factor that determine household cooking fuel choice.

Again, Ogwumike, Ozughalu and Abiona (2014) studied the determinant of energy use in Nigeria. Their findings revealed that, percentage of household using firewood for cooking declines as expenditure level increases while the percentage of households using kerosene, LPG and electricity as main source of cooking increases with rise in household expenditure level. Adeyemi and Adereleye (2016) examined the determinants of household choice of cooking energy in Ondo State, Nigeria and established that, income has a positive and significant influence on cooking energy choice.

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Furthermore, Bello (2011) examined the impact of wealth distribution on energy consumption in Nigeria, a case study of Gombe state and found that household income determines the choice of energy consumption in Gombe state.

In addition, Karimov and Nlom (2014); Eakins (2013); Mensah and Adu (2013) used ordered logit/probit models to examine the factors that influence household energy choice of cleaner source. Income was found to have a positive relationship with the probability of adopting cleaner energy. More so, Mekonnen and Kohlin (2009) analysed the determinants of household fuel choice in major cities in Ethiopia. From their findings, households in the urban areas had tendency to increase the number of fuels as their income rose.

Heltberg (2003) analyzed the household energy demand in eight developing countries (Brazil, Ghana, Guatemala, Indian, Nepal, Nicaragua South Africa and Vietnam) and found that non-solid fuels were normal goods in these countries households and firewood, animal dung and straw were inferior fuels. A similar study by Shittu, Idowu and Otunaiya (2004) revealed that, household income has a significant influence in determining energy demand. The effect of income was positive for kerosene, cooking gas and electricity except firewood.

Again, Gamtessa (2003) examined the energy demand for urban Ethiopia and found that income level was major factor to determine the consumption patterns of urban households. From his findings, as household income increases, the probability of choosing modern fuel also rises than the traditional fuel.

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In addition, Onyekuru and Eboh (2011) studied the determinants of cooking energy demand in the rural area of Enugu state. The result showed that household income is positive and statistically significant in determining the choice of cooking energy for kerosene. This indicates that households with higher income are more likely to switch to more expensive kerosene use. Wambua (2011) on his study on household energy consumption and dependency on common pool forest found that poverty level is an important determinant of the type of fuel combination.

On the other hand, the emerging empirical evidence showing that the effect of income on fuelwood demand may at times be insignificant irrespective of how income is measured increasingly questions such a simple pattern of income dependence. Guta (2014), Baland, Libois and Mookherjee (2015, 2017) and Israel (2002), all report that in some contexts fuelwood is not an inferior good as we sometimes assume.

The employment status of the household head also plays an important role in household energy choice for cooking. For instance, Nnaji et al. (2012) established that occupation of household head (farming & trading) has a negative relationship with household decision to use charcoal rather than wood whiles Couture et al. (2012) established that farmers are less likely to opt for wood as compared to the other professions (laborer, entrepreneur and executives).

Adusah-Poku and Takeuchi (2019) also established a significant positive effect between employment status and participating in LPG market. In addition, Mekonnen (2012) established that, occupation of household head (businesspersons, farmers and civil servants) positively affected firewood and charcoal consumption.

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Özcan, Gülay, and Üçdoğruk (2013) indicated that the probability of using liquid fuel for all other occupation groups is higher as compared to those working in agriculture (animal husbandry, hunting, forestry and forestry).

Education level of household head has been found to be an important factor when it comes to households‘ fuel decision. For instance, Demurger and Fournier (2011) and Abebaw (2007) find education level of the household head to have a negative relationship with firewood consumption. Again, Baiyegunhi and Hassan (2014) and Gupta and Kohlin (2006) find in their study that, higher education level makes households to move away from firewood towards the use of kerosene in Nigeria and India respectively. In Ethiopia, Gebreegziabher, Mekonnen, Kassie and Kohlin (2012) finds that, the higher the education level, the less likely it is that the households will choose wood and the more likely that, the household will choose electricity. In Kenya, Lay et al (2013) shows that, a higher education level is associated with a higher probability of using electricity and solar energy and a lower probability of using wood and kerosene. Similarly, a study conducted in Nepal by Baland et al. (2015) finds that, increased education is associated with falling firewood collection. Again, Couture et al (2012) and Laureti and Secondi (2012) found that, education level of household heads has a negative relationship with firewood use and thereby encouraging the use of electricity and gas. In addition, Eakins (2013) and Mensah and Adu (2013) established that, education level of household head has a positive relationship with the probability of adopting cleaner energy. More so, Farsi and Filippini (2007) indicated that, education of household head is an important factor in determining household fuel choice. Additionally, Denis, Nwokoye, Urom and Ozor (2017) in their study revealed that, education level of household head is a significant determinant in the use of kerosene, LPG and electricity. Furthermore, Bekele, Negatu and Eshete (2015) also

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find that, education level of household head is an important factor in the decision to use a particular energy type. Education as a powerful determinant of fuel switching can be because of the fact that, more education implies a higher income and better education translates into greater awareness of the negative health impacts of dirty fuels and enhanced knowledge about the efficiency and convenience of modern fuels.

Some demographic factors consistent in literature and included in this study are; age, gender, area of residence and marital status. The age of household head plays a role in households‘ decision to use a particular fuel type. Even though the empirical findings remain contradictory.

Some studies find that age is positively related with preference for traditional fuels. Edwards andd Langpap (2005) show a positive and significant relation of household heads age with wood consumption in Guatemalan. Similarly, Das, Groote and Behera (2014) in their study show that, households with older heads prefer fuelwood to electricity in Bhutan. In addition, Baiyegunhi and Hassan (2014) finds that an increase in the age of the household head in rural Nigeria induces a shift away from natural gas to fuelwood. More so, Demurger and Fournier (2011) find that the household average age has a positive and significant impact on firewood consumption in rural households of northern China. A similar study by Song et al found age to have a positive relationship with wood consumption. However, Nnaji et al (2012) find that age of household head has a positive relationship with household decision to use charcoal. Furthermore, a study conducted by Karimov and Nlom (2014), Eakins (2013), Mensah and Adu (2013) found age of household head to have a negative effect on the probability of the use of clean and efficient fuels. On the other hand, some researchers find age to be positively related with the preference for modern

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fuels. Guta (2012) finds that older household heads are more likely to prefer modern fuels to traditional fuels in rural households in Ethiopia. Similarly, Gupta and Kohlin (2006) show that older household heads are more likely to prefer LNG (light natural gas) to wood. A study in Turkey conducted by Ozcan et al (2013) shows that older household heads are more likely to shift away from wood towards natural gas, liquid fuel and electricity. In addition, Farsi et al (2007) provide evidence showing that older household heads are more likely to prefer LNG to wood in Indian households. Other studies such as, An, Lupi, Liu, Linderman and Huang (2002); Abebaw (2007) and Israel (2002) claim that age is not significant when it comes to fuel use.

Gender of the head of household as a factor that determines the fuel choice of household is highly debatable.

There are studies that show that households headed by females prefer modern fuels to traditional fuels. This may be attributed to the fact that, females are normally responsible for cooking and for that matter are directly affected by the emissions of greenhouse gases from the use of unclean energy. Farsi et al (2007), Rao and Reddy (2007), and Das et al (2014) find that female headed households prefer modern fuels to traditional fuels. However, Abebaw (2007); An et al. (2002), and Ouedraogo (2006) challenge this finding because they find that, female household heads are more likely to use firewood.

More so, Link, Axinn and Chimire (2012) show that large proportions of female members influence households‘ decision to use fuelwood. This is because; women are the main gatherers of fuelwood. In contrast, Heltberg (2005) finds that, large proportions of females do not affect the use of fuelwood in Guatemala. Again, in urban Bolivia, Israel (2002) finds an association of a large female share of family

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earned income with low probability of using firewood. A study conducted by Gupta and Kohlin (2006) in India finds that, the number of women not working does not affect fuel use. Further, Karimov and Nlom (2014), Eakins (2013), and Mensah and Adu (2013) find that, gender (male) of household head have a negative effect on the probability of the use of clean and efficient fuels.

Some previous studies have shown that, the area of household residence plays an important role in households‘ decision to use a particular fuel type as indicated in previous studies. For instance, Wiedinmyer, Dickinson, Piedrahita, Kanyomse, Coffey, Hannigan, Alirigia and Oduro (2017) in their study established that rural households rely predominantly on wood, while urban households are more dependent on charcoal and, to a lesser extent, LPG. Also Song et al (2012) indicated that, rural households are more likely to choose wood rather than the other sources of fuel.

Additionally, Kayode (2016) established that, location of property has a significant effect in determining energy consumption among households. In addition, Dalaba, Alirigia, Mesenbring, Coffey, Brown, Hannigan and Dickinson (2018) established that urban households are more likely to use LPG as compared to rural households. More so, Farsi and Filippini (2007) indicated that, urban residents have a higher probability of choosing clean fuel. Furthermore, Mensah and Adu (2015) in their study established that, urban residents are more likely to use modern fuel. Moreover, Ozcan et al (2013) showed that, urban dwellers use liquid fuel more than those living in rural areas do. A study conducted by Denis et al. (2017) showed that rural households are less likely to use kerosene, electricity and gas as compared to firewood. Similarly, a study by Song et al. (2012) showed that rural households are more likely to use wood than urban households are.

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Marital status of household heads has proved significant in determining the choice of cooking fuel among households. For example, a study conducted by Ouedraogo (2006) showed that, married household heads prefer firewood and kerosene to charcoal as cooking fuel. Similarly, Nnaji et al. (2012) also established that, married household heads are less likely to use kerosene as compared to firewood as cooking fuel. Some household characteristics included in this study and predominant in existing literature include household size and dwelling characteristics. Household size has been recognized as an important determinant of energy choices.

