ESTIMATING ELASTICITY FOR RESIDENTIAL ELECTRICITY DEMAND IN ADDIS ABABA

TINSAE WONDIMU

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ESTIMATING ELASTICITY FOR RESIDENTIAL ELECTRICITY DEMAND IN ADDIS ABABA

TINSAE WONDIMU ABERA

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This is to certify that the thesis prepared by Tinsae Wondimu Abera, entitled: "*ESTIMATING ELASTICITY FOR RESIDENTIAL ELECTRICITY DEMAND IN ADDIS ABABA"* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Development Economics complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Advisor	Signature	Date
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Internal Examiner	Signature	Date
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External Examiner	Signature	Date

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LIST OF ABBREVIATION

CSA	-	Central Statistical Agency
EEU	-	Ethiopian Electric utility
EEP	-	Ethiopian Electric Power
EEPCo	-	Ethiopian Electric Power Corporation
GWh	-	Gigawatt hours
ICS	-	Inter-connected System
IEA	-	International Energy Agency
KWh	-	Kilowatt hours
LPG	-	Liquefied Petroleum Gas
MoWIE	-	Ministry of Water, Irrigation and Energy
MW	-	Mega Watt
MTF	-	Multi Tire Framework
OLS	-	Ordinary List Square
SCS	-	Self-contend system
US	-	United States
W	-	Watt

ABSTRACT

This study is aimed at examining the elasticity of electricity demand and its determinants of household's electricity demand in Addis Ababa City. Besides, this study is following the electricity tariff change implemented, in an attempt to optimize electricity consumption in the country, in 2019. The effects of any price revisions on consumption will depend on the price elasticity of demand for electricity. Primary data was collected for this purpose from over four hundred households of Addis Ababa City and constant electricity model was used through OLS estimates. The electricity demand functions have been estimated using monthly consumption and expenditures of households. The study indicated that electricity demand is income, price, and also the substitute fuel price (charcoal) inelastic. Electricity is a necessity and a basic need of households in the Addis Ababa. Age, sex, own price, substitute price, income/expenditure, family size, number of rooms, household's house type and meter type are important in determining electricity demand. The study concluded that any planning associated with electricity tariff reform should consider the price elasticity of electricity demand. Moreover, the study suggested that pricing policy, at least in the long-run, can be an effective instrument for achieving electricity conservation and to manipulate consumption of traditional energy sources and energy policy planners should exploit the benefits of estimated price elasticity and income elasticities to make well informed decisions. Further the study contributes in the area of empirical electricity demand analysis.

***Key Words**: Residential electricity demand, price elasticity, income elasticity*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the Study

Access to modern, sustainable, affordable, and reliable energy services is central to addressing many of today's global development challenges. Improving households' access to energy and ensuring regular supply is considered central not only to achieve the SDG"S (Adusei L., 2012) but, also to improve the quality of life and sustain the socio-economic conditions of the people (Khandker et al., 2010).

Electricity plays a driving role in social-economic development and improvement of the quality of life of a society and it is also linked to all sectors of the economy (Ane and Ramy, 2015). Lack of access to electricity is seen as a major constraint to economic growth and increased welfare in developing countries. It drives economic and social development by increasing productivity, incomes, and employment; reducing workloads and freeing up time for other activities; and facilitating the availability of higher-quality or lower-priced products through local production (Ane and Ramy, 2015).

Ethiopia is believed to be potentially well endowed with a variety of clean energy sources, such as hydropower, geothermal, wind, and solar energy, however, much of the potential energy resources are not yet exploited (Ministry of Water, Irrigation and Energy, 2019). In 2005, the total energy production was 27.5 million tons of oil equivalent (Mtoe) and the country's electricity consumption was 2,402 Gigawatt hours (GWh). The production and consumption increased to 39.2 Mtoe and 10,558 GWh respectively in 2019 (MoWIE, 2019). In developing countries like Ethiopia, residential sector takes the dominant share of the total national energy consumption. The majority of the residential energy is used for cooking or preparation of food, and the energy carrier is mostly traditional biomass; however, the usage of modern fuels like electricity is increasing (MoWIE, 2019).

Electricity access in Ethiopia is about 44 percent which is 33 percent form gird and 11 percent from off-grid solutions (Padam *et al.*, 2018). This electricity service is limited not only by its access but also its quality in terms of its reliability is questionable (Ethiopian Electric Power and Ethiopian Electric Utility, 2017). Low access rates and lack of quality of service are directly and indirectly related to financial challenges in the Ethiopian power sector. Electricity infrastructure projects require substantial amounts of capital, and maintenance and replacement activities depend on power companies having stable cash flow. Revenue collected from the sale of electricity can be used for these activities, but current tariffs in Ethiopia are among the lowest in Africa, and are far below the cost of electricity generation (Ethiopian Electric Utility, 2021).

Energy is a conventional economic good in the sense that its demand responds to changes in relative prices, income of the consumers, population, preferences and other determinants in the same way that the majority of other goods do (Mekonnen, 2009). In addition, consumers demand energy ultimately for the services they derive from consuming it. The services derived from energy could be heating, lighting, and cooking and thus, energy products are means of fulfilling those services (Mekonnen, 2009).

Households are decentralized decision-making units, and come in all shapes and sizes. Energy consumption patterns differ from one household to another, potentially affected by economic, socio-demographic, geographic and physical characteristics. Moreover, uncertainties associated with human behavior naturally pose challenges, when considering Programs and policies that might be implemented in the residential sector. Thus, household electricity usage behavior will depend on income and the price of electricity, as well as a number of other factors, such as substitute energy sources (Ye, Koch and Jiangfeng, 2018).

All fuels in Addis Ababa are purchased. As income increases and urbanization continues modern fuel will become an increasingly important fuel source. Urban dwellers may be forced to take commercial fuels to meet their daily requirement (Birhane, 2016). According to economic theory, electricity demand will fall as the energy price increases, holding all other factors constant. Electricity tariff is an essential component of the power sector and it cannot be reformed alone without considering or making a coordinated effort towards sector wide reform (Passey *et al.*, 2017).

The policy effects of raising electricity tariffs are multifold. On one hand, raising electricity tariffs is believed to be an important measure to promote energy conservation and reduce emission. On the other hand, raising electricity tariffs will inevitably affect the welfare of the household, with differentiated effects on different social groups, such as rich versus poor or urban versus rural households. Quantitatively evaluating these policy effects needs good estimates of price and income elasticities of demand for electricity. Moreover, good estimates of price and income elasticities of demand for electricity are critical input parameters for many research studies (Shi, Zheng and Song, 2012). Thus, this study is aimed at to determine the elasticities of residential electricity demand based on data of a household survey.

1.2 Statement of the Problem

Accessibility, both economically and physically, to adequate and reliable energy sources is significant for social and economic development in any country. Economic growth and use of recent energy seem to be highly related. While developing countries are characterized by low level of per capita electricity consumption, advanced countries have already reached higher level of per capita electricity consumption. According to IEA (2018), electricity access is defining as the annual consumption of at least 250 kWh of electricity in rural areas and 500 kWh in urban areas for a household. However, the per capita consumption of electricity in Ethiopia is very low which stood at about 100 kWh per year (MoWIE, 2019).

Even though Ethiopia has been investing a lot in electricity generation, electricity access in Ethiopia is one of the lowest in Africa (Beyene, 2018). Traditional fuels are still the major sources of energy consumption in Ethiopia (Birhane, 2016). Low prevailing electricity tariffs have saddled the country with large debts, threaten the credit worthiness of government-owned power companies, and drag down the national budget (Beyene, 2018). Recognizing this problem, Ethiopian government is revising the prevailing tariff rate structure to realize cost recovery and help incentivize private sector participation in the power market, which is currently has on beginning level (EEU, 2017). Furthermore, due to the general macroeconomic policy direction towards a market oriented economy, a versatile rate of exchange and price deregulation were implemented resulting in continuous increases in prices of petroleum fuels and electricity tariff, although kerosene and electricity prices are still being subsidized (Gamtessa, 2003). The existing electrical power generation, transmission, and distribution costs are, on the average , about $0.09 per kilowatt-hour (kWh), while the present tariff for electricity lies between $0.04 and $0.06 per kWh and average electricity tariff for residential use increased from Br 0.1399 to Birr 0.3897 during the same period (EEU, 2017). Moreover, LPG price that was Birr 0.66 in September

1992 and the prices are higher as we move outside Addis since price is varied owing to differences in transportation costs (Gamtessa, 2003). Currently reached birr 28.10 in Addis Ababa.

Needless to say, the increase in prices of modern energy would however act against the government's declared objective of bringing about energy transition. The affordability issue is sort of crucial given the very low income of the people. For instance (Bereket et al,, 2002) indicated that electricity consumption is highly unaffordable for urban households in Ethiopia. Moreover, prices for commercial cooking fuels are already very high in the market for the majority of urban households. A substantial portion of the urban households continue to suffer as their incomes have not kept pace with the rising prices and face higher financial burden to meet their cooking demands. Therefore, meeting the energy requirements in sustainable manner continues to be a major challenge (Birhane, 2016).

So far in Ethiopia, a number of studies are carried out on various issues associated with urban energy demand. Some are (Asmerom, 1991; Kebede et el., 2002; Zenebe, 2007; Mekonnen, 2009; Gamtessa, 2003; Zenebe et al., 2010; Birehane, 2016). However, these studies didn't attempt to analyze the price elasticity of residential electricity demand. So, this study is unique in that it primarily aims to study the elasticity of residential electricity demand in Addis Ababa town. Besides, this study is following the electricity tariff change implemented, in an attempt to optimize electricity consumption in the country, in 2019. Put differently, this study fills the gap in research in areas of analyzing the elasticity of residential electricity demand in the capital city of the country using data collected after the electricity tariff reform. This makes the research timely and relevant and have policy implications.

1.3 Research Question

1. What are the determinants of electricity demand in Addis Ababa?
2. What are the current price and income elasticities of the residential electricity demand in the Addis Ababa?

1.4 Objective of the Study

1.4.1 General Objective

The main objective of this study is to estimate elasticities of household electricity demand and identify its determinates of electricity demand in Addis Ababa of Ethiopia.

1.4.2 Specific Objectives

The specific objectives of this research are:

i. Estimate determinants of household electricity demand
ii. Estimate household elasticity of demand for electricity price and income change

1.5 Hypothesis of the study

The research hypothesis is:

i. The price elasticity of demand for electricity in Addis Ababa households is inelastic in the short-term and elastic in the long term
ii. Households will change their consumption if electricity prices increase
iii. Household electricity demand will depend not only electricity price change but also on income and other demographic and variables related to dwelling.
iv. High electricity prices will force households to substitute alternatives

1.6 Significance of the study

Primarily, identifying the determinants of household's electricity demand and elasticity of demand for electricity price change may help the government for targeting the necessary policies towards the vulnerable groups and based on affordability. Therefore, this research is very critical because it help determine whether Ethiopian electric utility to get the desired retains from the increase (through a constant demand) or not, it's also be important to understand whether the average Addis Ababa households has the ability to pay for the new rates. Another important take out is the question of substitute products is addressed in this research.

So far, there is no study that has been carried out concerning determinants of electricity demand and elasticity of demand for electricity for electricity price change in Ethiopia in general and in Addis Ababa in particular. In doing so, the research work were contribute to the existing limited literature for Ethiopia in this area. Moreover, the result of this study is helpful for the electric utility, energy authority and other concerned bodies in providing information for guiding policy in relation to the estimates of elasticities of demand for electricity for price change.

1.7 Scope and Limitation of the study

Elasticities of demand for electricity and determinants of electricity consumption in the case of Addis Ababa city is the focus of this study. The very limitation of this study is that it doesn't include the household’s electricity appliances and appliance efficiency. It is possible to make accurate predictions of electricity consumption when we know the duration of use, and voltage of each electrical appliance. However, this data is difficult to gather by this study. In other words, this research could have been more comprehensive and meaningful had it included the number of appliances owned by the household and appliances efficiency.

1.8. Organization of the Thesis

The rest of the thesis is organized as follows. Chapter two discussed the relevant literature (theoretically and empirically) while the third chapter introduces data used and specifies the model. The fourth chapter analyzes and interprets the econometric results. The final chapter conclude the thesis with policy implications.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Theoretical Literature Review

2.1.1 Definitions and Concepts of Electricity

Electricity is a secondary energy source; it is the flow of electrical power or charge. Electricity is both a basic part of nature and one of the most widely used forms of energy. The electricity that we use is a secondary energy source because it is produced by converting primary sources of energy such as coal, natural gas, nuclear energy, solar energy, and wind energy, into electrical power. Electricity is also referred to as an *energy carrier*, which means it can be converted to other forms of energy such as mechanical energy or heat. Primary energy sources are renewable or nonrenewable energy, but the electricity we use is neither renewable nor nonrenewable (US. Energy Information Administration, 2020).

Electricity is delivered to consumers through a complex network. Electricity is generated at power plants and moves through a complex system, sometimes called the *grid*, of electricity substations, transformers, and power lines that connect electricity producers and consumers. Most local grids are interconnected for reliability and commercial purposes, forming larger, more dependable networks that enhance the coordination and planning of electricity supply (U.S. EIA, 2020). In Ethiopia, the entire electricity grid consists of hundreds of thousands of miles of high-voltage power lines and hundreds of thousands of miles of low-voltage power lines with distribution transformers that connect number of power plants to millions of electricity customers all across the country (EEU, 2017).

Both commercial and traditional energy sources are vital in the study of energy consumption. Commercial energy sources refer to modern fuels that are traded to the market place and exchanged at going market price while non-commercial energy sources refer to traditional fuels that are collected by the users or by other collector who sell fuel for customer without involving any commercial type financial transaction. However, traditional fuel does not always mean non-commercial since such fuel may have been brought commercially (Sanstad, 2011).

Electricity use has dramatically changed daily life. Despite its great importance in daily life, few people probably stop to think about what life would be like without electricity. Like air and water, people tend to take electricity for granted. However, people use electricity to do many jobs every day from lighting, cooking, backing, heating, and cooling homes to powering televisions and computers (U.S EIA, 2020). Electricity is at the heart of modern economies and it is providing a rising share of energy services. Demand for electricity is set to increase further as a result of rising household incomes, with the electrification of transport and heat, and growing demand for digital connected devices (International Energy Agency, 2019).