Chambwera (2004), Bekele et al. (2015) and Zenebe (2007) showed that, household size is a major determinant of energy demand among households. Again, Chen, Heerink and Berg (2006) and Guta (2012) indicate a significant impact on household size on fuel transition. Studies conducted by Ouedraogo (2006), Ozcan et al (2013), Pandey and Chaubal (2011) and Rao and Reddy (2007) show that larger households prefer unclean fuels to clean fuels. Additionally, Gamtessa (2003) and Mekonnen (2012) indicated that, household size has a positive effect on traditional fuel use. More so, Bello (2011) established that household size has a negative relationship with modern fuel use. Again, Karimove and Nlom (2014), Eakins (2013) and Mensah and Adu (2013) find household size to have a negative effect on the probability of the use of clean and efficient fuels. Furthermore, Nnaji et al (2012), Song et al (2012) and Hyde, Kohlin, and Amacher (2000) find household size to have a positive relationship with the household decision to use firewood. On the contrary, Farsi and Filippini (2007), Baiyegunhi and Hassan (2014), Gupta and Kohlin (2006) and Hosier and Dowd (1987) find that households with more members are more likely to choose clean fuels. The varying conclusions arrived by these studies may be because they were carried out in different environment using different data.

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Some dwelling characteristics are sometimes included among the determinants of fuel choices. These include; the number of rooms, dwelling ownership, modern or traditional dwelling units and many more. These characteristics are often considered as proxies for a household's wealth and living conditions. Arthur, Zahran and Bucini (2010), Baiyegunhi and Hassan (2014) and Lay et al. (2013) find that, house owners are more likely to move towards cleaner fuels than tenants are. Contrary to this, Ouedraogo (2006) and Pundo and Fraser (2006) find that, tenants are more likely to move towards cleaner fuels than house owners are. Again Bekele et al (2015) finds that dwelling ownership is an important factor in the decision to use a particular energy type. In addition, Kayode (2106) finds that, ownership status of the property is relevant in determining the consumption of energy in the household.

In Nigeria, Baiyegunhi and Hassan (2014) observe that households living in traditional houses are less likely to choose natural gas and electricity over fuelwood. A study conducted in Guatemala by Heltberg (2005) shows an association between number of rooms with a switch away from wood towards LPG exclusively. In Mozambique, Arthur et al (2010) find that, the house size measured by the number of rooms is associated with the adoption of electricity. Empirical evidence shows that supply factors such as affordability, accessibility and reliability influence households' energy consumption.

Accessibility and availability also influence households' decision to use a particular fuel type. The availability of traditional fuels is measured by the distance to fuelwood (An et al., 2002; Heltberg, 2005; Kaul & Liu, 1992), perceptions of households of availability (Hosier & Dowd, 1987) and the geographic location (Peng, Hisham and Pan 2010). A study conducted in Zimbabwe by Hosier and Dowd (1987) finds that,

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households that do not have difficulties in collecting wood tend to use more wood. Other studies have reported availability and distance to LPG filling stations as factors that hinder LPG adoption and use (Oteh, Agwu, Nwaogu & Nto, 2015; Srinivasan & Carattini, 2016). Wiedinmyer et al (2017) indicated that, fuel availability is a stronger prediction for fuel choice. In Kenya, Lay et al (2013) finds that, improved access to electric power induces households to move away from wood and kerosene towards electricity. Karimov and Nlom (2014), Eakins (2013) and Mensah and Adu (2013) find that urban households' access to cleaner fuels like LPG has a positive relationship with the probability of adopting cleaner energy. In addition, Dalaba et al. (2018) in their study perceived affordability as the main barrier to LPG adoption. More so, Farsi et al. (2007) found that, accessibility has a positive effect on choosing LPG. Again, Rahnema, Sanchez, and Giordano (2017) established that affordability is very significant in predicting consumer fuel choices. Hiemstra-Van der Horst and Hovorka (2008) established that reliability of fuel distribution networks is an important factor in fuel choice pattern among households.

Previous studies on expenditure on energy

Some studies also examined the determinants of household energy expenditures. There are evidence of socioeconomic factors, household characteristics and demographic factors explaining energy expenditure patterns among households. For example, Kojima, Bacon and Zhou (2011) examined the factors influencing household decision on quantity of LPG consumed per person in six developing countries (Guatemala, India, Indonesia, Kenya, Pakistan and Sri Lanka). They found household expenditure and price to be positively and negatively related to the quantity of LPG consumption respectively. Additionally, Chambwera (2004) conducted research on economic analysis of urban firewood demand in Harare, Zimbabwe and

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established that total energy expenditure increased proportionally with the increase of total household expenditure. More so, Khandker, Shahider, Douglas and Hassan (2012) in their study find that, income is important in increasing energy expenditure among households in India especially among the poor society. Adusah-Poku and Takeuchi (2019) examined the factors affecting household energy expenditure in Ghana and found that, income, price of LPG, gender of household head, age of household head, area of residence, number of rooms, household size and level of education of household head play a significant role in rural and urban households' expenditures on LPG. In contrast, Alkon, Harish, and Urpelainen (2016) use nationally representative household data from India for 1987–2010 to reveal that increases in monthly energy spending have not been driven by increases in household income and that households are willing and able to spend on energy when modern fuels are available.

A study conducted by Longhi (2015) found that although socioeconomic characteristics have a moderate impact, dwelling characteristics, such as household size have considerably larger impacts on households' energy expenditure. Another study by Curtis and Pentecost (2015) established that, couple with children are more likely to spend on energy as compared to single working aged adults.

A study conducted by Adusah-Poku and Takeuchi (2019) is closely related to the current study, despite the difference in methodologies adopted. In contrast to Adusah-Poku and Takeuchi (2019), this study used GLSS7 data and employed the multinomial logit model to examine the factors that influence choice of cooking fuel among households in Ghana. In addition, this study made use of primary data collected from household heads in Techiman municipal and employed the double

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hurdle model to investigate factors that affect LPG participation and expenditure decisions. More so, this study included some factors such as affordability, accessibility and sensitization in analyzing LPG participation decision.

The above theoretical and empirical review influenced the researcher‘s decision to include socioeconomic, demographic, household and supply factors in this study.

2.3 Chapter Summary

This chapter reviewed reviewed literature under two themes, namely theoretical and empirical literature. Three theories that explain energy transition and expenditure among households were reviewed in this chapter. These theories are; energy ladder theory, energy stacking theory and the two stage budgeting theory.

Most studies have tended to focus on the determinants of household cooking fuel choice. These studies can be grouped mainly into research investigating (1) the determinants of household energy demand and energy choices (Heltberg, Arndt, & Sekhar, 2000; Chambwera & Folmer, 2007; Akpalu et al., 2011; Ouedraogo, 2006; Barnes et al., 2005), and (2) works exploring the validity of the energy ladder hypothesis (Hosier & Dowd, 1987; Bello, 2011; Farsi & Filippini, 2005). Most of these studies identify income, fuel prices, education, household size, and access to modern infrastructure as the key factors determining household choice in cooking fuel. On the other hand, some studies have attempted to examine the determinants of household energy expenditures. For example, Adusah-Poku and Takeuchi (2019) established a significant positive effect between employment, income, reliable LPG supply, education level, urban residency and access to electricity to be statistically significant in influencing the probability of a household participating in the LPG market and LPG expenditure once the decision to participate is made.

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CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter involves a discussion of the methods and techniques used in undertaking the study. It starts with a description of the study area, research design, sources of data, model specification and empirical models.

3.1 Research Design

A research design explains how data is collected, types of instruments used and the intended approach for analysing the data (Gravetter & Forzano, 2009). It is the general plan for implementing a research strategy (Pandey & Pandey, 2015). It stipulates what the study involves, whether it will be done in groups or individual subjects and specifies how many variables will be included in the study. This study implemented the cross sectional descriptive research design and adopted the quantitative approach in analyzing factors that affect choice of cooking fuel and expenditure on LPG. The adopted research design is cost effective as cross sectional design collects and compares of numerous variables such as socio-economic and demographic factors related to the study possible at a time (Pandey & Pandey, 2015).

For the purpose of this study, information on sources of cooking fuel was obtained from the GLSS7 data to analyse factors that affect choice of cooking fuel among households. Again, information on LPG expenditure was solicited from households in Techiman in the Bono East Region in order to analyse factors that affect participation and expenditure decisions.

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Quantitative approach was adopted in order to enable the use of numerical values in measuring variables for households that were subjected to statistical analysis and interpretation. The main objective of the study was to analyse factors that affect cooking fuel choice and expenditure on LPG. GLSS7 data was used to analyse factors that affect choice of cooking fuel in Ghana and data from the field was used to analyse factors influencing LPG participation and expenditure decisions in this study.

3.2 Theoretical Framework

The theoretical framework is established from the effect of income and other factors on household energy consumption base on the energy ladder theory and energy stacking theory.

The aim of these theories is to capture the intricacies that are involved with choices that households make in energy consumption taking into account the various socioeconomic factors that may affect such choices. Consumers‘ behaviour determine the combination of fuels that they use and the quantities of such fuels. The theoretical framework will help develop an understanding of consumers‘ behaviour about energy consumption in general and LPG in particular.

3.2.1 Concept of consumer preferences

The consumer theory is concerned with how a rational consumer would make consumption decisions. These decisions are based mainly on income constraints and the availability of the goods. In understanding the consumers‘ behaviour, the study is able to predict how changes occur to consumption of energy when there is a change to the consumers‘ social, economic environment. The underlying hypothesis is that a consumer chooses a vector of goods from a set of alternatives and does so in such a way that he maximises utility subject to his budget constraint. This consumer

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behaviour is presented in terms of preferences and possibilities. Under the consumer theory, the consumer is assumed rational and therefore in choosing the preferences is guided by some properties. In general, neoclassical economics from which the consumer theory is derived is basically an approach in which the economy is depicted as a collection of profit maximising firms and utility-maximising households interacting through perfectly competitive markets (Godwin, Harris, Nelson, Roach, and Torras, 2013 cited in Kayode, 2016). It focuses on the determination of prices, outputs, and income distributions in markets through supply and demand. This implies that neoclassical economics operates based on three main assumptions, which include the fact that people have rational preferences of outcomes that can be identified and associated with values; that whilst firms tend to maximise profits, consumers maximize utility and the fact that people act independently based on full and relevant information. The neoclassical approach regards the economy as a closed system and the theory assumes that only firms and consumers make up a system and that they interact in perfectly competitive markets where firms maximise their profits from producing and selling goods and services and consumers maximise their utility from consuming goods and services.