Lack of electricity access impairs progress in human welfare and quality of life. Directly or indirectly, electricity access enables transformative progress in education, health care, access to water, essential communications, and information, and access to financial services and opportunities for income generation. Power supply inadequacy (shortages in generation and supply) undercuts the productivity of manufacturing and commerce and reduces overall economic growth (World Bank, 2014).

2.1.2. Theoretical Rationale behind Residential energy use: a derived demand

Energy demand by the household is a derived demand, we do not demand energy per se; energy is combined with other goods, typically a capital good, in order to produce (or derive) the services we ultimately wish for. For example, we combine electricity and a TV set, oil and a heating system, gas and a stove and so on.

Most studies of residential demand for electricity use as explanatory variables income and the price of electricity, some also include the user costs of appliance holdings and the prices of alternative fuel types. The theoretical foundation of those studies is the well-known theory of consumer behavior. In this approach the utility function depends on the quantities of the commodities a household buys on the market. A more reasonable and promising starting point may be the household production theory. The study presented in this paper builds on the household production theory (Flaig, 1990; Michael and Becker, 1973; Heckman, 2015).

According to (Flaig, 1990; Michael and Becker, 1973) approach, energy is not a consumption good but an input factor to the household production process. The household production model emphasizes that market goods and services are not themselves carrying utility, but are inputs to a process that yields household-produced commodities, which, in turn, yield utility. The household production theory stresses that certain goods do not affect a household's utility directly, but rather through intermediate goods which are produced by the household using market-based goods and services and time as inputs. This opens the way to a much richer formulation of the demand function. It seems that particularly the market prices of substitutes for the goods produced at home (meals, entertainment etc.) are important additional determinants of energy consumption. In his theoretical discourse, Flaig, (1990) points out that energy is one input for providing different household services, which is reflected in the household's electricity demand model presented in chapter 3.

From an economic perspective, the demand for energy, water and household waste collection can be best viewed within the context of household production (see Michael and Becker, 1973). The demands for energy are derived demands, since these goods are not directly consumed. Energy for instance is primarily used to power consumer durables, while water is used as an input for cleaning and cooking (Linderhof, 2001). In other words, the demands for energy are derived from the demands for certain goods and services (so-called 'commodities'), such as transportation, cooling, cleaning, heating, and cooking. Moreover, consumers do not directly experience utility from the consumption of energy, water and household waste collection. Rather, they experience utility from the consumption of the commodities that are produced using these as inputs (Linderhof, 2001).

The approach by incorporating production concepts into the theory of consumption, the household production function approach implies that households respond to changes in the prices and productivities of factors, to changes in the relative shadow prices of commodities and to changes in their full real income as they attempt to minimize their costs of production and to maximize their utility (Michael and Becker, 1973). A reduction in the price of some factor of production will shift the production process toward techniques that are more intensive in the use of that factor and toward commodities that use the factor relatively intensely. The theory of derived demand implies, for example, that the relative increase in the use of the factor will be larger the greater the elasticities of substitution in production and in consumption (Michael and Becker, 1973).

As (Michael and Becker, 1973) if factor prices remain constant, an increase in the marginal productivity of some input induces several responses. To minimize costs of production, the factor's relative use in the production process will increase. Since the relative price of the commodity using this factor most intensively is reduced, the relative consumption of this commodity will increase. Since the rise in productivity raises full real income, the demand for all "normal" commodities (those with positive income elasticities) will increase. The absolute demand for the factor whose productivity rose will rise (or fall) if the combined effects of substitution in production and consumption and of expansion through the change in income outweigh (or are outweighed by) the productivity effect itself (Michael and Becker, 1973).

Economists such as (Kashian, Heinrich and Kueffer, 2016) and (Walter and Snyder, 2007) embellish that price elasticity of demand is calculated by dividing the percentage change in quantity demanded of a good by the percentage change in price that caused it, other things being equal. The price elasticity of demand summarizes how people respond to price changes for a wide variety of economic goods.

The impact of a price change on the quantity demand of goods is usually described by the price elasticity of demand. Accordingly, (Berman, Hammer and Tihansky, 1972) defines the impact for change in the price of fuels in two types, short term and long term. The short-term impact on the residential consumption of a particular fuel should be very small (inelastic) for even relatively large changes in its price. This is because consumption have a large capital investment in fuel-consuming devices, which militates against abrupt shifts to different equipment (e.g., replacing electric water heaters, stoves, dryers, or space heating with their gas counterparts) or total elimination of the devices. The “locked-in” consumer would only be able to react by reducing the intensity of use by, for example, reducing wattage and usage of lighting, careful monitoring of space heating and air conditioners (setting to more moderate temperature while home and very moderate temperature while away, closing off unused rooms, adding insulation, etc.) operating washing temperature setting on hot water heaters. Of course, those customers replacing equipment could be influenced in their purchase by major increase in fuel prices (Berman, Hammer and Tihansky, 1972).

There is considerable evidence that residential demand for electricity is price sensitive when consumers can adapt their consumption over a long period of time. In the long run, residential demand for electricity would be reduced by increases in the real price of electricity (Robert H., 1975), much of that decrease results from a shift in the mix of gas and electric household devices.

Anderson (1973), has also demonstrated that residential consumption of electricity per household is price sensitive (Anderson, 1973).

Abrate, (2001), argue that economic theory provides two expectations about price elasticity. Firstly, a higher price should reduce the quantity demanded and the price elasticity should be negative. Secondly, since more substitution can take place when more time is given, price elasticity for a given product which allow little time for substitution (short-run) will be more inelastic then when more time is allowed for substitution and the development of substitution technologies (long-run). In the long-run, elasticities are meant to incorporate both changes in utilization behavior and any adjustments to the stock of appliances owned by the household. The long-run effects of electricity price changes are an equilibrium outcome of households' appliance replacement decisions (on the demand side) and appliance manufacturers' choices of technological characteristics and prices for new appliances (on the supply side) (Berman, Hammer and Tihansky, 1972).

2.1.3. Determinants of Household Electricity Consumption

2.1.3.1 Socio-economic factors and energy

Most studies emphasize the obvious economic variable as a determinant of energy use in the household level. Both the choice of fuel type and the amount consumed are highly related to income. There is an increase in the amount of energy use as income increases. In terms of type of fuel consumed, lower income groups consume more of biomass fuels than the middle- or high-income groups. In developing countries the consumption of biomass fuel is still high in middle and high income groups, but the share of modern fuels increases in these categories (Filippini and Pachauri, 2004).

Income is a key driver of residential energy demand and perhaps more important as such than what it would seem at first glance. As we become richer, we can afford to use combinations of energy and capital goods as substitutes for, say, our input of time. For example, when buying a dish-washer, a washer or similar appliances, we can trade off some other private consumption goods to gain leisure time. Furthermore, as income increases, we might make intra-fuel substitutions and switch from one heating system to another that is likely to be more efficient. But perhaps the most useful insight we obtain from economic theory is that income encompasses many of the attitudinal variables that superficially appear to affect demand (Organisation for Economic Co-operation and Development (OECD), 2008).

With increased income, the opportunity cost of time also increases along with purchasing power, and consequently the household's willingness to pay for a better quality of fuel and greater convenience of use. Hence with an increase in income, a household is more likely to move up the energy ladder from using dirty fuel to using clean fuel. Household income is one of the important parameters influencing the choice of fuel (Rahut *et al.*, 2014).

The amount of per capita expenditure is commonly used as an economic determinant variable in energy use studies. For instance, (Pachauri, 2004) indicated that 61.4% of the total variation in per capita energy use is mainly explained by the total per capita expenditure. Employment status and educational level could also explain the variation in the amount and type of energy consumed. There is an association between occupation and energy use in that attaining higher employment status enables people to use modern energy sources (Reddy, 2004).

The other economic factor of household electricity consumption is price of the energy. If the relative price of energy increases, we expect reductions of demand *ceteris paribus*. There are different insights from the literature on price elasticities, the first point is that we must consider two kinds of price elasticities, short run and long run (OECD, 2008). The short-term impact on the residential consumption of a particular fuel should be very small (inelastic) for even relatively large changes in its price. This is because consumption have a large capital investment in fuel-consuming devices, which militates against abrupt shifts to different equipment (e.g., replacing electric water heaters, stoves, dryers, or space heating with their gas counterparts) or total elimination of the devices (Berman, Hammer and Tihansky, 1972).

On the other hand, in the long run, residential demand for electricity would be reduced by increases in the real price of electricity (Robert H., 1975), much of that decrease results from a shift in the mix of gas and electric household devices. Anderson (1973), has also demonstrated that residential consumption of electricity per household is price sensitive (Anderson, 1973). In the long-run, elasticities are meant to incorporate both changes in utilization behavior and any adjustments to the stock of appliances owned by the household. The long-run effects of electricity price changes are an equilibrium outcome of households' appliance replacement decisions (on the demand side) and appliance manufacturers' choices of technological characteristics and prices for new appliances (on the supply side) (Berman, Hammer and Tihansky, 1972).

Long-run elasticities might be considered more important, yet short-run elasticities will speak clearly about distributional consequences during a period of time when households have not fully adjusted their capital stock (OECD, 2008). Secondly, it is known from basic economic theory that there is a close link between price elasticity and substitution possibilities. Hence, when substitution possibilities are limited, price elasticities will also be small. A household facing higher energy prices can typically use a whole array of different ways to lessen the impact of the price increase on their budget (OECD, 2008).

2.1.3.2 Demographic factors and energy use

The number of households could be a more important determinant of energy use than population size (Phdungsilp, 2006). Other demographic factors like household size and composition, age and gender of the head of household, level of urbanization and dwelling attributes constitute the most important and promising variables for research in the future (O'netll Brian C. and Chen Belinda S., 2002). Among these variables' household size is the most researched variable in energy use studies.

Household size has a significant influence not only on energy use per household but on a per capita basis. The main reason for this influence of household size on per capita energy use is the prevalence of economies of scale at household level. Economies of scale indicate that as household size increases, sharing of energy services results in lower per capita energy use in household with larger size (O'netll Brian C. and Chen Belinda S., 2002). Another study indicate that an increase in household member by one result in significant decrease in the per capita energy use except with a household size of two members (Pachauri, 2004).

The age of head of household is also an important factor for the variation in energy use across households. (Pachauri, 2004) identified significant result on increase in per capita energy requirement with households at the later stage of the family life cycle. Another study by Frizsche (1981) also found out that there is a significant difference in the total and mix of energy use by stage of family life cycle. The result indicates more of an inverted U shape where by energy consumption rises throughout the child raising years. The amount of energy use at later stage decline at slower rate but remains higher than the lower stage with the same number of family number.

The other measure of energy use is the household composition that includes number of children, number of adults, ratios of children to adult and sex of household members. However, a clear variation of energy use can be distinguished between adults and children. A household with large number of children are expected to consume smaller amount of energy than adults (O'netll Brian C. and Chen Belinda S., 2002). Similarly households with members having higher levels of education are more likely to use modern fuels whereas illiterate or low levels of education in the household increases the chance of using traditional fuels (Filippini and Pachauri, 2004; Mekonnen and Köhlin, 2008).

Another household factor that can influence energy use is the housing condition that includes mainly the size, ownership, type, number of rooms and construction materials. These elements have influence on the total household energy use (Pachauri, 2004). The other important element that determines the type and amount of energy use is place of residence. Urban areas are also associated with high level of household energy use and a higher proportion of consumption of modern fuels as compared to rural areas (Dzioubinski *et al.*, 1999; O'netll Brian C. and Chen Belinda S., 2002).

Finally, other demographic changes like aging, preference of nuclear family over extended families, late age at marriage, higher divorce rates and the propensity to live alone could affect energy use in the future in developing countries. This shows that there are a number of dimensions in which demographic factors can influence household energy use. However, there is a huge gap in considering demographic variables as an important determinant of household energy use. The reason for this gap is due to shortage of studies that shows the demographic variables have influence on energy use (O'netll Brian C. and Chen Belinda S., 2002).

2.1.3.3 Other factors and energy use

The availability and extent of use of different type of appliances and the end use of energy sources influence the efficiency level of the energy used. This indirectly affects the type and amount of household energy required (Konemund, 2002). The potential, availability and price of energy sources are also another external factor that influence on the supply side. Energy policy also put its own influence on choices, innovation, cost effectiveness, subsides and access of energy sources (Hadgu *et al.*, 2013; Heltberg, 2005).

The non-economic determinants of energy use are also important aspects to look at. Non-economic determinants of energy use include attitudinal, behavioral, and cultural practices. These practices, although frequently subjective and personal, have their bases in shared material conditions and experiences. These non-economic determinants for energy use manifest themselves through lifestyle, convenience, habits, constraints, customs, preferences, priorities, control over and access to resources (Annecke, 1999). For instance, differences in life styles and culture among different household groups in terms of food and cooking habits, tastes and preferences influence energy use (Pachauri, 2004; Mekonnen and Köhlin, 2008).

Demand for energy depends on the household's preferences for goods and services. Preferences vary across populations; the elderly may well prefer an in-door temperature that does not suit the young and, as many parents of teenagers will testify, the number of showers varies with a household's demographic composition. Because preferences differ, it is obvious that two households with identical observable characteristics (income, education, sex and so on) may demand different baskets of goods, including energy goods (OECD, 2008). Detailed research by (Lutzenhiser, 1993) shows that similar households living in similar housing display widely varying energy consumption patterns.

Generally, factors that determine the frequency of use in a household also determine the total energy consumption. The stock of energy-consuming devices held by the household, which is determined to a large extent by household income. The size of the family determined the intensity of use of major appliances such as stove, washing machine, dryer, water heater, and lighting. It also influences the size and number of many devices. The size and volume of the housing unit (and the quality of its insulation) determine the intensity of use of air conditioning and space heating needed to maintain a given temperature (Berman, Hammer and Tihansky, 1972). The price of fuels influences the quantity of fuel consumed. The amount of time spent away from the household will have an effect on fuel consumption; this in turn is largely determined by the size of the family and its income (Berman, Hammer and Tihansky, 1972).

2.2. Empirical Literature Review

2.2.1. Ethiopia energy potential and production and consumption trend

Ethiopian is endowed with a huge renewable energy potential. However, the country has managed to develop insignificant amount of its potential. The country has variety of renewable energy resources including hydro, wind, geothermal, solar and bio-energy. The gross hydro-energy potential of the country is 45,000MW. The country has also a huge wind and geothermal energy resource potential estimated about 1,350 GW and more than 7,000 MW respectively (MoWIE, 2019). Regarding non-renewable energy resources, the natural gas reserve is about 112 billion m^3 and the reserve of coal is over 300 million tons. The table below shows the overall energy resource potential of the country and the exploited level of each resource so far.