A utility function (max U = f(X, Y)) will exist where these characteristics are present in a consumer‘s preference ordering. Consumers behave to maximise utility, which implies that consumers will make choices between sets of goods that will satisfy their budget constraint and yet bring about maximum utility. The budget constraint is represented as below:

$$X = \sum_{I=1}^{n} piqi \qquad (1)$$

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Where the sum of the products of price (p) and quantities (q) must be equal to the total expenditure X. This budget constraint combined with the principles of consumer preferences results into the utility maximization problem.

Max U (q) will be subject to Σpiqi = X. We make piqi = X by assuming non satiation and exhaustion of the budget set (consumer spends all his income). First Order Conditions (FOCs) will be taken after setting the Lagrange.

Setting Lagrange

$$\begin{aligned} &\underset{q_i\lambda}{L} = U(q_{1,}q_2 - - - q_n) + \lambda\left[X - \sum p_i q_i\right] \\ &\frac{dL}{dq_i} = U_i - \lambda p_i = 0, i = 1,2 - - - n \\ &\frac{dL}{d\lambda} = X - \Sigma p_i q_i = 0 \end{aligned} \qquad (2)$$

Equation (2) is reduced to Marshallian demand function in which utility from consumption of a good or set of goods is maximised subject to expenditure and prices.

$$Q_i = q_i^m(xp_i) \qquad (3)$$

The parameters involved in equation (3) are prices and income, Qi indicates the level of consumption for any given set of price and money income.

Traditional consumer theory deals with how a rational consumer would make consumption decisions. There exist a particular structure, which allows for economically meaningful results to be obtained. Consumer‘s set of choices are assumed to be defined by certain prices and the consumer‘s income or wealth. It analyses how consumers maximize the desirability of their consumption as measured

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by their preferences subject to limitations on their expenditures, by maximizing utility subject to a consumer budget constraint (Levin and Milgrom, 2004).

3.2.2 Energy stacking theory

The effect of income and other factors on household energy consumption will be analysed based on the two-stage budgeting theory. Proposed first by Strotz (1957) and extended by other researchers including Gorman (1959), Chambwera and Folmer (2007), this theory maintains that households engage in a two-stage process in their consumption decisions. In the first stage, households decide what amount of their income to allocate towards the energy component of their consumption and a further decision is made as to how much of their energy budget to be allocated to the individual fuels. It can be assumed that households use a two-stage budgeting process (Figure 3).

Therefore, this study will rely on the two-stage budgeting model proposed by Baker, Blundell and Micklewright, (1989). who indicate that disaggregate fuel expenditures depend on relative fuel prices and other household level factors as well as weakly separable preferences between fuel and non-fuel goods. Unlike Baker et al., this study will however use income and other household factors due to the absence of reliable information on fuel prices in the dataset employed for the analysis.

Following from Curtis and Pentecost (2015) and Eakins (2013), the following general functional form and empirical equations are specified and estimated for the various categories of fuels considered by this study:

$$E_i = f\left(Y_i, A_i, H_i\right) \qquad (4)$$

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Where E is annual energy consumed by the ith household, Y is household income, H is sociodemographic characteristics of the household while A represents the stock of energy-consuming devices.

3.3 Model Specification

The study employed both multinomial logit model and the double hurdle model to analyse household choice of fuel for cooking and determinants of expenditure on LPG.

3.3.1 Multinomial logit model

In order to examine household choice of energy sources, the multinomial logit model was used. The multinomial logit model estimates the effects of explanatory variables on an explained variable.

The study adopted the multinomial logit (MNL) model to investigate households' decisions on sources of energy. This model is applicable because the dependent variable, sources of energy has more than two categories, representing the different options households have in terms of access to energy. The MNL model is used when the number of choices facing an individual is more than two (Greene, 2000). The MNL, like other choice models, is founded on the random utility theory and begins by assuming that the individual chooses an alternative from a set of alternatives that will maximize his/her utility (Greene, 2000).

The multinomial logit model gives the choice probabilities of each alternative as a function of the deterministic portion of the utility of all the alternatives. Assuming that there are j alternatives and that the dependent variable y is defined to take value j if the jth alternative is chosen, then in general, the probability of choosing the jth alternative is given as:

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$$\Pr(i) = \frac{\exp(V_i)}{\sum_{i=1}^{j} \exp(V_i)} \quad (5)$$

The implication of equation (5) is that the probability of making choice increases monotonically with an increase in the deterministic utility of that alternative but decreases with increases in the deterministic utility of each of the other alternatives (Greene, 2000).

Based on the choices of sources of energy, equation (5) can be re-written as:

$$\Pr(i) = \frac{\exp(V_i)}{\sum_{j-FOW,CH,LPG,ELE}^{4} e^{\exp(V_i)}} \quad (6)$$

Equation (6) simply means that the probability of choosing one of the energy sources is a function of the deterministic utility of that energy source and the sum of the deterministic utility of all the available energy sources. The alternatives in this model are firewood, charcoal, LPG and electricity. In this study, ‗LPG' alternative will be set as the reference category.

In practice, the deterministic component of the utility takes the form $\beta' \mathrm{jx}_{\mathrm{ij}}$. The explanatory variables do not vary with the alternatives in a model but they vary with households. Therefore, for a multinomial logit, the probability of a household (i) choosing one of the energy sources (j) can be re-written as:

$$P_{r(ij)} = \frac{e^{\beta_j x_i}}{\sum_{j=FOW,CH,LPG,ELE}^{4} e^{\beta' j x_i}} \quad (7)$$

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3.3.1.1 Empirical model for household choice of cooking fuel

The estimated model can be specified as follows:

$$SE_{ij} = \beta_{0ij} + \beta_1 hinc_{ij} + \beta_2 hsize_{ij} + \beta_3 hage_{ij} + \beta_4 hgender_{ij} + \beta_5 heduc_{ij} + \beta_6 hloca_{ij} + \beta_7 hempstat_{ij} + \beta_8 hresid_{ij} + e_{ij} \quad (8)$$

Where; hnic which represents income of household, hsize which represents household size, hage which represents age of head of the household, hgender which represents gender of the household head, heduc which represents the educational status of the head of the household, hempstat which represents employment status of household head, hresid which represents place of household residence (urban versus rural).

The variable income was used because, according to the energy ladder theory, fuel for cooking is a normal good thus, the higher one's income the higher the probability of using a clean fuel source for cooking.

In addition, most studies indicate income as the main driver behind the use of modern fuels. For instance, Farsi et al (2007) applied an ordered discrete choice framework to model fuel choices and patterns of cooking fuel use in urban households. The study showed that lack of sufficient income was one of the main factors that retarded households from using cleaner fuels. A similar study by Vassileva (2012) on characterization of household energy consumption in Sweden established that income is among the factors that influence consumption the most.

Many studies established that household size is an important factor in determining the choice of cooking fuel among households. For example, Pandey and Chaubal (2011) and Ozcan et al (2013) showed that larger households prefer unclean fuels to clean fuels. Again, Karimov and Nlom (2014) and Mensah and Adu (2013) established that, household size have a negative effect on the use of clean and efficient fuels. Besides,

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Baiyegunhi and Hassan (2014) established that households with more members are more likely to choose clean fuels.

Moreover, the variable age of household head was considered because there are many empirical evidence to prove the significance of age in the determination of choice of cooking fuel among households. For instance, Baiyegunhi and Hassan (2014) Karimov and Nlom and (2014) indicated that age has a positive relationship with fuelwood use. Some researchers also find age to be positively related with the preference for modern fuels (Gupta & Kohlin, 2006; Farsi et al., 2007; Guta, 2012; Ozcan et al., 2013).

In addition, some studies find gender to have an impact on households‘ decision to choose a particular fuel source. For instance, Nlom and Karimove (2014), Eakins (2013) and Mensah and Adu (2013) indicated that, gender (male) of household head have a negative effect on the probability of the use of clean and efficient fuels. This empirical evidence informed the researcher‘s decision to include gender as an explanatory variable.

The empirical evidence from previous studies informed the researcher‘s decision to include educational status in this study. For example, Baland et al. (2015) and Lay et al (2013), in their study find higher education level of the household head to have a negative relationship with firewood consumption. From the above empirical evidence, educational status of household head needs to be considered in determining the choice of cooking fuel among households.

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The researcher included employment status of household head because, empirically, many studies established that, employment status has an impact on fuel choice among households. Some of these studies include Couture et al (2012) who established that, occupation (farming) of the household head has a negative relationship with firewood use whereas Nnaji et al. (2012) indicated that occupation of household head (farmers & traders) has a positive relationship with household decision to use firewood. From the above empirical evidence, employment status has an impact on choice of cooking fuel hence the researcher's decision to include it in this study.

Wiedinmyer et al. (2017) in their study established that rural households rely predominantly on wood, while urban households are more dependent on charcoal and, to a lesser extent, LPG. This proves that area of residency has an impact in households' decision to choose a particular fuel source hence the researcher's decision to include it in this study. Also Song et al (2012) indicated that, rural households are more likely to choose wood rather than the other sources of fuel.

3.3.2 Double hurdle model

For the primary data, the researcher used the double hurdle model to examine the factors that influence LPG participation decision and expenditure decision in the Techiman municipality. The double hurdle model was used because the researcher wanted an effective way of modelling the pattern of household participation and expenditure on LPG. The researcher could have used either the Tobit or Heckman model for this research but instead chose the double hurdle due to the reasons below.

The Tobit model does not allow for the set of variables used in explaining whether y is positive or zero to differ from the set of variables used in explaining the value of y conditional on y being strictly positive. The main restrictions of the Tobit model are

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its strong normality and homoscedasticity assumptions, which bias the results if violated. Failure of the normality and homoscedasticity assumptions also implies that a single process does not determine the choice between y = 0 and y > 0 as well as the value of y; given y >0.

The Heckman model assumes that a household‘s expenditure on LPG is zero only because the household does not use LPG. The key difference between the Heckman model and double-hurdle models is that the Heckman does not account for households with zero expenditure even though they participate in the market, whereas the double hurdle model includes such households.

Cragg (1971) formulated the double hurdle model. This model gives an effective way of modelling the pattern of household expenditures on commodities. The model postulates that, households must go through two separate hurdles before they can observe positive level of expenditure.

The first hurdle is the decision to choose positive or zero spending (participation decision) and the second hurdle is deciding the amount to be spent on the condition that, the household decide to spend a positive amount (expenditure decision). The model can be specified as follows:

$Y_{i1}^{*} = w_i^{'}\alpha + v_{i.}$ ..... (Participation decision)

$Y^{*}_{i2} = x_i^{'}\beta + u_i$ ..... (Expenditure decision)

$y_i = x_i^{'}\beta + u_i$ if $y^{*}_{i1} \succ 0$ and $y^{*}_{i2} \succ 0$

$y_i = 0$ Otherwise

Where y^{*}_{i1} is the latent endogenous variable representing a households participation decision, y^{*}_{i2} is a latent endogenous variable denoting a households expenditure

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decision; y_i is the observed level of expenditure; w_i is a set of household characteristics explaining the participation decision; x_i is a set of individual characteristics explaining the expenditure decision; u_i and $v_{i.}$ are independent, homoscedastic, normally distributed error terms. The log likelihood function of the double hurdle is estimated by using the maximum likelihood techniques:

$$LL_{DoubleHurdle} = \sum_{0} \ln\left[1-\varphi(w_i\alpha)\Phi(\frac{x_i\beta}{\sigma_i})\right] + \sum_{+} \ln\left[\Phi(w_i\alpha)\frac{1}{\sigma_i}\phi(\frac{y_i - x_i\beta}{\sigma_i}\right] \quad (9)$$

Below is the probability of participation and the level of expenditure conditional on participation respectively;

$$P[y_i \succ 0 \mid x] = \Phi(w_i\alpha)\Phi\left(\frac{x_i\beta}{\sigma_i}\right) \quad (10)$$

$$E[y_i \mid x_i \succ 0, x] = x_i\beta + \sigma_i\left(\frac{\phi\left(\frac{x_{i\beta}}{\sigma_i}\right)}{\Phi\left(\frac{x_{i\beta}}{\sigma_i}\right)}\right) \quad (11)$$

3.3.2.1 Empirical model for household participation and expenditure decisions

The estimated model can be specified as follows:

$$LPG_{part} = \alpha_0 + \alpha_1 hinc + \alpha_2 maristat + \alpha_3 emptype + \alpha_4 heduc + \alpha_5 hseown + \alpha_6 resid + \alpha_7 accessbty + \alpha_8 relbty + \alpha_9 sensi + \alpha_{10} afbty + v$$
$$LPG_{exp} = \beta_0 + \beta_1 hinc + \beta_2 resid + \beta_3 hsize + \beta_4 maristat + \beta_5 emptype + \beta_6 heduc + \beta_7 afbty + \beta_8 accessbty + u$$
(12)

The explanatory variables used for participation decision include; hinc which represents household income, maristat which represents marital status, emptype which represents sector of employment, heduc which represents educational level, hseown which represents house ownership, resid which represents area of residence, accessbty which represents LPG accessibility, relbty which represents LPG reliability, sensi

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which represents sensitization of household, afbty which represents LPG affordability, hsize which represents household size.

The existence of some explanatory variables in both participation and expenditure decision is to enable the researcher determine whether those variables are significant determinants of both participation decision and expenditure decision.

The variable income was used because, there are many empirical evidence to prove incomes‘ significance in the decision to participate and spend in a particular fuel market for cooking. Adusah-Poku and Takeuchi (2019) established that, income is a statistically significant factor influencing the probability of a household participating in the LPG market and LPG expenditure. From the energy ladder theory, fuel for cooking is a normal good in the sense that once a households‘ income increases, the household is bound to climb up the ladder and opt for a clean fuel than what was used initially. Therefore, the researcher‘s decision to include income was based on both empirical and theoretical review.

Household size is the total number of people that consume from the same budget set. This variable is deemed necessary because of the many evidence from empirical review that showed the significant effects of household size in the decision to participate and spend in a particular fuel market. For example, Longhi (2015) analyzed whether changes in household socioeconomic circumstances translate into changes in households‘ energy expenditure and found that, dwelling characteristics such as household size has larger impacts on energy expenditure. In addition, Adusah-Poku and Takeuchi (2019) established that, household size has a significant effect in the households decision to participate in the LPG market. These evidence above informed the researcher‘s decision to include the variable household size.

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The decision to include educational status in this research was based on empirical evidence that showed that educational status of household head has a significant impact on participation and expenditure decisions of LPG. For instance, Adusah-Poku and Takeuchi (2019) and Kojima et al. (2011) established that educational level of household head has a significant effect on LPG participation and expenditure decisions.

House ownership is often considered as proxy for a household‘s wealth and living conditions. From empirical literature, house ownership is seen to have a significant impact on the decision to participate in a particular fuel market. For instance, Arthur et al (2010), Baiyegunhi and Hassan (2014) and Lay et al (2013) find that, house owners are more likely to move towards cleaner fuels than tenants.

Contrary to this findings are the findings of Ouedraogo (2006) and Pundo and Fraser (2006) who established that, tenants are more likely to move towards cleaner fuels than house owners. Based on the significant impact of dwelling ownership in literature, the researcher decided to include it in this study.

From literature, occupation status of household head has a major impact in households‘ decision to participate and spend in a particular fuel market. For example, Nnaji et al (2012) showed that occupation status (farming & trading) has a positive relationship with firewood use. Whereas Couture et al (2012) find that heads of the families belonging to socio-professional categories with strong responsibilities (executive, merchant, tradesman or self-employed”), probability of using wood as a main energy increases, compared to farmers since they have considerable means to ecological and environmental concerns and awareness. These empirical findings

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informed the researcher‘s decision to include the variable employment type in this research.

Various studies conducted have proven that demographic characteristics such as household residence has an influence in the participation and expenditure decisions regarding a particular fuel type. For example, Adusah-Poku and Takeuchi (2019) established that urban households are more likely to participate and spend in LPG market after the decision to participate has been made as compared to rural residents. In addition, Wiedinmyer et al (2017) established a significant effect of household residency and fuelwood consumption. Laureti and Secondi (2012) also established that urban households are more likely to participate in LPG market. This significant impact residency had in previous studies on choice of fuel for cooking, influenced the researchers decision to include it in this study.

The researcher decided to consider some supply factors such as affordability, availability and accessibility to LPG due to the role these factors play in literature.

The affordability of a fuel is determined by its price which is an important factor in household energy use, in terms of both fuel choice and also quantity of fuel consumed (Barnes et al., 2005; ESMAP, 2003; Leach, 1992; Wuyuan et al., 2008 cited in Kowsari & Zerriffi 2011). Again, access to reliable sources of modern fuels is also recognized as a major factor affecting fuel choice (Barnes et al., 2005; Cecelski & Elizabeth, 2002; ESMAP, 2002; Fitzgerald et al., 1990; Leach, 1992 cited in Kowsari & Zerriffi 2011). A study done by Adusah-Poku and Takeuchi (2019) also established that reliable LPG supply had a significant impact on LPG participation and expenditure. The availability, accessibility and reliability of energy supplies are major

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contributing factors to fuel choice hence the researcher‘s decision to include it in this study.

Sensitization on LPG use was considered because; a study conducted by Dalaba et al (2018) and Oteh et al. (2015) established that acceptability is limited by widespread concerns about the safety of cooking with LPG. Again, educational attainment of household head appears to be significant in many studies conducted. The researcher was motivated to add sensitization in order to determine whether having adequate information and knowledge about LPG use will influence households‘ decision to participate in the LPG market.

3.4 Study Area

The study made use of both primary and secondary data. The secondary data covers the entire country (Ghana) whiles the primary data covers Techiman. Techiman is a leading market town in Ghana and located at a historical crossroads of trade routes. Techiman has a population of 147,788 and has recently been named as the capital town of Bono East region (GSS, 2014).

The main source of fuel for cooking is charcoal, which is used by 46.9 percent of households. Wood is the second most used cooking fuel accounting for 32.7 percent. Gas is used by 10.6 percent of households, and 8.1 percent do not cook. All the other cooking fuels are used by less than five percent of households. The use of gas by one in ten households is not high enough to off-set the destruction of the vegetation cover associated with wood and charcoal which are used by almost sixty percent (57.5%) of households (GSS, 2014).

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decision to use LPG. Household sector is one of the most important energy consumption sector (Wang et al., 2011). The energy consumption of the residential sector informed the researcher‘s decision to concentrate on households in the municipality.

3.5.2 Sample size and sampling procedure

Multi stage sampling technique was used. In the first stage, the researcher randomly selected 11 settlements out of the 20 settlements in the municipality. Eleven (11) settlements were selected because the researcher wanted to cover at least half of the total settlement in the municipality. In the second stage, 20 households per settlement were considered using the systematic sampling technique. Combining both stages of sampling resulted in a final sample of 220 households covering the 11 randomly selected settlements. The sample unit was achieved by using the formula 50 + 8 m where m is the number of variables in the study (Tabachnick & Fidel, 2007). In this study eleven explanatory variables were used in the empirical model and according to the equation, the sample size of the study should be greater than 50 + 8 (11) = 138. Hence, the sample size of 220 is greater than 138. This implies that the sample size used in this study adequately satisfies the said requirement and thus, satisfactory for multiple regression analysis.

3.5.3 Data instrument

The study made use of questionnaires for sampled households. The researcher visited the residences of households at the convenience of respondents to administer questionnaires. The questionnaire consisted of closed-ended questions. This is because it is easier and quicker for respondents to answer, the answers of different

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respondents are easier to compare and answers are easier to code and statistically analyze.

3.5.4 Pre-testing

The instrument (questionnaire) was piloted with a small segment of the respondents in Winneba in the Efutu Municipality to assess its reliability, validity and effectiveness to collect data. The reliability of the instrument was tested using the Cronbach alpha. The results gave a scale reliability coefficient of 0.8311, which shows that the instrument is reliable for the analysis. In testing for the validity and effectiveness of the instrument, the municipality was deemed appropriate because, like the study area, charcoal is the main source of cooking fuel in the municipality and almost one out of five (49.1%) households use charcoal for cooking (GSS 2014). The pre-test revealed that respondents were misinterpreting some questions. These questions were reframed in a more concise and precise manner.