Table 2.1: Indigenous energy resource potential

Resource	Unit	Exploitable Reserve	Exploitable Percent
Hydropower	MW	45,000	<30%
Solar/day	kWh/m^2	Avg. 5.5	<1%
Wind: Power Speed	GW m/s	1,350 > 6.5	<1%
Geothermal	MW	7000	<1%
Wood	Million Tons	1120	50%
Agricultural waste	Million Tons	15-20	30%
Natural gas	Billion m^3	112	0%
Coal	Million Tons	300	0%
Oil shale	Million Tons	253	0%

Source: MoWIE's Brochure, 2019

Both the total energy consumption level and share of modern sources of energy consumption in Ethiopia is one of the lowest in the world. Moreover, the energy sector is predominantly based on traditional biomass at household level, which accounts for nearly 78% of the energy needs while modern fuels contributed about 22% of total energy consumed in 2019, of which, 85% Hydrocarbon products (light petroleum products 26%, heavy petroleum products 49%, Coal 7% and petroleum Cooke 3%) and 15% electricity (MoWIE, 2019).

In 2019, the country has only 4,244 MW of installed generation capacity, with 90 percent produced from hydropower, 8 percent from wind, 2.0 percent from fossil fuels and 0.2 percent from geothermal sources. The electricity sector has experienced significant growth over the last twenty years. The electricity generation increased from 1,048 Giga Watt hour (GWh) in 1989 to 3,547 in 2008 and to 13,655 GWh in 2019 showing a 3 folds increase in the last ten years. In the same manner the electricity consumption increased from 879 GWh in 1989 to 2,836 in 2008 and to 10,558 GWh in 2019. The electricity consumption has also shown the same trend with a 3 folds increase in the last ten years (MoWIE, 2019).

2.2.2. Household Energy Demand in Ethiopia

The energy sector in Ethiopia can be generally categorized in to two major components: traditional and modern (traditional biofuel usage and modern fuels i.e electricity and petroleum). As more than 80% of the country's population is engaged in the small-scale agricultural sector and live-in rural areas, traditional energy sources represent the principal sources of energy in Ethiopia. Domestic energy requirements in rural and urban areas are mostly met from wood, animal dung and agricultural residues. At the national level it is estimated that biomass fuels meet 78 % of total energy consumed in the country (MoWIE, 2019).

In urban areas access to electricity and petroleum fuels has enabled a significant proportion of the population there to employ these for cooking and other domestic energy requirements. Access to biomass fuels has declined significantly in all areas of the country and drastically in some parts. Reduced access to woody biomass has had serious developmental and social impacts (MoWIE, 2019).

A survey by the Central Statistics Agency (CSA) in 2016 showed that about 33.76% of the total households use electric-solar for lighting followed by electricity (28.05%) and kerosene (23.82%) in Ethiopia. A higher proportion of urban residents use electricity (95.91%) for lighting, while the use of kerosene (30.56%) and solar (43.07%) are predominant in rural areas. Major types of cooking fuel used by all households are firewood, charcoal, Crop residue/leaves, dung cakes, kerosene and electricity. The use of modern source of cooking fuel such as butane gas, bio-gas, electricity and kerosene for cooking is uncommon in the rural areas (1.16 %). Use of electricity is around 21.42 present followed by purchased firewood (37.97%), Charcoal (16.73 %), collected fuelwood (16.21%) and kerosene (1.25 %) are also used by urban households (Central Statistical Agency, 2016).

In Ethiopia 90% of the total national energy consumption is in the household sub sector while industry, agriculture, transport, service and commerce sectors together constitute the remaining 10% of the energy consumption (MoWIE, 2019). Regarding of electricity consumption the domestic consumption takes the highest share at 44% seconded by the total industrial and construction consumption (Low Volt and High Volt) which is 31% and 25% in services sector (MoWIE, 2019). Accordingly, nearly 34890Ktoe of biomass is consumed for energy purposes with about 81% of the estimated 16 million households using firewood and 11.5% of them cooking with leaves and dung cakes (MoWIE, 2017).

The electricity generation capacity of Ethiopia is about 4244MW of which more than 90% is from hydro while wind, geothermal and diesel power plants are also in the mix (Ethiopian Electric Power, 2019). The total energy sales of the Inter-connected System (ICS) the main electricity grid and the Self-Contained System (SCS) separate mini grids, stand at 9242 GWh during the 2017/2018 fiscal year. The peak demand of ICS in 2018 reached about 2602.9 MW (7.4% growth as compared with 2409.45 MW in 2017) (MoWIE, 2019). Currently, Ethiopian Electric Utility riches 7,010 large and small towns in the country and have more than 3 million customers (EEU, 2019).

Electricity access in Ethiopia has been mainly stated as the area where the grid network is extended but the actual electricity connectivity of households has been very low especially in rural areas. Electrification is defined as the annual consumption of at least 250 kWh of electricity in rural areas and 500 kWh in urban areas, for a household of five (IEA, 2020). Accordingly, the per capita electricity consumption of Ethiopia is estimated to be, in rural areas is 45 kWh per month, while in urban areas is 150 kWh, a low level, compared with a Sub-Saharan Africa average of 521kWh (MoWIE, 2017).

LPG is used mainly for cooking in the urban household. The demand for LPG has declined over the last ten years (1994–2004). This is because LPG is becoming the most expensive cooking fuel in Ethiopia. The supply of LPG also dropped significantly due to decline in demand. The highest total LPG supply was 8,227 m3 in 1994 and now dropped to the level of 700 m3 in 2000. Over the same period, LPG demand declined at the rate of 23% per annum. Unlike kerosene, the demand for LPG is price elastic for higher income groups. This implies an increase in price would persuade customers to alter their behavior towards other source of energy. Since the major LPG consumers are higher income group, they switched to electricity (CSA, 2016).

Currently, for the majority of urban households in the country, prices for both traditional and commercial energy sources are already very high in the market. Most of urban residents are found to spend a lot of money on different fuels, as much as 25% of the household's income is spent on wood for cooking. This means a large economic burden on the household budget. For example, in Addis Ababa, 42.6% of the households consume fuel from biomass (wood, charcoal, crop residue, dried dung cakes) and 48.21% rely on fossil fuel and often utilize electricity for cooking (CSA, 2016).

However, many urban households of the country are beginning to change their energy consumption from using woody biomass to modern energy fuels by the thing improved stoves such as Lakech (improved charcoal stove), Mirt and also improved injera baking biomass stove, electric injera mitad and baking stoves (Birhane, 2016).

2.2.3. Household Electricity Consumption Trend of Addis Ababa

The household fuels of Addis Ababa can be categorized as modern and traditional. Electricity, kerosene and Liquid Petroleum Gas (LPG) make up the modern fuels while Charcoal, fuel wood, sawdust and dung made up the traditional fuel. EEU, which functions under MoWIE as the national power utility, indicated that 70 percent of the housing units in urban areas of the country used electricity as the main source of lighting in 2000 which increased to 75.3 percent in 2004 and 88.0 percent in 2011, but the use of electricity for cooking is limited to very few households in the larger towns. Yet over 63.3 percent of the households use firewood as the main source of fuel for cooking in urban areas of the country (Gamtessa, 2003).

Electricity consumption increased by 8.41 percent in 2016 relative to 2011. A close look at modern fuel consumption trends reveals that in 2016, electricity accounted 63.09 percent for cooking and 98 percent for lighting. LPG and other modern energy fuels has lowest share (CSA, 2016). The 12.17 percent decline in LPG consumption in 2016 relative to 2011 is very likely due to the increment in price of LPG and increment in electricity supply. Similarly, the 17.7 percent drop in charcoal consumption (CSA, 2016).

The urban socio-economic survey conducted by the Department Economics of Addis Ababa University in the year 2000 covers seven towns and cities. And study found, the number of households consuming dung cakes, leaves, crop residue, twigs and branches and LPG are very small. Taking them all together, only 20 percent of the households consume them. Thus, while they individually account for very small proportion, their share as a group is not insignificant. In terms of the number of households consuming a particular energy source, electricity is the leader followed by kerosene, charcoal, and firewood, in that order. Thus, the use of modern fuels is widespread, conforming to the salient feature of energy consumption pattern in urban centers (Gamtessa, 2003).

In addition, the study shows that the average overall expenditure is Birr 481.30 whereas energy expenditure is Birr 59.63 per month, which accounts for about 12.40 percent of the average overall households' expenditure. This is very close to data from CSA (1997) report of the 1995/96 survey that indicates that the average monthly expenditure on energy accounts for 9.24 percent. There have been significant increases in prices of kerosene and electricity tariff since 1995/96 and this may be one of the reasons behind the rise in energy budget. Addis Ababa is the leader in terms of average monthly energy expenditure and its share in the overall monthly household budget, were Birr 68.12 expended for energy (Gamtessa, 2003).

In recent years, most urban households are increasingly using electricity to cook, as the prices of other fuels such as kerosene, LPG and charcoal are rising steadily, while the price of electricity remains constant for the last eight years. While the use of electricity for cooking increased from 2.4 percent in 2004 to 6.2 percent in 2011, there has been exponential growth in recent electricity use. CSA, (2011) Electricity, which is used by about one third of urban households, is the third most important fuel for cooking / baking. Addis Ababa's highest percentages of urban households use electricity (68 percent) use it for cooking. Approximately 50% of households in Addis Ababa use electric stoves for baking.

2.2.4. Empirical literature on Elasticity of Electricity Demand

The international empirical literature estimating the price and income elasticities is abundant mainly at the country level, but only a few studies have used disaggregated/microdata. Most of these studies use aggregated time series data, and only a few micro studies use the available household-level data. Among these, a recent study (Schulte and Heindl, 2017) shows that the price elasticity of electricity demand depends on the level of total household expenditure. The study estimates both the price and expenditure elasticity of electricity demand in the residential sector in Germany. It indicates that households at higher expenditure strata react more to price changes, a change in energy price can alter the burden of energy expenditure borne by the households at different expenditure levels (Schulte and Heindl, 2017).

Filippini & Pachauri, (2004) are estimating the price and income elasticities of electricity demand in the residential sector of all urban areas of India, using disaggregate level survey data for over thirty thousand households. They classify the electricity demand function through three seasons; winter, monsoon and summer using monthly data. And they found, electricity demand is income and price inelastic in all three seasons, and that household, demographic and geographical variables are important in determining electricity demand, something that is not possible to determine using aggregate macro models alone (Filippini and Pachauri, 2004).

Damsgaard, (2003) collected a microdata set for Sweden with the explicit purpose of examining the relative importance of different explanatory variables driving electricity demand. He collected household survey data (household characteristics, size of dwelling, heating system, insulation and other energy conservation measures, the stock and use of appliances, and awareness about and interest in energy conservation issues) and he combined them with public and company register data on income, prices, consumption and local weather conditions. In all, the data set comprises 1,225 observations. He finds that the price elasticity is highest in households without direct electrical heating. The income elasticity is generally found to be low, even zero, for households having electrical heating.

Carter (2011) uses an estimated model of residential electricity demand to examine the impact of proposed tariff changes on a representative sample of 130 Barbadian households. The estimated equation results suggest that the price elasticities of demand for particular appliances varied significantly, with households that utilize solar water heating being more price elastic than households that utilize air conditioning and electric water heating electric heating. The income effects were, however, statistically insignificant, as they may have been captured by choices of appliances rather than utilization. The estimated model results were then employed to examine the effect of a proposed change in the tariff structure for electricity in Barbados. The simulated results seem to indicate that changes in the electricity rate structure are likely to have very little impact on household's demand for electricity. However, changes in consumption patterns could occur within upper consumption and upper income households (Carter, 2011).

On the other hand, studies that use panel data to estimate the price and income elasticities of residential electricity demand are vary widely across studies. A study by (Filippini, 2011) analyze electricity data at the city level for 22 Swiss cities over the period 2000 to 2006. They find that the own-price elasticities vary between -0.80 and -0.89 during the peak period and between -0.90 and -0.95 during the off-peak period (positive cross-price elasticities imply that peak and off-peak electricity are substitutes).

Reiss and White (2005) developed a model for evaluating the effects of alternative tariff designs on electricity use. The model concurrently addresses several interrelated difficulties posed by nonlinear pricing, heterogeneity in consumer price sensitivity, and consumption aggregation over appliances and time. He estimated the model using extensive data for a representative sample of 1300 Californian households, and found the mean annual electricity price elasticity for Californian households to be - 0.39 (Reiss and White, 2005).

Rehdanz, (2007) studies residential energy demand in Germany, using extensive data on energy use by a large sample of German households (more than 12 000) in 1998 and 2003. The analysis focuses on conditional demand (the capital stock is given). She includes a substantial number of socio-economic background variables in her regressions and provides some interesting insights into factors such as age and the number of children in the household. The economic key variables, income and price, significantly affect energy expenditures; the expenditure elasticity is about 0.1. She reports a gas-price elasticity at 0.43, where expenditures are limited to those for space heating and water heating. Thus, the price elasticity is equal to -0.57, which is in line with other studies on gas demand by households. As noted, she finds that the number of children is negatively correlated with energy expenditure. Overall, she finds that a set of socio-economic variables and descriptors of the building is correlated with household energy demand.

Halvorsen, Larsen. and Runa Nesbakken, (2001) use panel data to shed some useful light on price elasticity changes over time. They use the Norwegian Consumer Expenditure Survey from 1975 to 1994 within a discrete-continuous framework (see McFadden, 1977). The pooled data provide information about 23,284 households, including detailed data on household characteristics, price and temperature. Their model relates electricity consumption to appliances (freezers, refrigerators, washing-machines, dishwashers and kitchen stoves), prices of electricity, alternative heating fuels (kerosene and heating oil), socio-economic household characteristics and heating days. The key contribution is the study of the price elasticity for electricity over time; it turns out to be roughly -0.8 at the beginning of the study period (1976) and at the end (1993). Demand became price-elastic over a short spell (1981/82). The most curious finding is that the long- and short-run elasticities are virtually the same. The explanation is, according to the authors, that there are no substitutes, even in the long run. As the authors explain, they only had information about household appliances. With more information about heating alternatives, it is likely that the results would have been different. The income elasticity is found to be rather low, around 0.1, but with a slight upward trend (the maximum is around 0.2). Interestingly, the income elasticity is lowest for newly established households.