3.5.5 Field work

The actual fieldwork commenced after the pre-testing. Due to the wide coverage of the sample and the time constraint, a research assistant was recruited and trained for the exercise. The researcher supervised the work of the research assistant by monitoring and evaluating her work daily to ensure that valid and accurate data was collected.

3.6 Secondary Data Source

The secondary data used for the study is the seventh round of the Ghana Living Standard Survey conducted by the Ghana Statistical Service from October 2016 to October 2017. The households who participated in the survey were selected using a two-stage stratified random sampling technique to collect the data over a 12-month

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period in 2016/17. The sections covered in the GLSS 7 survey include education, health, employment, access to financial and insurance services, credit and assets, migration and tourism, agriculture, governance and demographic characteristics. Though this survey was not solely dedicated to household energy issues, it collected information on the main fuel used for cooking as well as expenditure on electricity, transport fuel, LPG, kerosene, and biomass. Although the study covered a nationally representative sample of 15,000 households across the administrative regions of Ghana, the final sample size was 14,009 households due to a 94.4% response rate. After merging information from different sections that contained the variables of interest, the sample size reduced to 12,866 households.

3.7 Chapter Summary

This chapter dealt with all the issues concerning the study area, study design, data sources, theoretical framework and empirical models for the study.

This study implemented the cross sectional descriptive research design and adopted the quantitative approach in analyzing factors that affect choice of cooking fuel and expenditure on LPG.

The theoretical framework was based on the concept of consumer behavior and the two stage budgeting theory. In order to examine household choice of energy sources, the multinomial logit model was used. For the primary data, the researcher used the double hurdle model to examine the factors that influence LPG participation decision and expenditure decision in the Techiman municipality.

The study made use of both primary and secondary data. The secondary data covers the entire country (Ghana) whiles the primary data covers Techiman.

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CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents results and discussion based on data gathered from the field and GLSS 7 data with regard to household choice of cooking energy, their decision to use LPG and level of LPG expenditure.

4.1 Descriptive Statistics of Variables in the Multinomial Logit Model

This section presents the descriptive statistics of variables in the multinomial logit model based on the GLSS 7 data. These variables are grouped into categorical and continuous variables. The categorical variables are gender of household head, employment status of household head, education level of household head and the area of residence of household. The continuous variables are income, household size and age of household head.

4.1.1 Categorical Variables

Table 1: Descriptive statistics of categorical variables

Variables	Scale	Frequency	Percentage
Gender	Male	8,702	67.64
	Female	4,164	32.36
Employment Status	Employed	5,854	45.50
	Unemployed	7,012	54.50
Area of Residence	Rural	7,485	58.18
	Urban	5,381	41.82
Educational Status	No Education	6,993	54.35
	Educated	5,873	45.65

Source: Author‘s computations based on GLSS 7 data

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The descriptive statistics of the categorical variables are presented in table 1. Table 1 indicates that 67.64% of households are headed by males whiles 32.36% are headed by females. This shows that households headed by males are twice that of females and it indicates the dominance of males in the Ghanaian population. The descriptive statistics indicate that 45.50% of household heads are employed whiles 54.50% of them are unemployed. This shows that many household heads are not among the active labour force. With residential settlement, the table shows that about 58% of households reside in the rural area whereas about 42% are urban residents. This is a clear indication that majority of the Ghanaian population live in the rural areas. From the table, about 54% of household heads have had no education at all whereas about 46% have had some sort of education. This implies that most household heads are uneducated.

4.1.2 Continuous variables

Table 2: Descriptive statistics of continuous variables

Variable	Obs	Mean	Std. Dev	Min	Max
Age	12,866	46.71949	15.70811	15	99
Household Size	12,866	4.381471	2.838628	1	28
Income	12,866	28212.82	157714.5	.0216667	7723805

Source: Author‘s computations based on GLSS 7 data

Table 2 presents the descriptive statistics of continuous variables in the model. From table 2, it can be noted that, household size is the relatively least dispersed series with a standard deviation of 2.83 whereas income is relatively highly dispersed with a standard deviation of 157714.5 hence a high level of income inequality. The minimum age is 15 years and the maximum age is 99 years with a mean of 47 years. Table 2 indicates that the mean household size is 4 with a maximum of 28 members

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and a minimum of 1 member. From table 2 it can be noted that the mean income is 28212.82 cedis with a minimum income of 0.0216667 cedis and a maximum income of 7723805 cedis.

4.1.3 Multinomial model results

Table 3 presents the multinomial logit model results of household choice of cooking fuel sources. From the results, it can be noted that the multinomial logit model is well fitted and rejects the null hypothesis that all coefficients except the intercept are zero with the chi-square being significant at 1% level. Moreover, the model explains about 35% of the variations in the probability that a particular energy source for cooking would be chosen for cooking purposes.

Table 3: Results of estimated coefficients of multinomial logit model

Variables	Wood	Charcoal	Electricity
Log Income	-0.4485***	-0.2725***	-0.2242
	(0.0254)	(0.0216)	(0.1511)
Female	-0.1427*	0.1760***	-1.4242**
	(0.0763)	(0.0627)	(0.6186)
Educated	-2.251***	-1.5392***	-1.2658***
	(0.0801)	(0.0703)	(0.4505)
Employed	-1.3661***	-0.1305*	0.1508
	(0.0811)	(0.0738)	(0.5217)
Urban	-2.9802***	-0.6308***	-1.2659***
	(0.0764)	(0.0672)	(0.3893)
Hhsize	0.3828***	0.1869***	-0.5318***
	(0.0167)	(0.0147)	(0.1882)
Age	0.0113***	0.0110***	-0.0869***
	(0.0024)	(0.0022)	(0.0265)
Constant	6.3949***	3.4786***	3.7436***
	(0.2465)	(0.2164)	(1.3719)
No. Observations	12,866		
Log Likelihood	-8637.7887		
LR Chi-Square (21)	9422.43		
Prob>Chi-Square	0.0000		
Pseudo R-Square	0.3529		

Note: Figures in brackets are the standard errors; base outcome (Gas); *significant at 10%;** significant at 5%; *** significant at 1%. Source: Author's computations based on GLSS 7 data

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In this study, the log of households‘ income was taken and used for the regression. The results indicate a negative 1% significant effect of income on wood and charcoal. This shows that the higher the income of the household the less likely the probability of opting for wood and charcoal rather than LPG as cooking fuel. The above finding implies that the energy ladder theory is indeed valid in Ghana since an increase in income decreases the adoption of traditional fuels but rather increases the adoption of modern fuels for cooking. Similarly, Baiyegunhi and Hassan (2014) have established that income is a significant factor in the use of modern fuel. On the contrary, some empirical evidence show that the effect of income on fuelwood demand may at times be insignificant irrespective of how income is measured which questions the simple pattern of income dependence (Israel 2002; Guta, 2014 & Baland et al., 2015, 2017).

The results indicate that relative to male household heads, female household heads are less likely to opt for wood and electricity rather than LPG as cooking fuel but are more likely to opt for charcoal rather than LPG as their cooking fuel. This relationship is statistically significant at 10%, 1% and 5% for wood, charcoal and electricity respectively. Consistent with this finding is the finding of Nyembe (2011) who established that female household heads are more likely to choose charcoal rather than electricity as cooking fuel. Contrary to this finding are the findings of Ouedraogo (2006) and Mekonnen and Kohlin (2009) who indicated that female household heads are more likely to opt for firewood as cooking fuel.

Again, the results indicate that there exist a negative 1% significant effect between educated household heads and the use of wood, charcoal and electricity. This shows that once a person is educated, that person is less likely to choose wood, charcoal and electricity as cooking fuel rather than LPG. This may be because, education implies a

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higher income and such a person is abreast with the disadvantages of using unclean fuel sources and has enhanced knowledge about the efficiency and convenience of modern fuels. In the case of electricity, even though electricity is cleaner than LPG, an educated person has some knowledge regarding electricity tariffs and the level of consumption that guarantees a subsidy hence a lower probability of such a person using electricity to cook rather than LPG. Consistent with this finding are the findings of Baland et al. (2015) and Lay et al (2013) who find education level of the household head to have a negative relationship with firewood consumption.

Moreover, the results indicate that relative to unemployed household heads, employed household heads are less likely to select wood and charcoal for cooking. Interestingly there is a significant association between employment status and choice of cooking fuel sources among households at 1% confidence level for wood and charcoal respectively. The impact of employment status on electricity use is not statistically significant. This may result from the fact that, employment implies a reliable income hence employed household heads are able to afford cleaner cooking fuels as compared to unemployed households since they have no basic source of income and hence cannot afford clean fuel (LPG). This is probably due to the fact that, fuelwood is mostly gathered and does not require any financial cost to enable one have access. Consistent with this result is the finding of Adusah-Poku and Takeuchi (2019) who established that, there exist a positive relationship between employment status and LPG adoption.

Relative to rural households, urban households are less likely to choose wood, charcoal and electricity as their cooking fuel rather than LPG. This may be attributed to the availability of clean fuels especially LPG in urban areas compared to the rural

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areas. There is a 1% level of significance between residency and choice of cooking fuel among households for wood, charcoal and electricity. In line with this result are the findings of Laureti and Secondi (2012) who established that urban households are more likely to use gas and the findings of Song et al (2012) who also showed that rural households are more likely to opt for wood rather than other sources of fuel.

Furthermore, there exist a negative relationship between household size and electricity adoption and a positive relationship with the other sources of fuel (wood and charcoal). This shows that households with large family sizes are more likely to use wood and charcoal rather than LPG whiles households with large sizes are less likely to use electricity rather than LPG for cooking. A probably explanation may be that larger households prefer firewood since they have more members to collect firewood for cooking which is freely available or cheaper than other fuel in case they were to be bought. It may also be probably due to scarcity of resources since each member of the family needs to be taken care of hence making resources limited therefore the inability to afford clean fuel sources. This finding is consistent with the findings Ozcan et al (2013) who showed that larger households prefer unclean fuels to clean fuels.

Again, Karimov and Nlom (2014) found household size to have a negative effect on the probability of the use of clean and efficient fuels. Song et al (2012), find household size to have a positive relationship with the household decision to use firewood. On the contrary, Baiyegunhi and Hassan (2014) indicated that households with more members are more likely to choose clean fuels.

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From the results, there exist a significant positive relationship between age and wood and charcoal. The older the household head the more likely the probability of wood and charcoal adoption rather than LPG as cooking fuel. However, older household heads are less likely to opt for electricity as cooking fuel rather than LPG. This may be because, older heads are likely to be out of active labour force and therefore do not have a reliable source of income hence making the purchase of clean fuel a bit of a challenge as compared to wood or charcoal, which can be gathered, or can be purchased at a cheaper price. In line with this result is the finding of Mensah and Adu (2015) who established that age has a negative relationship with modern fuel use. On the other hand, some researchers find age to be positively related with the preference for modern fuels (Guta, 2012 & Ozcan et al., 2013).

4.1.4 Marginal effect

The estimated coefficients from Multinomial Logit model only give the direction of the effect of the explanatory variables on the dependent variable but do not represent either the actual magnitude of change or probabilities. Hence the need for the calculation of marginal effects that gives a better understanding of the explanatory variables on dependent variables.

Table 4 presents the marginal effects coefficients of multinomial logit model of household choice of cooking fuel sources.

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Table 4: Results of marginal effects of household choice of cooking fuel sources

Variables	Wood	Charcoal	Electricity
Log Income	-0.0283***	-0.0050*	-0.0000
	(0.0022)	(0.0026)	(0.0003)
Female	-0.0323***	0.0440***	-0.0031**
	(0.0069)	(0.0080)	(0.0014)
Educated	-0.1261***	-0.0542***	-0.0003
	(0.0061)	(0.0076)	(0.0009)
Employed	-0.1506***	0.1027***	0.0012
	(0.0064)	(0.0087)	(0.0011)
Urban	-0.2959***	0.1666***	-0.0006
	(0.0044)	(0.0068)	(0.0007)
Hhsize	0.0287***	-0.0029*	-0.0015***
	(0.0013)	(0.0017)	(0.0002)
Age	0.0004*	0.0009***	-0.0002***
	(0.0002)	(0.0003)	(0.0001)

Note: Figures in brackets are standard errors; base outcome (Gas); *significant at 10%;**significant at 5%; *** significant at 1%

Source: Authors computations based on GLSS 7 data.

The marginal effects estimate show that a percentage increase in households‘ income decreases wood and charcoal adoption by 2.8% and 0.5% respectively and this relationship is statistically significant at 1% and 10% for wood and charcoal respectively.

Again, the results show that relative to male household heads, the probability of female household heads choosing wood and electricity for cooking decreases by 3.2% and 0.3% respectively and the likelihood of using charcoal for cooking increases by 4.4%. From the results, the relationship between gender of household head and fuel choice is significant at 5% for electricity but at 1% level for wood and charcoal. In addition, the results established that, the probability of educated household heads adopting wood and charcoal decreases by 12.6% and 5.4% respectively and this is significant at 1% level. The marginal effect of employment status indicates being employed decreases the probability of using wood by 15.1% and increases the probability of opting for charcoal by 10.3%. This relationship is significant at 1%

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level for wood and charcoal. A change in residing in the rural area to urban area decreases the probability of selecting wood by 29.6% and increases the probability of adopting charcoal by 16.7% at a 1% significance level. Furthermore, the estimates show that an increase in household size by one person increases the likelihood of choosing firewood and charcoal by 2.9% and 0.3% respectively whereas the probability of using electricity decreases by 0.1%. The relationship between fuel adoption and family size is significant at 1% level for wood and electricity and 10% level for charcoal. An increase in age of household head by a year tends to increase the probability of choosing wood and charcoal by 0.04% and 0.09% respectively whereas it decreases the probability of choosing electricity by 0.02%. This relationship is significant at 1% level for electricity and charcoal but at 10% level for wood.

4.2 Descriptive Statistics of Variables in the Double Hurdle Model

Primary data was used to analyse the factors that affect LPG participation and expenditure decisions among household heads in Techiman. Using the double hurdle model, the variables under consideration are grouped into categorical and continuous factors.

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4.2.1 Categorical variables

Table 5: Descriptive statistics of categorical variables in the double hurdle model

Variables	Scale	Frequency	Percentage
Sector of Employment	Formal	22	90
	Informal	198	10
Gender	Male	114	51.82
	Female	106	48.18
Marital Status	Not married	96	43.64
	Married	124	56.36
Education	No education	56	25.45
	Basic	96	43.64
	Secondary	46	20.91
	Tertiary	22	10
Dwelling Ownership	Yes	93	42.27
	No	127	57.73
Area of Residence	Rural	100	45.45
	Urban	120	54.55
LPG Use	Yes	94	42.73
	No	126	57.27
Reliability	Yes	135	61.36
	No	85	38.64
Accessibility	Yes	142	64.55
	No	78	35.45
Affordability	Yes	116	52.73
	No	104	47.27
Sensitization	Yes	10	4.55
	No	210	95.45

Source: Field Survey 2020

Table 5 presents the descriptive statistics of categorical variables in the double hurdle model. From the table, it can be noted that sector of employment of household heads is grouped into formal and informal sector. From the table it can be noted that out of

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the 220 respondents 22 (10%) work in the formal sector whiles 198 (90%) work in the informal sector.

Another variable under study is gender of household head. Out of the 220 respondents, 114 (51.82%) are males and 106 (48.18%) are females. This shows that males head many households and proves the dominance of males in the Ghanaian population and for that matter household decision-making. From the table, it can be noticed that out of the total respondents 96 (43.64%) are not married whereas 124 (56.36%) are married.

It can be noted from the descriptive statistics that out of the 220 respondents, 56 (25.45%) had never been to school before, 96 (43.64%) reached the basic level, 46 (20.91) had completed high school and 22 (10%) had graduated from various tertiary institutions. From the table 4.4 out of the 220 respondents, 93 (42.27%) were owners of their various dwelling places where as 127 (57.73%) had rented their various dwelling places.

With respect to area of residence, the descriptive statistics show that 100 (45.45%) out of the respondents were rural residents whiles 120 (54.55%) were urban residents.

Out of the 220 respondents 94 (42.73%) were using LPG whereas 126 (57.27) were not using LPG. This shows that more than half of the respondents were using other fuel sources for cooking instead of LPG.

From table, it can be realized that out of the 220 respondents, 135 (61.36%) responded yes for LPG reliability and the rest 85 (38.64%) said LPG supply was not reliable. This shows that more than half of the sampled population considers LPG supply reliable. Again, from the table, 142 (64.55%) of respondents noted that LPG was accessible whiles 78 (33.45%) said LPG was not accessible.

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From the table, it can be noted that 116 (52.73%) respondents were of the opinion that LPG was affordable whereas 104 (47.27%) said it was not affordable.

4.2.2 Continuous variables

Table 6: Descriptive statistics of continuous variables

Variables	Obs	Mean	Std Dev	Min	Max
Income	220	1177.682	683.9301	200	5000
Family Size	220	3.918182	2.26803	1	15
L.P.G Exp	220	31.5	32.52712	0	150

Source: Field Survey 2020

Table 6 presents the descriptive statistics of continuous variables in the double hurdle model. From table 6, it can be noted that, family size is the relatively least dispersed series with a standard deviation of 2.27 whereas income is relatively highly dispersed with a standard deviation of 683.9. From table 6, it can be noted that the mean income is 1177.7 cedis with a minimum income of 200 cedis and a maximum of 5000 cedis. The results from table 6 indicates that, the mean family size is 4 with a maximum of 15 members and a minimum of 1 member. The results from table 6 indicates that, the mean expenditure on LPG is 31.5 cedis with a minimum expenditure of 0 cedis and a maximum expenditure of 150 cedis. The 0 minimum expenditure is an indication that some households were not using LPG hence incurring no expenditure on LPG.

4.2.3 Double hurdle model results

Results of Double Hurdle model are presented in two sections. The first section looks at the participation decision of households in the LPG market. The second section on the other hand considers the results of the expenditure decision on LPG among households. From the results, it can be noted that the double hurdle model is well

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fitted and rejects the null hypothesis that all coefficients except the intercept are zero with the chi-square being significant at 1% confidence level.

Table 7: Estimated coefficients of the participation decision

Variables	Parameter Estimate	Standard Error	z - value
Urban	1.2699**	0.6447	1.97
Income	0.0021***	0.0005	4.17
Basic Education	0.1763	0.4591	0.38
Secondary Education	-0.1682	0.6605	-0.25
Tertiary Education	0.9120*	0.4740	1.92
Houseowners	0.4097	0.5469	0.75
Married	-0.1487	0.4958	-0.30
Reliability	2.2459***	0.7181	3.13
Affordability	1.8649***	0.5695	3.27
Accessibility	3.1076***	0.8086	3.84
Sensitization	2.0860***	0.7181	2.90
Formal Employment Sector	3.2306***	1.0825	2.98
Constant	-7.2604***	1.3421	-5.41
Insigma constant	3.0148***	0.0835	36.09
/sigma	20.3848	1.7027	
Number of observations	220		
Log psedolikelihood	-570.9004		
Wald chi2 (15)	141.77		
Pro b> chi2	0.0000		
Pseudo R2	0.2122		

Note: *significant at 10%;**significant at 5%; *** significant at 1%

Source: Field Survey 2020

The results indicate that relative to rural household heads, urban household heads are more likely to use LPG thus, there is a positive relationship between urban residence

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and LPG usage. This relationship is statistically significant at 5%. Consistent with this result are the findings of Adusah-Poku and Takeuchi (2019) and Wiedinmyer et al (2017) who opined that urban households are more likely to participate in LPG market. This relationship may be due to the limited availability of clean fuels in rural settings and easy access to traditional fuels such as fuelwood and charcoal.