Shi, Zheng and Song, (2012), are estimating residential demand for electricity in China using a unique household level data set. They specified household electricity demand function are local electricity price, household income, and a number of social-economic variables at household level. And they found the residential demand for electricity responds rather sensitively to its own price in China. Electricity elasticities across different heterogeneous household groups (e.g., rich versus poor and rural versus urban) are also estimated. The results show that the high-income group is more price elastic than the low-income group, while rural families are more price elastic than urban families (Shi, Zheng and Song, 2012).

Zhang, (2011) estimate a causal effect of price on electricity consumption for urban households during the introduction of increasing block pricing policy in Guangdong province of China, Using difference-in-differences models with a fuzzy regression discontinuity design. They find that consumers do not respond to a smaller (approximately 8%) increase in marginal price. However, consumers do respond to a larger increase in marginal price. An approximately 40% increase in marginal price induces an approximately 35% decrease in electricity use (284 kW h per month). Their result suggests that although the increasing block pricing could affect the behavior of households with higher electricity use, there is only a limit potential to overall energy conservation.

Arthur, Bond and Willson, (2012), use household survey carried out in Mozambique during 2002/3 (IAF), and their study calculates the price and the income elasticities of demand for domestic energy, using an econometric method developed by Deaton. They found low-grade sources such as firewood and charcoal are less elastic (elasticities of −0.41 and −0.28 respectively) than candles, kerosene and electricity (respectively −0.88, −0.79 and −0.60). Income elasticities are respectively 0.45, 0.32, 0.93, 0.84 and 0.69, placing firewood and charcoal as the less responsive to income variations and candles and kerosene as the most responsive.

Zhou and Teng, (2013), uses annual urban household survey data of Sichuan Province from 2007 to 2009 to estimate the income and price elasticities of residential electricity demand, along with the effects of lifestyle- related variables. They found that in the urban area of Sichuan province, the residential electricity demand is price- and income-inelastic, with price and income elasticities ranging from -0.35 to -0.50 and from 0.14 to 0.33, respectively. Such lifestyle-related variables as demographic variables, dwelling size and holdings of home appliances, are also important determinants of residential electricity demand. Their search findings imply that urban residential electricity demand continues to increase with the growth of income.

Meier, Jamasb and Orea, (2013) investigate the relationship between household income and expenditure on energy services in the United Kingdom. As a key-result, Meier et al. (2013) find that the income elasticity of electricity and gas demand is contingent on household income. Households with low income exhibit a rather low-income elasticity of energy demand (about 0.2). Households at the top end of the income distribution exhibit an income elasticity of up to about 0.6.

Narayan, Smyth and Prasad, (2007) examine the household electricity demand in the G7 countries over several decades. In a panel co-integration framework, Narayan, Smyth and Prasad, (2007) use per capita annual electricity consumption as dependent variable and per capita income as well as energy prices as explanatory variable. The authors find strong evidence for panel co-integration, which implies that there are deterministic or stochastic trends in the time-series data, for example economic trends as described by Fouquet (2014). Narayan, Smyth and Prasad, (2007) find that long-run residential demand for electricity in the G7 countries is income inelastic and price elastic.

Krishnamurthy and Kriström, (2015) provide an empirical analysis of electricity demand, i.e., by estimating price elasticities for selected OECD countries based on household survey data from 2011. The sample does not include Germany, the country considered in this study, and there is no differentiation by income or size of households. However, (Krishnamurthy and Kriström, 2015) find rather strong differences in the price sensitivity of consumers across the considered countries. Price elasticities range from about -0.3 (South Korea, the Netherlands) up to -1.5 (Australia).

2.2.5. Empirical Literature on Determinates of Electricity Demand

A study by Bedir, Hasselaar and Itard, (2013) on the determinants of electricity consumption in Dutch dwellings shows that there is no correlation between the location of appliances, the existence and duration of mechanical ventilation, the number of energy-saving light bulbs in the living room, or in the rest of the house and electricity consumption. Home ownership and electricity exclusive rent are not significant predictors of electricity consumption. Gender, education, existence of elderly people and infants in the household, change in household composition do not influence electricity consumption.

Yohanis et al.,(2008) monitored 27 dwellings in detail in Northern Ireland for a year. Type of dwelling, location, ownership and size, household appliances, number of occupants, income, age, and occupancy patterns seemed to have a significant influence on electricity consumption. They found a clear correlation between electricity consumption and floor area and that electricity consumption per person decreased as the household size increased. The electricity consumption for homes that were occupied during the day by unemployed or retired people was generally lower. In homes with no daytime occupant's electricity consumption was 2.5 times higher than the average in total, and 1.5 times higher during the day than those occupied during the day. They had peak consumptions in the morning (prior to working hours) and in the evening. Houses with no presence during the day had a bigger floor area than the others and were occupied by higher income families, which could explain the higher average electricity consumption (Yohanis *et al.*, 2008).

Brounen, Nils and Quigley, (2012) examine the driving forces of residential energy use in the Netherlands with a strong focus on demographic characteristics. Their main findings are that space heating is largely determined by the characteristics of the occupied dwelling (space, age, building type) while electricity consumption is strongly driven by household composition. These results imply that equivalence scales for electricity consumption and space heating may differ because of the different driving forces of consumption. With respect to space heating Rehdanz, (2007) and (Meier and Rehdanz, 2010) also find a strong influence of non-pecuniary variables (i.e. property ownership). Furthermore, (Rehdanz, 2007) shows that the actual type of heating system - in particular the type of used fuels - can have a strong influence on the price sensitivity of households.

Huang, (2015), employs quantile regression to analyze the determinants of household electricity consumption in Taiwan over the period 1981- 2011. They found that the effects of demographic, socioeconomic, and household dwelling characteristics on household electricity consumption may differ across quantiles and may change over time. And also, household income and household size were significant in all quantiles for each year. They identify the characteristics of high electricity consuming households. Households with higher income, larger household size, and more elderly members consumed more electricity. In terms of dwelling attributes, larger housing areas, homes with more appliances, and owner-occupied, business-used, and multi-floor houses contributed to higher household electricity consumption. Strategies for reducing electricity consumption should focus on specific groups that tend to exhibit higher electricity use. However, they also found that the low-income and small-size households may have higher electricity consumption on a per capita basis. Thus, as household size decreased, the increase of per capita electricity demand driven by the change of household size should be a matter of concern.

Ndiaye and Gabriel, (2011) carried out a survey on dwelling characteristics and problems and household members in 40,000 households in Ireland (National Survey on Housing Quality NSHQ). The survey included data on the main electricity-consuming appliances (order in the number of dwellings that possess these appliances: refrigerator, telephone, TV, VCR, microwave oven, washing machine, freezer, dryer, electric shower, personal computer, dishwasher). The other variables were years of residence in the dwelling, dwelling value, location of the dwelling, ownership of dwelling, dwelling type, dwelling age, weekly income, electricity tariff, occupant age, occupation, and household composition. All variables were found to be significant. The regression analysis showed that the factors that increase electricity consumption were electricity tariff (low tariff households consumed more household is on low tariff for off-peak mains electricity; this is normally used by households with electric central heating), house value (high-value dwellings consumed more), income (high-income households consumed more), dwelling age (more recent dwellings consumed more) and household type (consumption was higher in households with elderly people or children). The factors that have a negative influence on electricity consumption are years of residence in dwelling (shorter occupation in the dwelling = lower consumption), ownership of dwelling (tenants used less), occupation (groups that were present less often used less), dwelling type (apartments, semi-detached, terraced houses used less than detached houses), location (nonurban dwellings used more), age (people over 64 used less than the people below 40, and people below 40 used less than people between 40 and 64).

Baker and Rylatt, (2008) conducted a questionnaire in 190 dwellings in Leicester and Sheffield in the UK in 2005. The predictors were floor area, occupancy, age, number of rooms, number of bedrooms, home working, main heating, number of TVs, Digi boxes, PCs, portable electric heaters in use, and showers per week. The regression analysis showed that all the variables had a significant influence on increasing the electricity consumption in dwellings. Number of bedrooms and home working were the most important parameters for electricity consumption.

Tiwari, (2000) using regression model on the 1987–1988 household survey of the Bombay Metropolitan Regional Development Authority (BMRDA), which included a total of 6358 dwellings, analyzed the impact of the structure of the dwelling, age of the dwelling, location of the dwelling, number of rooms, household size, age of respondent, appliance index (ownership of an appliance and the voltage), income and electricity tariff on electricity consumption. The electricity consumption increased with the income of the family, household size, age of the dwelling, number of rooms, age of respondent, and appliance index and decreased as the electricity tariff increased

Birhane, (2016), assess the patterns and determinants of household energy consumption among poor family in woreda 8 of Althad village, Addis Ababa using percentage and simple correlation techniques. And found that the largest share of the domestic energy comes from the modern fuels in terms of expenditure and gross energy consumed. However, the majority of the people depend on traditional fuels. The study also reveals that the amount of monthly expenditure on different types of household energy varies depending upon the types of energy sources, which mainly determined by household income, size and appliance. The amount of both gross and useful domestic energy consumed increases with the increase of household income. Relatively higher income households consume more energy, while low-income households utilize inadequate energy. Large share of low income groups consume traditional fuels (Birhane, 2016).

(Ahmed, 2016), investigating the linkages between energy, gender disparity and income poverty among urban and per-urban households residing both in and surrounding parts of Arba-Minch town, performed regression analysis using cross-sectional data to identify major determinants of household end-use energy consumption. And found that, the household income as the most important factor determining household consumption of end-use energy but, other socioeconomic characteristics were also found to have a considerable effect on households' fuel preferences (Ahmed, 2016).

Gamtessa, (2003), examine the energy demand and consumption pattern of households in selected urban areas, performing censored least absolute deviation estimation (CLAD) of demand functions using micro data indicates that demand for all forms of energy is price elastic. Cross price relations indicate that kerosene is a substitute for both charcoal and firewood, whereas electricity is a substitute for all the three. Charcoal and firewood are complements. The result that electricity is a substitute for all forms of energy gives indication that the long-run option in ensuring energy transition is to harness the huge hydro-electric generation potential of the country. All the energy sources considered were found to have income elasticities very close to one owing to the fact that energy consumption is a necessity (Gamtessa, 2003).

2.2.6. Summary of Empirical Literature

The empirical literature estimating the price and income elasticities is abundant mainly at the country level, but only a few studies have used disaggregated/microdata (e.g., Gamtessa, 2003; Moshiri and Martinez Santillan, 2018; Zhang, 2011; Moshiri, 2015; Zhou and Teng, 2013; Arthur, Bond and Willson, 2012; Filippini and Pachauri, 2004).

The differences in techniques lead to criticisms and counter-criticisms over the techniques used, but no one technique has ever been shown to be either especially good or especially bad in price elasticity estimation. The selection of models depends mainly on the availability of data and the objectives of the research. Demand for energy is generally quite price-inelastic. There is some consensus on the short-run price elasticity being about 0.3. The long-run price elasticity could be 0.7. The important point is that energy demand responds to price in a non-negligible manner over the long run. Moreover, demand for energy responds to income, but the response varies substantially across studies. The income elasticity is likely to be lower than unity, even in the longer run. It is much lower in the short run. More recent estimates tend to suggest rather low-income elasticities.

The empirical studies that related with energy consumption and demographic variables like age, family size and educational level. In some studies, the relationship is negative, in others non-significant; yet there are studies that find positive relationships. Insofar as the impact of demographic variables on energy consumption can be detached from the impact of income, empirics suggest that energy consumption varies over the life cycle and cultural practices.

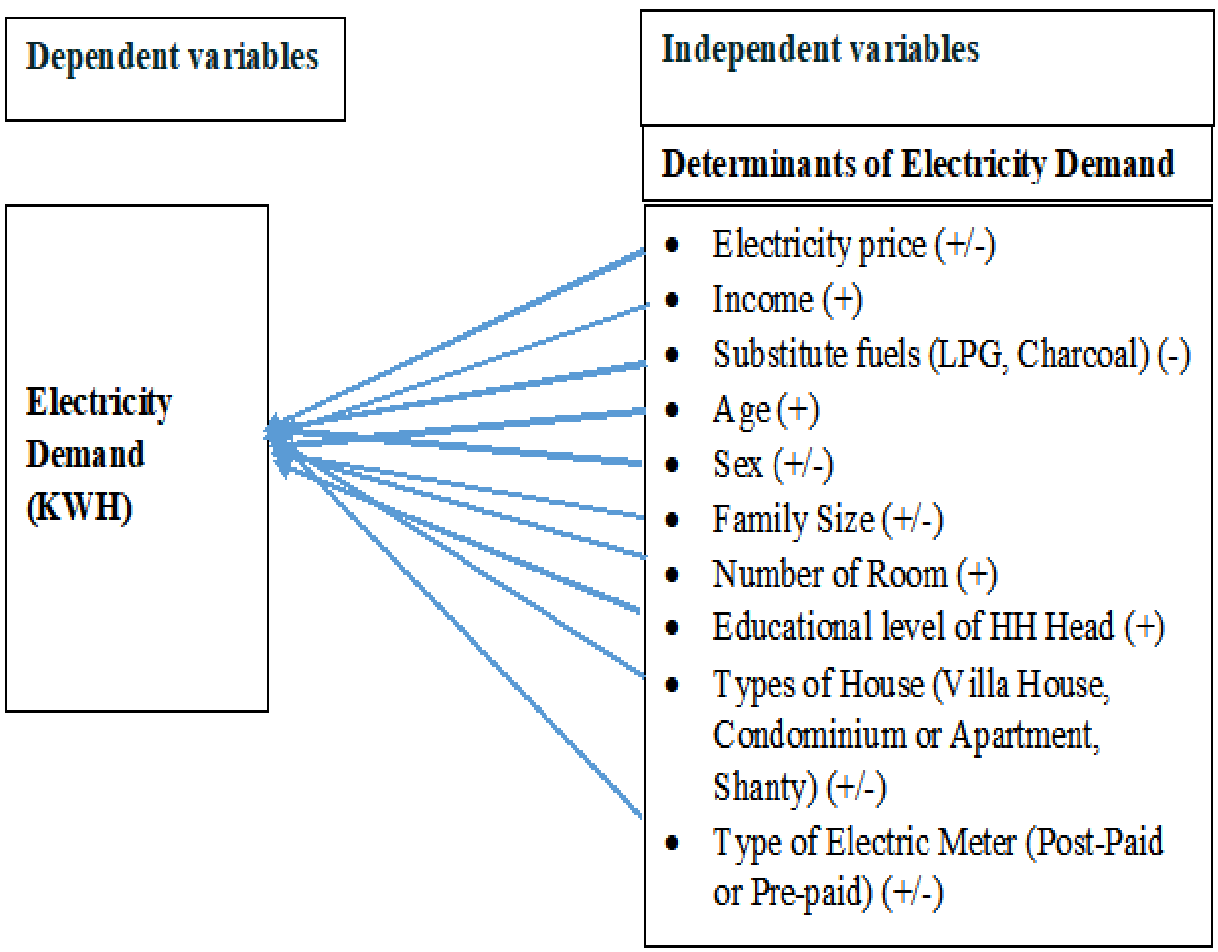
Finally, the residential energy demand includes contributions by, *inter alia*, engineers, economists and researchers from other social sciences. Economists tend to stress the importance of economic variables such as price and income, engineers the existence of technological solutions (and the tardiness of adoption, the so-called energy paradox), while the force of attitudinal factors are focal points in studies by other social scientists. The relative importance of the factors thought to affect residential energy demand remains debated. Even so, empirical evidence strongly suggests that energy prices and income affect demand; the role of attitudinal variables is more uncertain.

2.3 Conceptual Framework of the Study

Following this theoretical illustration, conceptual framework of the study is presented in Figure 2.1. This Figure shows the relationship between household electricity consumption and the determinants which are; electricity price, household income, price of substitutes (Liquefied Petroleum Gas (LPG) and charcoal), and some demographic (Age, sex), and Variables related to dwelling (the household size, the room numbers of the dwelling, the educational level, types of homes the households living and types of electric meter) with their own measurements and expected impact were, positive or negative. Household income and electricity price are two important economic variables that are assumed to determine household electricity demand. Since electricity is not the only energy source for a household, electricity demand can also be influenced by the price of other alternative fuels (Liquefied Petroleum Gas (LPG) and Charcoal). Hosier and Kipondya, (1993) indicated that urban households mainly depend on modern energy sources like electricity. A number of factors influence the type of energy sources used by households among which household income is the most significant factor.

In general, high price or shortage of energy is a broad and complex concept which is determined by family income, family size, and appliances used and types of energy used. When the reverse situation occurs, the community tries to cope up the impact by using available resources in the area (Birhane, 2016). The other factors that characterize the pattern of energy consumption is that the higher the socioeconomic status and level of education of the households, the higher the amount of energy consumed and the chance to use modern fuels like electricity and LPG (Sokona, 1997).

Figure 2.1: Conceptual framework of the study



Source: Authors creation, 2021

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

The study was carried out in Addis Ababa city, the capital city of Ethiopia, which is located close to the equator at an altitude of roughly twenty-three hundred meters above sea level, where it enjoys a mild climate. The city has a complex mix of highland climate zones, with temperature differences of up to 10°C depending on elevation and prevailing wind patterns (Selamawit, 2018). Regarding the climate condition, with an average elevation is 2,500 meters above sea level; Addis Ababa has a fairly favorable climate and moderate weather conditions (Addis Ababa City Administration, 2019).

Geographically speaking it is located between 8055’ and 9005’ North Latitude and between 38040’ and 38050’ East Longitude. The city covers an area of 54,000 hectares and has the largest city in the country by population, with a total population of 4,793,699 according to UN World Urbanization Prospects on 2020. The city center has extremely high density (up to 30,000 people per km), concentrating around 30% of the population on 8% of the land, generally with poor living conditions (Ibid.). It is composed of City Government at the top, 10 Sub City Administrations in the Middle, and 116 woredas Administrations at the bottom (Office of the mayor Addis Ababa, 2019).

Addis Ababa is significant for Ethiopia aspiration of vision 2025, which is to become middle-income country. Its economy grows by 14% annually. The city alone currently contributes 34 percent approximately 50 percent towards of the national GDP. Despite this, the city faces significant development challenges. For example, unemployment is estimated at 23.5%, while poverty is 22% (Tesfaye, 2015). Electricity is the major sources of energy. Most households rely on electricity rather than using biomass fuel for both cooking and lightening purposes. Light petroleum Gas (LPG), Kerosene and other biomass fuels (wood & charcoal, and agricultural residues) are still the major substitute of energy goods.

3.2 Research Approach and Design

The research employed a household-based cross-sectional survey on Addis Ababa to collect information from selected households. The questionnaires have been designed to capture both the actual and perceptional information from the households. The questions are basically aimed at gathering information about household's monthly electric consumption and price, alternative energy sources price and household income and characteristics, magnitude of the expenditure made by the household in different type of energy, dwelling type, electric meter type (Pre-paid or Post-paid), data related to the perception of the new electric price change, households' practices and attributes. By using quantitative research approach, the researcher collected objective reality and numeric facts.

3.3 Data Types and Methods of Collections

The major sources of data include both primary and secondary sources. To obtain primary information, data was collected through household survey. The questionnaire was first prepared in English and translated into Amharic. In the survey, the questionnaire was administered through face-to-face interview. The questionnaire has been conducted with the head of the sample households. It was designed in such a way that it provides information on the household size and its income level, the types of energy sources used by the household, the magnitude of expenditure made by a household on different types of energy and the types of energy sources used, the amount of electricity consumption, other substituted fuel used, and to know other factors that determine electricity consumption in the household.

Secondary data were collected from Addis Ababa city administration, sub cities vital event registration offices and Health offices working plan and performance reports. To determine household sample size, the study used secondary sources such as current work plan and performance reports of the sub cites relevant offices.

In this study the researcher used methods of data collection which are helpful to capture the relevant data for the study. To gather primary data from sampled household, the researcher used household survey. According to (Peter, Cilve and Stevenson, 1992), this technique helps the researcher to contact a large number of people at short period of time and to collect factual information in order to classify people and their circumstances to gather straightforward information relating to the determinates of the household's electricity demand, the cause of elasticity of demand for electricity, households perception of the new tariff change, the effects of electricity price change on their income, strategies that could adopt by the households to decrease the burden of electricity prices increment.

The research was conducted by the administering of a questionnaire was used close-ended types of questions. The questionnaire was refined prior to fieldwork, through discussion and joint review with enumerators; pretesting of the questionnaire was undertaken with a few households before the main sample interviews. Any problems in the content of the questionnaires and other instruments were resolved during the pre-test.

In the field work conducted, data on the consumption of energy resources for this study were gathered in terms of expenditure. Estimates of fuel consumption were made based on the respondents 'estimates of their monthly use both in quantity and birr. The respondents were asked to show their monthly electricity bill if they use post-paid meter and if they use per-paid meter they asked their monthly basis expenditure. Thus, the expenditure on household electricity should be converted to the unit of energy (KWh) resources consumed by a household. Secondary data were collected by reviewing current reports on electricity and energy consumption on Addis Ababa city and the country, previous research thesis on energy consumption.

3.4 Sample Design

3.4.1 Sample Size Determination

The target population for the study was the Addis Ababa households, who own electric meter residing within the city. Two-stage sampling technique was applied to select the sample households. In the first stage, sample sub-city (the primary sampling units) was selected by employing simple random sampling technique and then sample enumeration areas within the selected sub-city (the secondary sampling units) were selected purposely using stratified random sampling method and then sample households (respondents) were selected from each enumeration area, by random walk technique.

For sampling purposes, the selected sub-city (Akaki kality, Bole, Gulela and Lideta) were categorized into three strata based on the dominance of the type of residential housing units, were selected by the sub-city administration expert/personnel. After classifying the sub-city into three strata, three enumeration areas from each sub-city were selected. Stratum one (enumeration area with more shanty houses) has four enumeration areas, namely, Akaki, Goro, Menen and Berbera Berenda. Stratum two (enumeration area with more of better off housing units or villa houses) has four enumeration areas, namely, Teruneshe Bajing, Shala, Ras Deasta and Tore Hayeloche. Stratum three (enumeration area with more Condominium or Apartment houses) has four enumeration areas, namely, Tulu Dimtu, Hayat, Afincho Bere and Balecha Area. After identifying the sample enumeration area, households (respondents) will be selected by random walk technique. The total determined sample size was distributed proportionally for each randomly selected enumeration areas within the stratums.

3.4.2 Sampling Techniques

In this study the researcher determines sample size based on Yamane (1967, p.886). The target populations of this study are 400 households in Addis Ababa who have electric meter. The data obtained from Ethiopian Electric utility shows 805,295 domestic category households own electric meter (both Pre-paid & Post-Paid) and having electric access. Therefore, the researcher will be confident at 95% regarding the values of sample in relation to true value of population at specified level of precision (e=0.05). This level of significances was estimated by the researcher in order to manage the sample in terms of cost and time and by considering the homogeneity assumption of energy use by respondents. As margin of error reduce the confidence level increases and the desired sample becomes too large to manage within the scope of time of study and budget at researches hand.

The simplified formula developed by Yamane (1967) are written as follows

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

Where n is the sample size, N the population (total household size) and e is the level of precision or sample error.

$$n = \frac{805{,}298}{1 + 805{,}298(0.05^2)}$$

$$n = \frac{805{,}298}{1 + 805{,}298(0.0025)}$$

$$n = \frac{805{,}298}{2014}$$

$$n \approx 400$$

A total of 400 households are included in the sample from selected twelve stratums/enumeration areas. This sample size was proportionally distributed for each selected stratum. According to the criteria, the household should have an electric meter in the houses. Due to the presence of shared connections, the study uses those who own electric meters rather than shared households, shared household will be exclude.

Table 3.1: Determination of sample households across sub-cities

Sub-City	Stratums in Woreda	Households Size	Proportional Percentage	Sample Household Size
Akaki Kaliti	3	24,494	0.08	31
	1	28,137	0.09	35
	13	15,760	0.05	20
Bole	9	42,991	0.14	54
	3	46,267	0.15	58
	10	14,563	0.05	18
Gulela	3	23,301	0.07	29
	8	63,505	0.20	80
	4	14,528	0.05	18
Lideta	5	20,685	0.07	26
	2	10,172	0.03	13
	8	12,800	0.04	16
Total				**400**

Source: Addis Ababa city Administration

3.5 Method of Data Analysis

Descriptive analysis

The study focused estimating the elasticity of residential electricity demand in Addis Ababa city. Hence, a descriptive statistical technique was employed in the assumption that it would help to search a large variety of data related to the problem under the study. Data results were organized and summarized by descriptive statistics which were presented in the form of tables and graphs. Statistical results were conducted by using the STATA software version 14 while econometric analysis also done though this software that analyzing the data collects through questionnaire.

An electricity demand model

The residential demand for electricity is a demand derived from the demand for a well-lit house, cooked food, hot water, etc., and can be specified using the basic framework of household production theory (Flaig, 1990). According to this theory, households purchase "goods" on the market which serve as inputs that are used in production processes, to produce the "commodities" which appear as arguments in the household's utility function. In our specific case, a household combines electricity and capital equipment to produce a composite energy commodity.

Therefore, the household's utility function can be written as:

$$U= U\ (S\ (E, CS), X; D, H) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where S is the composite energy commodity, E is electricity, X a purchased composite numeraire good that directly yields utility, while D and H represent demographic and variables related to dwelling which determine the household's preferences.

In this framework the household's decision can be thought of as a two-stage optimization problem. In the first stage, the consumer behaves as a firm, and the objective is to minimize the cost of producing S, whereas in the second stage of the optimization problem, the household maximizes its utility.

Following household production theory, the optimal input demand functions for E can be written as:

$$E = E\ (P_E, P_{CS}, Y; D, H) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2)$$

Where P_E is the electricity price, P_{CS} is the price of the electrical appliances and Y is income. Equations (2) reflect the long run equilibrium of the household. This model is static in that it assumes an instantaneous adjustment to new equilibrium values when prices or income change. Specifically, it is assumed that households can change both their rate of utilization. Therefore, we can expect two types of consumer responses to an increase in the price of electricity. In the short run, a household can lower the rate with which it utilizes its current stock of appliances, for example by adjusting lighting system and water heaters. In the long run, since changes in P_E can result in changes in the relative prices of inputs, it may alter the mix of inputs. This may lead households to adjust more electricity efficient appliances than less electricity efficient appliances.

This study will use a single equation approach to model the residential demand for electricity and it will postulate that the demand for electricity depends on the price of electricity, the prices of substitute fuels, income and some demographic and variables related to dwelling. Due to different limitations this study was not able to estimate the price of the electrical appliances (Pcs). This is a common problem that arises when using aggregate data. Moreover, cross-section data on appliance prices are not available. Therefore, they may be excluded from the model without causing bias in estimation (Robert H., 1975).

The empirical model, based on equation (2), can be represented by the following demand function:

$$E = E\,(P_E, P_K, P_c, Y, HS, AD, ED\ DHT, DPP) \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Were,

E = monthly residential electricity consumption per household in kWh;

P_E = electricity price in birr per kWh;

P_K = Liquefied Petroleum Gas (LPG) price in birr per liter;

Pc = Charcoal price in birr per kg;

Y = Household personal income, approximated by total expenditure;

HS = Number of household members living in the household;

AD = Number of rooms of the dwelling;

ED = Educational level of HH head;

DHT = dummy variable to control for the difference of the amount of electricity consumption, which depend on the types of houses that households live, i.e., Villa House, Condominium and Shanty Houses. The value of the dummy variable that takes a value of 1 if the household lives in Villa and 0 otherwise.

DPP = dummy variable to control the effect of behavioral differences on electricity consumption. The value of this dummy variable is equal to 1 for households have pre-paid meter and 0 is for post-paid meter.

The variables number of household members living in the household and room numbers of the dwelling, and educational level of the household, are included in the model in order to take into account the effect on electricity consumption of the size of the household.

The dummy variable for the types of houses that the households living is entered in the model, in order to take into account, the impact of having big house or not on the amount of electricity consumption. The basic hypothesis on households having pre-paid or post-paid meter is that households having pre-paid meter have more awareness on the amount of electricity they consume than post-paid meter households, which have greater possibilities on household's behavioral change on their electricity consumption.