Moreover, the results show that income is statistically significant at 1% level in influencing households' decision to participate in the LPG market. The higher the income of the household head, the more likely the probability of using LPG. This is in line with the findings of Adusah-Poku and Takeuchi (2019) who found that, there exist a positive relationship between income and LPG participation. Empirical evidence also prove a positive relationship between income and the use of clean fuel like LPG for cooking (Ouedraogo, 2006; Demurger & Fournier, 2011). These findings conform to the energy ladder theory, which states that there exist a positive relationship with income and the use of cleaner fuels. This is probably because cleaner fuels like LPG are expensive as compared to traditional fuels hence; low-income households cannot be able to afford it hence the positive relationship.

Tertiary education level has a positive significant effect on the decision to use LPG. This shows that once a person's education attainment is higher, the higher the probability of choosing LPG as cooking fuel. This is probably because of the high awareness of the adverse effects associated with the use of solid fuels such as wood and charcoal the person is has.

Again, the results indicate that there exist a positive relationship between LPG usage and some supply factors such as affordability, reliability and accessibility.

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The more affordable, reliable and accessible LPG is, the higher the likelihood of household heads choosing LPG as cooking fuel. This relationship is statistically significant at 1% level. The findings of this study is in line with Schlag and Zuzarte (2008) who established that there exist a positive relationship between LPG participation and the above mentioned supply factors (accessibility, reliability and affordability. Dalaba et al (2018) also established that affordability and accessibility were the main barriers to LPG adoption. In addition, Adusah-Poku and Takeuchi (2019) also established a positive relationship between reliable LPG supply and LPG usage. A possible reason is that if the fuel is not available or accessibly, people cannot possibly use such fuel. Affordability of a fuel is determined by its price, which is an important factor in household energy use thus if the fuel is not affordable it will prevent households from using such fuel.

Relative to un-sensitized household heads, sensitized heads are more likely to participate in the LPG market. This shows that sensitization increases the probability of participating in the LPG market and it is statistically significant at 1% level. This is probably because if households do not have enough knowledge about the safety precautions in dealing with LPG, they will be reluctant in its usage. Dalaba et al (2018) in their study found that, acceptability of LPG is limited by widespread concerns about the safety of cooking with LPG.

Relative to household heads who works in the informal sector of the economy, those who work in the formal sector are more likely to use LPG as cooking fuel. This association is statistically significant at 1% level. This may result from the fact that those who work at the formal sector have a reliable income source and hence can afford expensive fuels such as LPG. A similar finding by Nnaji et al (2012) showed

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that, household heads that works at the informal employment sector (farmers & traders) are more likely to use firewood.

The results show that that the variables level of education (basic & secondary), house ownership and marital status have no significant impact on LPG usage thus, all the above mentioned variables do not influence ones decision to choose LPG as cooking fuel.

Table 8: Estimated coefficients of the expenditure decision

Variables	Parameter Estimate	Standard Error	z-value
Formal Employment Sector	5.8463	6.0132	0.97
Urban	9.1405**	4.1581	2.20
Affordability	12.1230**	5.7993	2.09
Income	0.0068**	0.0031	2.16
Family Size	-1.3659	1.5896	-0.86
Married	14.1010***	5.1853	2.70
Basic Education	-2.3642	5.9500	-0.40
Secondary Education	-2.7326	7.1151	-0.38
Tertiary Education	4.7918	8.8360	0.54
Accessibility	20.6342***	7.1020	2.91
Constant	5.7675	8.8360	0.65
Insigma constant	3.0148	0.0835	36.09
/sigma	20.3848	1.7027	
Log psedolikelihood	-570.9004		
Number of observations	220		

Note: *significant at 10%;**significant at 5%; *** significant at 1%

Source: Field Survey 2020

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Table 7 presents results of the expenditure decision of households on LPG. The results indicate that relative to rural households, urban households are more likely to spend on LPG after the participation decision has been made.

This relationship is significant at 5% level. Generally, the problem of access to modern fuel is more intense in rural areas, particularly in remote areas and areas with low-density population where the distribution of modern fuels is either insufficient or unreliable (Elias and Victor 2005 cited in Kroon et al., 2011). This finding may probably be explained by the fact that, most rural residents' source of income comes from their farming activities and hence not enough to spend more on an expensive fuel such as LPG when they can have traditional fuels like firewood through gathering without any cost. In line with this result is the findings of Adusah-Poku and Takeuchi (2019) who established that urban residents are more likely to spend more on LPG once the decision to participate has been made.

Again, the results indicate a positive relationship between affordability and expenditure decision and this association is statistically significant at 5% level. Thus, the more affordable LPG is the higher the level of household heads expenditure on LPG. The reason behind this is probably that households gather traditional biofuels freely and are likely to continue relying on such fuels until the cost of using such fuels exceeds alternative fuel sources that are more expensive. In line with this result are the findings of Schlag and Zuzarte (2008) who indicated that affordability of a fuel is determined by its price which is an important factor in quantity of fuel consumed.

In addition, there exists a positive relationship between income and LPG expenditure at 5% significance level. Therefore, the higher one's income the higher the level of expenditure on LPG. This can be explained by the energy ladder theory, which relies

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on the microeconomic theory of rational choice. It assumes that that there is a universal set of fuel preferences, and households will choose to move up the ladder as soon as they can afford to do so at a higher income. This implies that since cleaner fuels such as LPG is expensive, it takes high income for one to be able to spend more.

Similar findings by Adusah-Poku and Takeuchi (2019) showed that, income is a statistically significant factor influencing LPG expenditure once the decision to participate has been made. Again, Vassileva (2012) found that income is among the factors that influence energy consumption the most.

The variable marital status has a positive relationship with LPG expenditure after the decision to participate has been made. Therefore, married household heads are more likely to spend more on LPG and this relationship is significant at 1% level. This is probably because; once a head is married, his or her household size automatically increases hence an increase in his or her level of expenditure. This finding is in line with Curtis and Pentecost (2015) who established that couples are more likely to spend on energy as compared to single working aged adults.

The more accessible LPG is the higher the level of expenditure after participation decision has been made. Therefore, households are willing and able to spend more on LPG provided they have access to it. This association is statistically significant at 1% level. A similar finding is the finding of Barnes et al., (2005) cited in Kowsari and Zerriffi (2011) who showed that access to reliable sources of modern fuels is a major factor affecting fuel use. This is in line with the researcher‘s expectations since people can only spend more on fuel provided they have access.

The results show that level of education, family size and sector of employment have no significant impact on LPG expenditure after the decision to participate has been

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made hence, these variables do not influence ones expenditure decision in the LPG market.

4.3 Chapter Summary

This chapter presented results and discussion based on data gathered from the field and GLSS 7 data with regard to household choice of cooking energy, their decision to use LPG and level of LPG expenditure.

The results from the multinomial logistic regression on determinants of household cooking fuel choice established that socioeconomic variables such as; income, employment status and educational status are significant determinants of household choice of cooking fuel. Demographic variables such as; gender, area of residence, household size and age are significant in the choice of cooking fuel among households. In addition, the results from the double hurdle regression on determinants of participation and expenditure decisions in LPG market showed that, income, tertiary education, area of residence, affordability, reliability, accessibility, sensitization and sector of employment have significant impact on the decision to participate in LPG market. Level of education (basic & secondary), house ownership and marital status were found to have no significant impact in the decision to participate in the LPG market. More so, income, area of residence, affordability, accessibility and marital status were found to have significant impact on expenditure decision once the decision to participate was made whereas level of education, family size and employment type were insignificant in explaining expenditure decision once the participation decision was made.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter is divided into five sections. The first section presents the summary of the findings of the study, the second section draws conclusions based on the findings whereas the third section covers policy recommendations. The remaining sections deal with the limitations of the study and suggestions for further research respectively.

5.1 Summary of Major Findings

The current study provides evidence on the factors which influence household preferences for cooking energy and LPG expenditure among Ghanaians using GLSS 7 (12,866 observations) and a primary data with a sample of 220. The multinomial logit model and the double hurdle model were used for the discrete analysis of the household cooking energy preferences and LPG expenditure respectively.

The first research question that guided the study was:

"What are the factors that influence choice of cooking fuel among households in Ghana?"

To answer this question, the multinomial logit model was used (that is equation 4 in the methodology chapter). Key findings produced from the study regarding the first research question included the following;

1. Income is statistically significant in the adoption of wood and charcoal rather than LPG but not statistically significant in the adoption of electricity. The higher the household income, the lower the probability of adopting wood and charcoal rather than LPG as cooking fuel.

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2. Gender is statistically significant with the adoption of wood, charcoal and electricity rather than LPG as cooking fuel. Relative to male household heads, female household heads are more likely to opt for charcoal and are less likely to choose wood and electricity rather than LPG as their cooking fuel.
3. Educational attainment of the household head has a negative relationship with wood, charcoal and electricity usage. Educated household heads are less likely to use wood, charcoal and electricity rather than LPG as their cooking fuel. This shows that once a person is educated, that person is less likely to choose wood, charcoal and electricity as cooking fuel rather than LPG.
4. It was established that, employment status has a negative relationship with the choice of wood and charcoal rather than LPG as cooking fuel. Relative to unemployed household heads, employed household heads are less likely to opt for wood and charcoal rather than LPG as their cooking fuel.
5. The study found households' area of residency to be negatively associated with the use of wood, charcoal and electricity in cooking. Relative to rural households, urban households are less likely to opt for wood, charcoal and electricity as their cooking fuel rather than LPG.
6. Furthermore, there exist a negative relationship between household size and electricity adoption and a positive relationship with the other sources of fuel (wood and charcoal). The larger the household size the more likely the probability of choosing wood and charcoal for cooking and the less likely the probability of adopting electricity rather than LPG as cooking fuel.
7. The age of household head was fund to have a positive relationship with wood and charcoal adoption rather than LPG whiles there exist a negative relationship with electricity adoption rather than LPG. The older the

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household head, the more the probability of adopting wood and charcoal and the less likely the probability of adopting electricity rather than LPG as cooking fuel.

The study found that education status, area of residency, household size and age of household head are all statistically significant in explaining the choice of wood, charcoal and electricity in cooking rather than LPG by households.

The second research question set to determine the validity of the energy ladder hypothesis in Ghana was:

–How valid is the energy ladder theory in Ghana?"