Estimation of demand function (3) requires the specification of a functional form. The log-log form offers an appropriate functional form for answering questions about price and income elasticities. In most of the literature surveyed, the constant elasticity model was used through OLS. Hence, this study also used the constant elasticity model. The major advantage, of course, is that the estimated coefficients amount to elasticities, which are, therefore, assumed to be constant.

The equation to be estimated is:

$$\ln E = \alpha_0 + \alpha_{PE} \ln PE + \alpha_{PK} \ln PK + \alpha_{PC} \ln PC + \alpha_Y \ln Y + \alpha_{HS} \ln HS + \alpha_{AD} \ln AD + \alpha_{ED} \ln ED + \alpha_{DTH} \ln DTH + \alpha_{DPP} \ln DPP \text{ --------------------------------------- (4)}$$

Since it is reasonable to assume that in a cross-section the observed difference in consumption of electricity represents not only variation in the utilization rate but also stock adjustment, estimates based on cross-sectional data are conventionally interpreted as long-run elasticities.

3.6 Definition of Measurements, and Hypothesis

3.6.1 Dependent Variable

The dependent variable is household electricity consumption, defined as monthly electricity use per household and measured in kWh (see (Alberini & Filippini, 2011; Romero-Jordán, Peñasco and Del Río, 2014; (Huang, 2015)). This monthly electricity demand is assumed to be a function of the electricity price, household income, price of substitutes (Liquefied Petroleum Gas (LPG) and charcoal), and some demographic (Age, sex), and Variables related to dwelling (the household size, the room numbers of the dwelling, the educational level, types of homes the households living and types of electric meter).

Household income and electricity price are two important economic variables that are assumed to determine household electricity demand. Since electricity is not the only energy source for a household, electricity demand can also be influenced by the price of other alternative fuels (Liquefied Petroleum Gas (LPG) and Charcoal). Therefore, the study includes the price of LPG and Charcoal in the estimation of the demand functions. These are also included in the model in order to test the hypothesis of whether these fuels are in anyway complementary to or substitutes for electricity. Educational level also included to see the household's consumption behaviors. Demographic variables like age, sex can also influence electricity consumption. Electricity demand can also be influenced by the number of rooms and family size through by size and numbers increments. The dummy variables types of dwelling that the household live and type of electric meter can also influence electricity demand.

3.6.2 Independent Variables

The choice of independent variables used in the study is influenced by literature reviewed on factors that determine household's electricity consumption in the urban area. Research findings and the knowledge about determinants of electricity demand in the urban area could be, price of electricity or its own price, household income, the price of substitutes energy sources (Liquefied Petroleum Gas (LPG) and charcoal), educational level, family size, other demographic variables, and Variables related to dwelling like, room numbers of the dwelling, type of homes the households living and types of electric meter. Let's discuss each one by one as follow:

Electricity Price

The variable electricity price is one of the predictors of electricity consumption. And the electricity price is defined as monthly electricity use per household and measured by the household monthly electricity expenditure divided by the quantity of household electricity consumption. This study assume electricity demand is influenced by its own price, the higher electric price the lower electric demand. However, it may could depend on the income of the household and price of substitute fuels. On the other hand, a rise in electricity prices *ceteris paribus* will lead to a fall in quantity demanded. As (Amusa, H., Amusa, K., Mabugu, 2009) analyzed the determinants of aggregate demand for electricity in South Africa by using bounds testing approach in an autoregressive distributed lag framework during the period 1960 to 2007. The results showed that demand for electricity was greatly affected by changes in income. However, the study found that changes in price of electricity had no effect on the demand for electricity.

Household Income

Household income is the main predictor of electricity consumption, common to all existing research. And household income is defined as monthly expenditure per household and measured by household's monthly expenditure (see (Pachauri, 2004)). The higher household income the more electric consumption will be expected. This study assumes that households in high income group will consume more electric than lower income group. Moreover, electricity can be regarded as a normal good (service) and, thus, higher disposable income is expected to increase consumption through greater economic activity and purchases of electricity using appliances in both the short- and long-run.

Most studies have indicated that income has a positive effect on household energy consumption (Pachauri, 2004; Cayla, Maizi and Marchand, 2011). In addition, household income influences the implicit discount rate when households purchase equipment. Higher income households would have the ability to invest in energy-efficient appliances, which would thereby lead to reduced electricity consumption (Sardianou, 2007).

Price of Substitute Fuels

The variable substitute fuel is most common predictor of electricity consumption. And substitute fuels price is defined as monthly substitute fuels (LPG and Charcoal) will be used per household and measured by the household monthly substitute fuels (LPG and Charcoal) expenditure price (see (Filippini and Pachauri, 2004; Carter, Craigwell and Moore, 2012). This study is assuming the price of substitute fuels influence electricity demand. The lower price of substitute fuel relative to electric could shift households to use substitute fuels. Households could also use substitute fuel on the time of power off and on low power voltage time. Economic theory suggests that electricity purchases will depend on the prices of its substitutes such as fuel oil. The independent influence of alternate fuel prices is rather small because of the response by suppliers and the constraints faced by consumers in fuel switching.

Household Head Educational Level

Household head educational level is the common predictor of electricity consumption. And it will be measured by the highest level of educational obtained by household heads in each households (see(Huang, 2015; Filippini and Pachauri, 2004). The study assumes that households having higher educational level will change and understand their consumption behavior. Previous studies showed two different views about the effects of education on electricity use. On the one hand, education level is associated with higher economic status. More educated people may pursue a higher quality of life and consume more electricity than the less educated. When household members were receiving their education, there was more expenditure on energy in term of lighting (Miah *et al.*, 2011). On the other hand, education can improve the level of knowledge about nature and the environment. People with higher education may tend to have more environmental concern and demonstrate stronger pro-environmental attitudes (Casey and Scott, 2006). Thus, the more educated may be more likely to save energy.

Moreover, it may be that those with higher education have greater capacity than the less well educated to understand more complicated cost-reflective tariffs, as well as the various opportunities available to them to change their electricity consumption behavior. They might also more confidently anticipate success in actually making the required behavioral changes, and thereby gaining maximum benefit from the new pricing plan. The better educated may also have a stronger understanding of the social and environmental impacts of peak consumption, and the shared consequences of failing to address it. Certainly there is evidence that better educated consumers do tend to reduce critical-peak period electricity consumption more than their less well educated counterparts (Faruqui and George, 2005).

Family size

Household size is the main and most common predictor of electricity consumption, common to all existing research. And it will be measured by the number of member of the household (relatives and non-relatives) in each households (see (Zhou and Teng, 2013; Filippini and Pachauri, 2004)). The higher family size the more electricity consumption will be expected. This study assumes that households with large family size will consume more electric than low household's size. The rationale behind is even if the households have some amount of appliance the tendency or usage of those appliance will the same with some members of the household left the house. On the other hand, households with more electric appliance and low family size are assumed to be the tendency of using those appliances is low, once some of the family members left the house some appliances could be off.

Number of Rooms

The variable numbers of room are one of common predictor of electricity consumption. And it will measured by the number of rooms that each households have (see (Zhou and Teng, 2013; Louw *et al.*, 2008; Huang, 2015) . This study assume households with more numbers of rooms will consume more electricity than having households with less room number. The rationale behind is that if number of rooms increase in the household the tendency of using appliance like lighting, heating, cooling, and another appliance will also increase.

Type of Dwelling

The dummy variable household dwelling type could influence electric consumption. And it will be measured households having Vila will be sign 1 and households having condominium and Shanty will be sign 0. The study assumes that households who live in villa type house will consume more than condominium and shanty. Households live in villa type house assumed to have more electric appliance than condominium and shanty. As (Brounen, Nils and Quigley, 2012) conducted an analysis on a sample of more than 300,000 Dutch homes and their occupants (Central Office for Statistics, Netherlands database). The results indicated that residential electricity consumption varied directly with household composition, in particular income and family composition. Dwelling size is strongly related to total energy consumption; electricity consumption is substantially larger in detached and semi-detached houses than in row houses or apartments. Besides, an additional room decreases electricity consumption by 0.5 percent.

According (Tiwari, 2000) regression model on the 1987–1988 household survey of the Bombay Metropolitan Regional Development Authority (BMRDA), which included a total of 6358 dwellings, analyzed the impact of the structure of the dwelling, age of the dwelling, location of the dwelling, number of rooms, household size, age of respondent, appliance index (ownership of an appliance and the voltage), income and electricity tariff on electricity consumption. The electricity consumption increased with the income of the family, household size, age of the dwelling, number of rooms, age of respondent, and appliance index and decreased as the electricity tariff increased.

Type of Electric Meter

The dummy variable electric meter could also influence the electric consumption. Electric meter divided in two types, Post-paid and Pre-paid electric meter. And it will be measured by households having post-paid meter will be sign 1 and having pre-paid will be sign 0. The study assumes that households who owned pre-paid electric meter could be understand their electric consumption pattern, the reason is that pre-paid users have a chance to compare the price they pay and time of use per kilowatt hour, for the specific time of use than post-paid users, which could give them to adjust their electric consumption. On post-paid system users are pay their bill after they use electric, which is household could use more or less electric than the previous month without understanding the electric consumption amount they use.

3.7 Ethical Consideration

First of all, the study was permitted from Addis Ababa University, School of Commerce Economics department in order to get acceptable the data that is collected from individual respondent incorporate directly. The confidentiality of responses and information obtained from the respondent are considered. In addition, at the time of data collection the researcher and data collectors give respect to the participants and asks permission about their voluntariness for response. The researcher also ethically considers not to put the participants at risk and not to act against the human rights of the county. For the analysis of the data collected the researcher ethically use only for this research project with integrity. The findings of the research were presented without any deviation from the outcome of the research. Also, the researcher gave full acknowledgements to all the reference materials used in the study.

CHAPTER FOUR

4. RESULT AND DISCUSSIONS

This section covers the detailed description of the sample household profile, elasticities of demand for electricity and determinants of electricity consumption in the case of Addis Ababa city. Demographic and socio-economic characteristics of the sample households are discussed in the first section and the results elasticities of demand for electricity and determinants of electricity consumption in the case of Addis Ababa city as follow-on preceding section.

4.1. Demographic and Socio-economic Characteristics of Households

4.1.1 Sex, Age, Household Size and Composition

The gender composition of households reveals that male heads are more in number 205 (52 percent) than the female counter parts 196 (48 percent). The more female respondents given to the researcher accurate answer or information about energy and other consumption in household. Out of the selected 401 sample households, the maximum age observed from sample respondents was 90 while the minimum is 21. The majority of the respondents (70 percent) are found above 40 age range. One of the most important characteristics of households that need to be considered in this study is the size of the household and its composition. The family size in these households, range from 1 to 9 while the average is around 4.3. The majority of the sample respondents (65.96%) have reported to have between 4 and 6 family members while a few of them (21.28%) have between 1 and 3 members.

Table 4.1: Sex, Age, Household Size and Composition

Variables	Category	Frequency	Percent
Age	Under 25	5	1
	25-40	115	19
	Above 40	281	70
Sex	Male	205	52
	Female	196	48
Household Size	Mean	4.3	

Source: own survey, 2021

4.1.2 Educational background

The detail information on educational level of household heads is shown in table 4.2.

Table 4.2: Household educational status

Level of education	Frequency	Percent
Primary Grade	133	36
Secondary Grade, TVT education and College diploma	115	31
BA/BSc degree	49	13
Did not complete any schooling	6	2
Can read and write	71	18
Total	374	100

Source: own survey, 2021

4.1.3 House Type, Number of Rooms and Meter Type

The house type of the respondents is that 136 respondents were live in villa type of house and 265 respondents were live in shanty and condominium type of house. With respect to dwelling ownership of the sample households, more than three fourth of the sample household's 83 percent live in their own houses, and 17 percent are live in rented from kebele and private houses. In spite of differences in ownership status, the socio-economic background of the respondents indicates that most of those living in shanty and condominium administering houses have relatively lower level of income compared to those living in the villa houses.

Household number of rooms is measured by the total numbers of rooms that the households have. From the sample household's 39 percent have four and above living room numbers, 19 percent have three living room numbers and 42 percent have two and one living rooms. Regarding with meter type from 401 sample households, about 205 respondents have post-paid electric meter and 195 have pre-paid meter.

4.1.4 Income-Expenditure and Occupational Status

The mean monthly expenditure was lower as compared to the higher monthly expenditure of respondents.

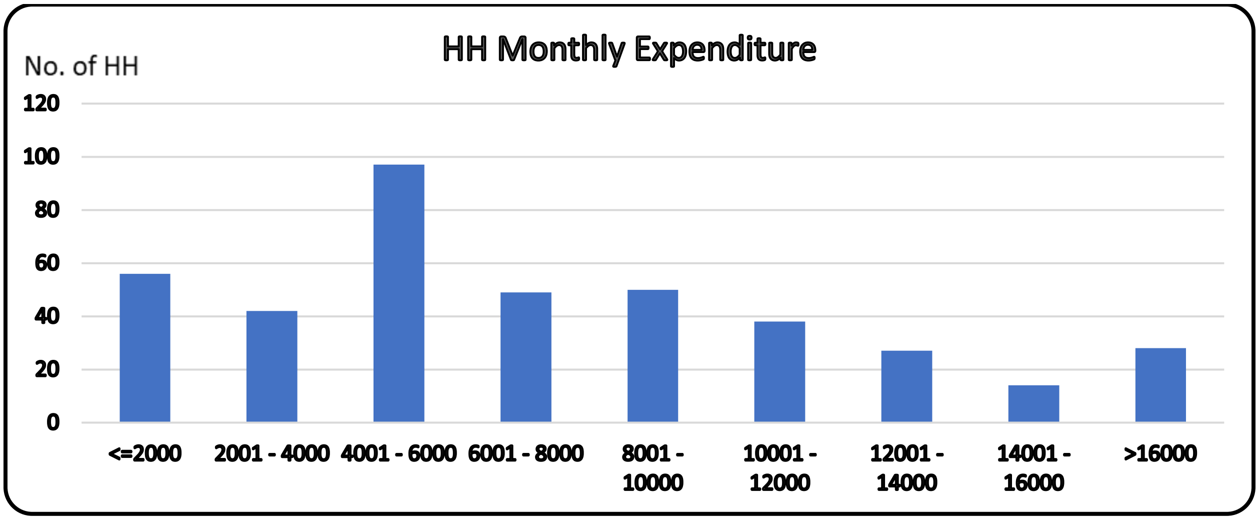


Figure 4.1 Total Monthly Expenditure of the respondent households
Source: Computed based on Primary data sources

4.2 Monthly electricity expenditure and consumption of the Households

To analyze the monthly electricity expenditure of the respondents under this study the household expenditure amount is categorized into eleven categories in a hundred-birr increment. As can be seen in figure 4.2, more than 42% of the respondent's monthly expenditure lies in 100 – 300 range. The detail of the respondent household monthly expenditure is presented below in figure 4.2.

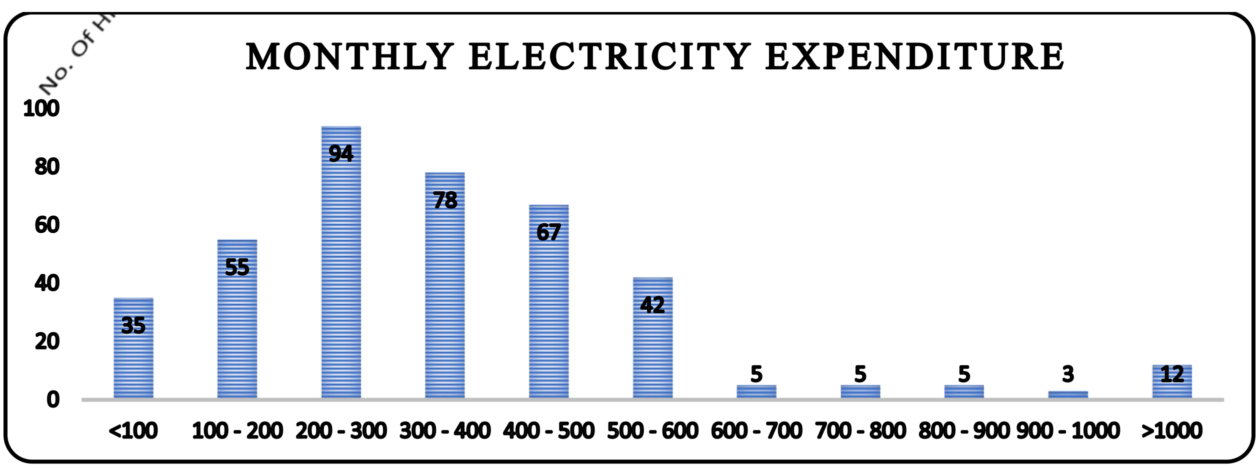


Figure 4.2 Monthly Expenditure on Electricity of the respondent households

Source: Computed based on Primary data sources

The electricity consumption in KWh of the respondents is described in figure 4.2. As can be seen below the amount of electricity in KWh that each household consumed in a month is categorized into seven blocks following the Ethiopian Electric corporation price block categorization. Around 44% of the respondents use 101 – 200 KWh of electricity per month.

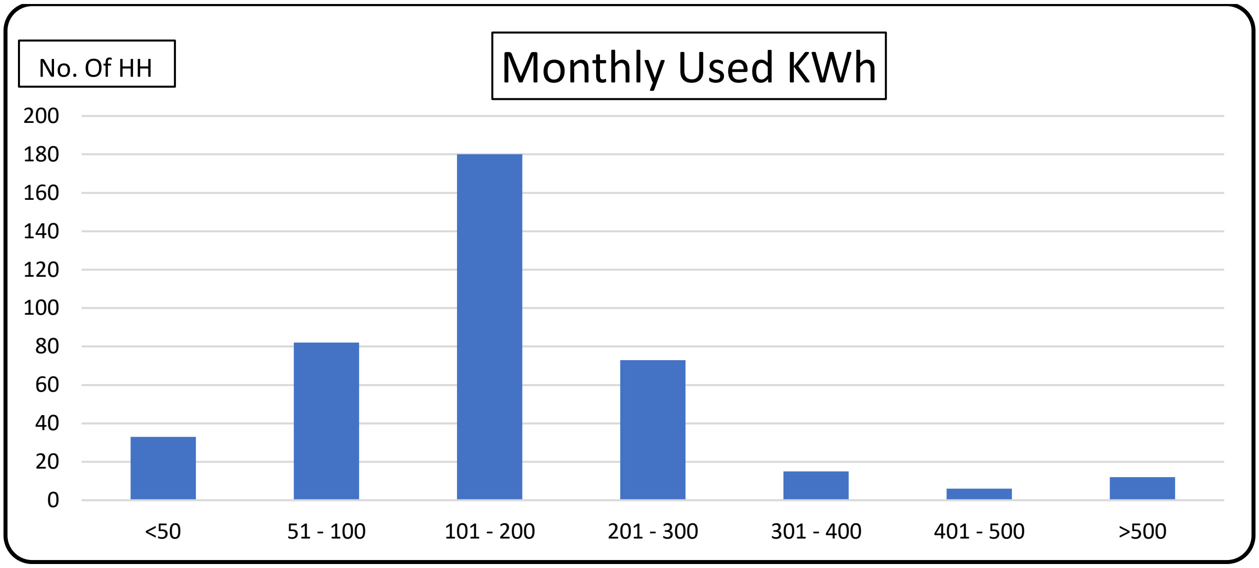


Figure 4.3 Monthly Electricity consumption of the respondent households in KWh

Source: Computed based on Primary data sources

4.3 Econometric Model Results

This section presents regression results of most important determinants which have influence over the elasticity of electricity demand of households in Addis Ababa. Prior to the estimation of the model parameters, the problem of multicollinearity or association among the potential explanatory variables is tested. Out of this, based on the result of VIF, the data had no serious problem of multicollinearity. Likewise, electricity demand model assumptions were conducted to check the errors have zero mean (E (ε) = 0), homoscedasticity, covariance between the error terms over time is zero, Normality, Multicollinearity testes. The result shows that there was no major problem on the model and among the variables.

Once the decision about the variables to be included in the model is made, the data is entered and analyses was carried out using STATA software to derive the parameter estimates of the electricity demand econometric model.

4.3.1 Correlation Analysis

Correlation is a measure of the degree of linear association between two variables that don't depend on the unit of measurements and it indicates about how the relationship is strong between two variables (Gujarati, 2003). Before conducting a regression analysis, it is important to conduct a correlation analysis among the study's explained variable and explanatory variables to check whether the association between the dependent and explanatory variable exists or not. The table below shows the correlation matrix among dependent and independent variables.

Table 4.3: Correlation Analysis of Variables

	lnPe	lnPc	lnY	lnHS	lmAD	lnEd	lnDTH	lnDHT
lnPe	1.0000							
lnPc	0.0489	1.0000						
lnY	-0.1022	0.0335	1.0000					
lnAD	0.0563	0.0387	0.0664	1.0000				
lnED	0.0484	-0.0210	0.0689	-0.0083	1.0000			
lnHS	-0.0293	-0.0484	0.1506	0.0931	-0.0826	1.0000		
lnDHT	0.0664	0.1894	0.0393	-0.1401	-0.0147	0.0445	1.0000	
lnDPP	0.0595	-0.1037	0.1535	-0.1304	0.0051	0.0052	-0.0165	0.0595

Source: Model result

The correlation result in Table 4.3 shows that the correlation matrix of dependent (E) variable with other independent variables (lnPe, lnPc, lnY, lnA, lnS, lnHS, lnAD, lnED, lnDTH and lnDPP) and correlation among independent variables with each other. Regarding the correlations between the dependent variable (Electricity consumption proxied by E) and explanatory variables, electricity price, family size, households house type, and meter type are positively correlated with electricity price (lnPe) except income (lnY) and household size (lnHS). This positive correlation shows that when the electricity price increase household electricity expenditure will decrease and the reverse is true. On the other hand, the negative relationship implies that the electricity price goes down as the independent variables rise and the reverse is true. Regarding the multicollinearity analysis (the correlation among independent variables) it is analyzed in the succeeding section (testing assumptions of OLS).

4.3.2 Tests for Electricity Demand Model Assumptions

In this study the diagnostic tests were carried out to ensure that the data fits the basic electricity demand model assumptions through Ordinary least squares. Consequently, the results for model specification tests were presented as follows:

Assumption one: the errors have zero mean (E (ε) = 0)

The first assumption required is that the average value of the errors is zero. In fact, if a constant term is included in the regression equation, this assumption will never be violated. In our case the model has constant term which is proved that the line did not pass through the origin and the first assumption of OLS is not violated. The average value of the error term in this study was expected to be zero (Brooks, 2008).

Assumption two: homoscedasticity (variance of the errors is constant (Var (ut) = σ2 < ∞)

In this study as shown in Appendix 1, both the Chi Square versions of the test statistic gave the same conclusion that there is no evidence for the presence of heteroscedasticity, since the Prob > chi2 were in excess of 0.05 (see appendix 1).

Assumption three: covariance between the error terms over time is zero (cov (ut, uj) = 0)

Assumption three stated that the covariance between the error terms over time is zero. In other words, it is assumed that the errors are uncorrelated with one another. If the errors are not uncorrelated with one another, it would be stated that they are auto correlated or that they are serially correlated. The Durbin-Watson Test for serial correlation assumes that errors are stationary and normally distributed with mean zero. It tests the null hypothesis Ho that the errors are uncorrelated against the alternative hypothesis H1 that is errors are correlated. In addition, lagged value of a variable (E (-1) is used in this research in order to adjust the autocorrelation.

If this null hypothesis was rejected, it would be concluded that there was evidence of a relationship between successive residuals, which implies the least-squares estimates sub-optimal, standard confidence intervals for betas are incorrect, and the error term is expectable.

According to Brooks, (2008), DW has two critical values: an upper critical value (d_U) and a lower critical value (d_L), and there is also an intermediate region where the null hypothesis of no autocorrelation cannot rejected. The rejection, non-rejection, and inconclusive regions are shown on the number line in figure 4.4 below.

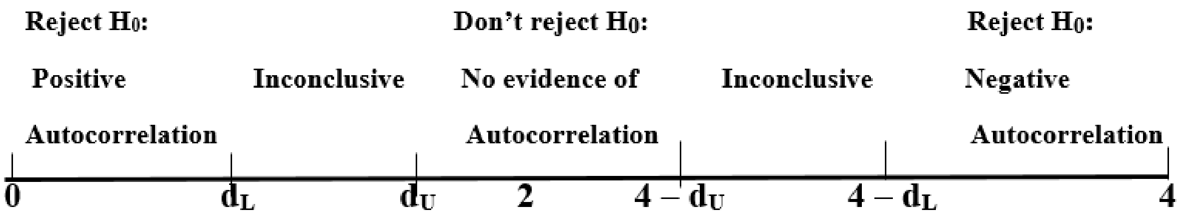


Fig. 4.4: Rejection and non-rejection regions for DW test

The study used the d_L and d_U values for 401 observations as approximation of 401 observation. As per the Durbin-Watson test (DW) table for 402 observations with 8 explanatory variables at 0.5% level of significance, the dL and dU values are 1.59 and 1.76, respectively. The DW values for model and for 401 observations were 1.78766. The relevant critical values for the test are dL= 1.59, dU = 1.76, and 4 -dU = 4-1.59 = 2.41; 4 -dL = 4-1.76 = 2.597. Accordingly, Durbin-Watson test value is clearly between 1.59 and 2.41 which is 1.78 and the DW value is lies in the non-rejection region. Hence, the above figure shows that the DW is between DU and 4-DU, which implies do not reject Ho since there is no evidence of autocorrelation and errors are independent of each other.

This test can be made through Breusch-Godfrey (BG) Serial Correlation LM Test, which is a more general test for autocorrelation up to the first order. In this case we have tried to make first order autocorrelation test (see appendix 2).

Assumption Four: Normality (Errors Are Normally distributed (T ~ N (0, ∞2))

According to (Gujarati, 2003) the classical normal linear regression model assumes that each error terms (µit) are distributed normally with zero mean and constant variance, simply it can be expressed as µit ~N (0, σ^2) where the symbol ~ means distributed as and N stands for the normal distribution, the terms in the parentheses representing the two parameters of the normal distribution, namely, the mean and the variance. In addition, (Brooks, 2008) also stated that the normality assumption (µit ~N (0, σ^2)) is required in order to conduct single or joint hypothesis tests about the model parameters. One of the most commonly applied tests for normality is the Jarque-Bera test. In this test, the null hypothesis is each error terms (µit) are distributed normally, and the alternative hypothesis is error terms are not normally distributed. Accordingly, if the p-value is greater than 5% the test result is insignificant, which implies that we failed to reject the null, and we can conclude that the error terms are normally distributed. Otherwise, we cannot conduct a hypothesis test about the model parameters.

In this study, the Jarque-Bera test was conducted after estimating multiple regression on the effect of electric price, charcoal price and income of the household and other control variables on electricity consumption (measured by E).

In this case, the figure (appendix 3) histogram normality test shows that Jarque-Bera p-value of 8.78% is greater than 0.05, so we cannot reject the null hypothesis at 5%. In addition to this, the Skewness (0.00) and Kurtosis (0.00) are zero. Therefore, in this study, we can conclude that the error terms (μit) are normally distributed after inducing dummy variables so it is possible to conduct hypothesis tests with full of confidence about the model parameters. The kurtosis and skewness results and histogram figure are shown in appendix 3.

Assumption five: Multicollinearity Test

The fifth important diagnostic test conducted in this study is multicollinearity test and it is used to identify the correlation between explanatory variables and to avoid double effect of independent variables from the model (Brooks, 2008).

An implicit assumption that is made when using the OLS estimation method is that the explanatory variables are not correlated with one another. If there were no relationship between the explanatory variables, they would be said to be orthogonal to one another. If the explanatory variables were orthogonal to one another, adding or removing a variable from a regression equation would not cause the values of the coefficients on the other variables to change (Brooks, 2008).

Brooks, (2008) mentioned that if the correlation coefficient along with the independent variables is 0.8 and above, multicollinearity problems will be existed. As it is indicated below the correlations between independent variables show no correlation between each independent variable. The table for Correlation Matrix between independent variables is shown on appendix 4.