In answering this question, the researcher used the results from the multinomial logit model (table 3 and 4 respectively). The log of household's income was used for the regression. The results indicated that income exerted a negative effect on wood and charcoal at 1% significance level. This shows that the higher the income of the household the less likely the probability of opting for wood and charcoal rather than LPG as cooking fuel. The marginal effects estimate show that an increase in households' income decreases the probability of choosing wood and charcoal by 2.8% and 0.5% respectively and this relationship is statistically significant at 1% and 10% for wood and charcoal respectively.

The above findings imply that the energy ladder theory is indeed valid in Ghana since an increase in households' income by 1% decreases the adoption of traditional fuels such as wood and charcoal in cooking.

The research question that aided in the analysis of factors that influence participation and expenditure decisions in the LPG market by households in the Techiman municipality was

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–What are the factors that influence LPG participation and expenditure decisions?"

To answer this question, the double hurdle model was used. The analysis yielded several interesting results such as:

1. The results indicated that urban households are more likely to use LPG thus, there is a positive relationship between urban residence and LPG adoption.
2. Moreover, the results showed that income is statistically significant at 1% in influencing households' decision to participate in the LPG market. The higher ones income the more likely the probability of participating in the LPG market.
3. Again, the results indicated that there exist a significant positive relationship between LPG participation and some supply factors such as affordability, reliability and accessibility.
4. Relative to un-sensitized household heads, sensitized heads are more likely to participate in the LPG market. This shows that sensitization increases the probability of participating in the LPG market.
5. Relative to household heads who work in the informal sector of the economy, those that work in the formal sector are more likely to participate in the LPG market. Hence, type of employment of household head is positively significant in explaining the decision to participate in the LPG participation.
6. The results showed that the level of education, house ownership and marital status have no significant impact on LPG participation.

The second part of the model deals with the analyses of the factors that affect expenditure decision once the participation decision has been made. Below are the findings from analyzing factors that affect LPG expenditure.

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1. The results indicate that area of residency is positively significant in determining LPG expenditure among households. Thus, urban households are more likely to spend more on LPG after the participation decision has been made.
2. In addition, there exist a significant positive relationship between income and LPG expenditure.
3. The variable marital status has a significant positive relationship with LPG expenditure after the decision to participate has been made. Married household heads are likely to spend more in LPG market.
4. Again, the results indicate that the more accessible and affordable LPG is the higher the level of expenditure. Hence, there is a significant positive relationship between affordability, accessibility and LPG expenditure.
5. The results show that the level of education, family size and sector of employment have no significant impact on LPG expenditure after the decision to participate has been made.

5.2 Conclusions

The results from the multinomial logistic regression on determinants of household cooking fuel choice established that socioeconomic variables such as; income, employment status and educational status are significant determinants of household choice of cooking fuel. Demographic variables such as; gender, area of residence, household size and age are significant in the choice of cooking fuel among households, though, not all the variables listed above were significant in all the fuel sources under study. For example, income and employment level were statistically significant in influencing opting for firewood and charcoal rather than LPG as a source of cooking fuel but not significant in electricity.

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In addition, the results from the double hurdle regression on determinants of participation and expenditure decisions in LPG market showed that, income, tertiary education area of residence, affordability, reliability, accessibility, sensitization and sector of employment have significant impact on the decision to participate in LPG market. Level of education (basic & secondary), house ownership and marital status were found to have no significant impact in the decision to participate in the LPG market.

More so, income, area of residence, affordability, accessibility and marital status were found to have significant impact on expenditure decision once the decision to participate was made whereas level of education, family size and employment type were insignificant in explaining expenditure decision once the participation decision was made.

5.3 Policy Recommendations

Below are some proposed recommendations based on the findings of the study. The results from both the primary and secondary data analyses showed income has a significant positive effect on modern fuel (LPG) participation and expenditure decisions. This implies that, the government should embark on poverty eradication programs and/or create more income generating opportunities like Nation Builders Corps (NABCO) and National Youth Employment Program (NYEP) that would move majority of poor households into the non-poor category and increase the number of households having reliable income sources. If households‘ livelihoods are improved, the likelihood of opting for clean fuels like LPG will increase thereby increasing the probability of meeting the target of 50% of the population using LPG by the end of 2020 as implied by the GEC.

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Educated household heads were found to be less likely to opt for wood and charcoal rather than LPG as their cooking fuel and sensitized household heads were more likely to participate in the LPG market. Therefore, there is the need for continuous educational campaigns to sensitize households on the advantages associated with the use of modern fuels. This will enable households to make fuel substitutions away from wood fuel to more efficient fuel sources like LPG. Hence, if agencies such as National Disaster Management Organization (NADMO) and the Ghana National Fire Service (GNFS) are entreated to embark on a retreat every now and then to sensitize people on the safety precautions to follow when using LPG, it will create massive awareness and thereby increasing the level of acceptability which will increase the level of participation and expenditure.

The study also indicates that area of residence has an impact on the choice of cooking fuel sources. Therefore giving priorities to rural households through subsidies and free cylinder distribution is imperative. This is because rural residents have free access to fuelwood and processing wood into charcoal does not come with any cost and even when purchased, comes at a cheaper price. Therefore, expecting someone to opt for a fuel source with an expensive price would be difficult. The price of fuelwood in rural areas is mostly the time spent on gathering the wood so if free cylinders are distributed for rural residents, households in the rural areas will be more willing to opt for LPG as their cooking fuel. Even though the Rural LPG promotion program was implemented by the Ministry of Petroleum to facilitate the distribution of cylinders in the rural areas, this programme had to end due to financial constraints and hence the intended target was not reached. Therefore, if the Ministry re-embarks on such a programme, then the likelihood of rural residents participating and spending more on LPG will be high.

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The results from the study established that, supply factors such as; affordability, reliability and accessibility have a significant positive impact on LPG participation and expenditure. This implies that, there is the need to embark on strategies to make LPG affordable, accessible and reliable. With affordability, the Ministry of Energy can increase the subsidy component on LPG in the price build up (same initiative was done in 1990 and it increased the annual consumption of LPG from 5000 tonnes to 34, 000 tonnes in the mid 90's.) to reduce the price of LPG. If this initiative is embark upon, then there should be regulations to avoid commercial vehicle operators from patronizing LPG as fuel for their cars since the subsidy will make LPG cheaper as compared to other fuels. This initiative is necessary because, it was the exact problem faced in the 90s that led to the scrap of the subsidy component in the LPG price build up.

The customs department of Ghana revenue Authority can introduce import duty waiver to bring down the cost of cylinders to make the use of LPG more affordable to attract households that are not participating and encourage households that are already in the market to maintain its usage and increase related spending.

Even though the Ghana National Gas Company (Ghana Gas) has been established to address shortages of LPG on the market due to supply constraints, the government through registered individuals can establish LPG retail-filling stations across the country especially in the rural areas to make LPG more reliable and accessible. The LPG bottle recirculation model should be intensified and given much attention since it can address institutional, and market constraints that hinders increasing access.

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The above-recommended policies are important in achieving the dual Government policy objective to increase LPG access to households and public institutions and ensure supply reliability.

5.4 Limitations of the Study

Since the design for the study was cross sectional, it just tell the researcher about differences and not true changes.

Additionally, the sample size even though satisfied the Greene's formula, it was not sufficiently large enough and it is susceptible to bias if the characteristics of non-respondents differ from respondents.

Lack of time and other resources (research assistants) to expand the sample population presented a major challenge. Ideally, all households in the Bono East Region should have been covered under the study but this was practically impossible hence limiting the researcher to the sample size of 220.

5.5 Suggestions for Further Research

This study focused on analyzing the choice of cooking fuel, participation and expenditure decisions in the LPG market. Future studies may have to consider undertaking the price and income elasticities of the various cooking energy sources. While the current study provides an important examination of the factors that determine participation and expenditure decisions in the LPG market, the focus was limited to only households in the Bono East Region. Thus, further research should aim at other regions of the country and the results compared to account for differences in the determinants of households expenditure on LPG in Ghana.

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APPENDIX

Questionnaire

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LPG EXPENDITURE AMONG HOUSEHOLDS

Dear Respondent

This survey aims at examining the expenditure on LPG among households in Bono East Region of Ghana. Please, you are assured that any information provided will be treated with the much needed confidence. Thank you.

1. Age (yrs): …….

2. Occupation: …….

3. Gender: please tick [√] Male [ ] Female [ ]

4. Marital Status: Please tick [√] Single [ ] Married [ ] Divorced [ ] Separated [ ]

5. How many children do you have? ……

6. Apart from your children, how many other dependents do you live with? ……

7. Educational Background, Please tick [√]

- No Education [ ]
- Basic Education [ ]
- Secondary Education [ ]
- Tertiary Education [ ]

8. How many years did you spend in school? .....

9. Is the house in which you live yours? Yes [ ] No [ ]

10. Do you have access to electricity? Yes [ ] No [ ]

11. What is your household‘s monthly income? .....

12. What is your household‘s monthly expenditure? …….

13. What proportion of income on cooking energy do you spend on the following?

- Firewood…….
- Charcoal …….
- Kerosene…….
- Electricity……

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14. Do you use LPG for cooking? Please tick [√]

Yes [ ] No [ ]

15. If yes, what proportion of income on cooking energy do you spend on LPG for cooking? …….

16. How many kilos do you normally buy? ……..

17. What amount do you spend on the kilos you buy? ……

18. How long does it last? (Number of days) .....

19. Do you perceive LPG to be reliable? Yes [ ] No [ ]

20. Do you perceive LPG to be affordable? Yes [ ] No [ ]

21. Do you perceive LPG to be accessible? Yes [ ] No [ ]

22. For what purposes do you use LPG?

- Cooking [ ]
- Heating [ ]
- Boiling water [ ]
- Others (specify) ……

23. How far is your source of LPG from your place of residence?

- 5-10 minutes' drive [ ]
- 11-20 minutes' drive [ ]
- 21-30 minutes' drive [ ]
- 31- 40 minutes' drive [ ]
- 41 and above [ ]

24. Do you face scarcity of LPG? Yes [ ] No [ ]

25. Have you had any training in the use of LPG? Yes [ ] No [ ]

26. If yes, by whom and where

…….

27. Have you had any sensitization on safety issues in connection with LPG use? Yes [ ] No [ ]

28. If yes by whom and where

……