4.3.3 Results of the regression analysis

The estimated coefficients and their associated t-values, obtained using an ordinary least squares (OLS) approach, the household electricity demand models are presented in Table 4.4. The estimated functions are well behaved. Most of the main parameter estimates are statistically significant 5%. In the table summary below (table 4.4), the multiple correlation coefficients R, indicates a strong correlation of .725 between household electricity demand and the eleven independent variables. R^2 = .718 reveals that the model accounts for 71.8 percent of the variation in the household electricity demand and is explained by the linear combination of all the independent variables of household electricity consumption. That is electric price to electric consumption, household income to electric consumption, charcoal price to electric consumption, household size, dwelling size, educational level of the head, house type and meter type explains 71.80% of electric consumption. The remaining 28.2 % of change was explained by other factors which are not included in the model.

In the regression result the p-value of each independent variables indicate that whether that independent variable is significant or not, whereas, the p-value of F-statistic indicates the overall significance level of the model used in the study or whether all variables are jointly significant or not. In F-statistic the null hypothesis is that the independent variables (lnPe, lnPc, lnPl, lnY, lnA, lnS, lnAD, lnHS, lnDHT and lnDPP) do not have a joint effect on the dependent variable, households' electricity demand (E). If p-value of F-statistic is greater than 0.05 (i.e. test is insignificant), means we failed to reject the null hypothesis, otherwise we reject the null hypothesis or the test is significant. In this case, as depicted in table 4.4 F-statistic of 102.85 with the p-value of 0.0000 is even significant at 1%. Thus, we reject the null hypothesis at a 1% significance level. Thus, we can conclude that all independent variables included in this study model have a joint effect on household's electricity demand (E).

The most important result that we obtain from this study are the estimated elasticities of income and price (Table 4.4). The elasticities indicate that the residential electricity of electricity demand in Addis Ababa is inelastic with respect to income as well as price.

From Table 4.4, electric price with p-value of 0.000 was found to be statistically significant at 1% level and negatively associated with returns on electric consumption. The result also shows that household income with a p-value of 0.000 recorded a significantly positive relationship with return on asset at 1% level. And charcoal price had negative and statistically significant influence on household's electric demand in Addis Ababa, at 1% significance level. The control variables household size, educational level, dwelling size and house type and not statistically significant effect on electricity consumption whereas; meter type had positive and statistically significant effect on profitability at 10% level.

Table 4.4: Residential electricity demand estimates (t-ratios in parentheses)

Variable	Model result	SE	t	P> /t/
Constant	-4.626044	.5582757	-8.29	0.000
lnPe	-1.772265	.0641382	-27.63	0.000
lnPc	-.2664456	.1341504	-1.99	0.048
lnPl	0 (omitted)			
lnY	.1513266	.0365467	4.14	0.000
lnA	-.0020209	.05779	-0.03	0.972
lnS	-.0116595	.0506934	-0.23	0.818
lnHS	.0077799	.0317415	0.25	0.807
lnAD	.0086289	.0317553	0.27	0.786
lnED	-.0014083	.0209239	-0.07	0.946
lnDHT	.0276938	.0497526	0.56	0.578
lnDPP	.1038498	.0511692	2.03	0.043
Prob > F	0.0000			
R-squared	0.7251			
Adj R-squared	0.7180			

Source: Model result

4.4 Discussion on Regression Results

The previous sub-section presents the regression analysis results of the study, and this section discusses the general result of each explanatory variables based on Ordinary least squares (OLS) regression results indicated in the table 4.4 above. In addition, the discussions analyzed the statistical findings of the study in relation to the previous empirical evidences. Hence, the following discussions present the relationship between explanatory variables and electricity consumption.

The explanatory power of the regressions is reasonably good given the individual cross-sectional data. Since electricity consumption and the continuous regresses are in logarithms, the coefficients are interpretable as demand elasticities.

4.4.1 Electricity Price

The own price of electricity has a statistically significant negative impact on the current rate of electricity consumption. The estimated own price elasticity is -1.75. This suggests that a 1 percent increase in the price index of electricity will (ceteris paribus) result in approximately a 1.74 percent decline in household consumption of electricity, that is, consumption becomes relatively inelastic with respect to own price.

The inelastic demand for residential electricity implies that increase in residential electricity price results higher expenditures on residential electricity. As own price rises the demand for that commodity decreases. Therefore, from an energy point of view we can say that there is little room for discouraging residential electricity consumption, using price increases alone. Highly likely that this elasticity consumption decline caused by the rising tariff block rate structure in electricity prices adopted in Ethiopia. Thus, if Ethiopia manages to exploit its electric power generation potential and supply electricity at affordable price to the people, many of the energy related problems could be curbed. Which could forward the energy transition from traditional fuels (fire wood and charcoal) to the modern fuel (electricity and LPG). This finding was consistent with the findings of (Kebede, B., Almaz, 2002; Zhou and Teng, 2013).

4.4.2 Price of Substitute Fuels

The charcoal elasticity for electricity is significant in the model and carries the expected sign. The charcoal elasticity is -0.29. This suggests that a 1 percent increase in the consumption of electricity will (ceteris paribus) result in approximately a 0.29 percent decline in household consumption of charcoal. The result show that the electricity demand is more charcoal-inelastic.

Charcoal is used many for cooking function and in period of electricity shortage were common substitutes mostly in urban areas. The study tries to shows that households in Addis Ababa are quite responsive to higher cost of electricity consumption. This in turn supports the conventional wisdom that households easily respond to higher prices through demand management and/or substitution of traditional fuels (charcoal). The negative relationship with electricity consumption has a policy implication for the possibility of ensuring energy transition from the charcoal to a modern fuel electricity through price incentives. This finding was consistent with the findings of (Gamtessa, 2003; Mekonnen, 2009).

The regression result of the price of Light Petroleum Gas (LPG) shows omit the variable values. The resign behind omitting the values of LPG was that the price of LPG was set by government authority and also the selling price homogenies with in one city, only price variation can be seen one city to another.

4.4.3 Income/expenditure

The income/expenditure elasticity for electricity is significant in the model and carries the expected sign. The level of income (Y) with an income elasticity of 0.15. This suggests that a 1 percent increase in the price index of electricity will (ceteris paribus) result in approximately a 0.15 percent increase in household expenditure of electricity. The result show that the electricity demand is more income-inelastic and that electricity is a necessity for households. An increase in the income of households is expected to increase the household expenditure of electricity. The income level of the household could influence the type and number of appliances. As noted earlier, electricity demand is a derived demand that is based on the household's portfolio of appliances. This finding was consistent with the findings of (Filippini and Pachauri, 2004; Schulte and Heindl, 2017; Zhou and Teng, 2013).

4.5 Determinants of Electricity demand in Addis Ababa

Various factors influence household electricity consumption. The most important factors in household electricity consumption include price of electricity, substitute energy fuels price, household income, household size, number of domestic appliances and their efficiency level at which various sources of electric are consumed. And also, electric consumption can be expressed by the socio-economic levels of a household. The estimation results for the parameter which are presented in Table 4.4, which shows that some control variables included in the model are not significant at the 95 percent confidence level, while the main study variables are significant. Thus, under this section I discuss the results of main study variables and for control variables with regard to direction wise, that were depend on their coefficient sign.

Electricity price (Pe): The result shown on table 4.4 that own electric price is found a significant determinant of household's electricity demand. This suggests that the demand for electricity will increase if the own price of electricity decreases or an increase in the price of electric reduces the amount of kWh consumed by the individual households. Thus, when electricity price increase households can rely on charcoal or other energy source than electricity. Therefore, the responsible authority should create incentive mechanisms for customers to increase electricity consumption. This finding was consistent with the findings of (Schulte and Heindl, 2017; Filippini and Pachauri, 2004; Shi, Zheng and Song, 2012).

Charcoal price (Pc): The result shown on the table 4.4 that charcoal price is a significant determinant of household electricity demand. The cross elasticity of charcoal in relation to electricity is inelastic and has negative coefficients. This suggests that while the demand for electricity will increase if the price of charcoal increases, the change will only be by a small proportion. This is largely due to the availability and convenience of households of purchasing charcoal from the local shops. The significance of charcoal in the model is consistent with the work of (Arthur, Bond and Willson, 2012; Halvorsen, Larsen. and Runa Nesbakken, 2001; Filippini and Pachauri, 2004).

Household income/expenditure (Y): The result shows on table 4.4 that income/expenditure is a significant determinant of household's electricity demand. Households with a higher income/expenditure are expected to consume more of the complementary commodities associated with electricity through having electric stoves, electric lamp, TV, freezer or heaters which increase indirect electric demand. Moreover, as income increases, electric consumption increases disproportionately, i.e., the expenditure share for electric decreases. This finding was consistent with the findings of (Carter, 2011; Filippini, 2011; Zhou and Teng, 2013).

Age (A): It was hypothesized that age of a household would have positive relation with household electricity demand. However, according to the econometric estimation results (see Table 4.4 above), this variable takes an unanticipated sign which is not consistent to the literature (Tiwari, 2000). The sign of the coefficient for the age is negative indicating that the aged households are less demand electricity than younger household heads. Thus, through direction wise household head age has no impact on household's electricity demand.

Household size (HS): The sign of the coefficient for the household size is positive indicating that households with large number of household size marginally higher per capita electric requirements. Moreover, larger household size needs more electricity for using electric appliance than small houses. Thus, through direction wise household size has an impact on household's electricity demand. This finding was consistent with the findings of (Yohanis *et al.*, 2008; Ahmed, 2016;).

Household room number (AD): The sign of the coefficient for the household room number is positive indicating that households living in larger houses have marginally higher per capita electric requirements. Moreover, larger houses need more electricity for lighting and use more electric appliance than small houses. Thus, through direction wise household room number has an impact on household's electricity consumption. This finding was consistent with the findings of (Huang, 2015; Birhane, 2016; Tiwari, 2000).

House type (DHT): The sign of the coefficient for the household house type is positive indicating that household's electricity consumption is largely determined by the characteristics of the occupied dwelling (space, age, building type) while electricity consumption is strongly driven by household composition. Thus, though direction wise household house type has an impact on household's electricity demand. This finding was consistent with the findings of (Brounen, Kok and Quigley, 2012; O'Doherty, Lyons and Tol, 2008; Tiwari, 2000).

Chapter Five

5. Conclusion and Policy Implications

5.1 Conclusion

The theme of this study is to estimate elasticity of electricity demand and look the determinants of household's electricity demand in Addis Ababa. The estimation processes apply logarithmic linear econometric models of electricity demand for Addis Ababa using household level micro data. The models are used to determine the responsiveness of electricity consumption to own price, income, price of substitutes and variables relating to demographic and geographic characteristics of households.

The results show that the estimated model of electricity demand using OLS regression analysis is fairly stable. The models provide estimates of income and own price elasticities of electricity demand for Addis Ababa. As would be expected, the estimates for price shows that the price changes significantly affect electricity consumption, and electricity is found to be price inelastic. It is an obvious fact that the effect of price revisions on consumption depends on the price elasticity of demand for electricity hence, electricity tariff reforms could play a potentially important role as a demand side management tool in Ethiopia. The cross-price elasticities for charcoal indicate that an increase in charcoal prices will lead to an increase in the demand for electricity. The estimates for income/expenditure elasticities show that electricity is a necessity and a basic need of households in the Addis Ababa and electricity demand is income inelastic.

In addition, variables relating to demographic characteristics of house type, household number of rooms, and household size were also found to have a measurable effect in explaining the variation in electricity requirements and discussed though direction wise. Altogether, our results help to identify the determinants of household electricity demand. Designing and developing policy measures focusing on specific determinants will help in achieving the main objectives of Ethiopian energy policy: ensuring the development of affordable, clean and modern energy and access to it for the rapid social and economic growth and structural transformation as well as for all citizens and become a renewable energy hub in the Eastern Africa Region by 2025.

5.2 Policy Implications

This section presents policy recommendations based on the analysis in the study. Each policy recommendation is evaluated by identifying possibilities and constraints in energy sector. It is an obvious fact that the effect of price revisions on consumption depends on the price elasticity of demand for electricity. Without access to efficient and affordable energy sources, people have very limited opportunities for economic and social advancement. Our results indicated that the long-run effect of price changes significantly affects electricity consumption, and hence, tariff reforms could play a potentially important role as a demand side management tool in Ethiopia.

On the basis of the outcome of the study and to improve electricity utilization among the households in Addis Ababa, the following policy implications are forward.

i. It suggests that pricing policy, at least in the long-run, can be an effective instrument for achieving electricity conservation and to manipulate consumption of traditional energy sources.
ii. Charcoal may play an important role in household energy demand in the short-run and government policy should take this into due consideration.
iii. Design means of decreasing the costs of electricity to make them more affordable.
iv. Policy makers and energy planners should exploit the benefits of estimated price elasticity and income elasticities to make well informed decisions.

5.3 Limitations of the research and Issues for Further Research

This study may have a number of limitations that I acknowledge. In fact, I have no reason to believe that any of these limitations should be existent in the analysis, but cannot of course rule them out. Regardless of the importance of the outputs of such study to policy makers, they are not free of limitations. To begin with, it doesn't incorporate stoke of appliance price and efficiency, however it's helpful to show the level of household's response with regard to electricity tariff change. This may be, of course, incorporating those data may an area of future study.

Another shortcoming originates from the sample size determination. Due to the budget, time, capacity etc. constraints this study was limited with small sample size. In addition, the study was use random walk technique to select sample households rather to use simple random sampling technique. Therefore, there are a number of questions left open and I suggest the following issues for further research.

References

Addis Ababa City Mayor Office, (2019). Available at: https://addismayor.gov.et/

Abrate, G. (2001) 'Demand Responsiveness under Time-of-use Pricing: An Application to Italian Industrial Customers', 29(8), pp. 757–774.

Adusei L. (2012) 'Energy Poverty : Exploring Households Energy Constraints and Coping Strategies . Case Study of Energy Poverty : Exploring Households Energy Constraints and Coping Strategies . Case Study of', pp. 1–63. Available at: http://stud.epsilon.slu.se/5105/1/adusei_l_a_121205.pdf.

Ahmed, M. (2016) The Energy, Gender and Income Poverty Nexus: Energy Consumption patterns in Urban and Peri-urban households of Arba-Minch town, southwestern. Addis Ababa University.

Alberini, A. and Filippini, M. (2011) 'Response of residential electricity demand to price: The effect of measurement error', Energy Economics, 33(5), pp. 889–895. doi: 10.1016/j.eneco.2011.03.009.

Amusa, H., Amusa, K., Mabugu, R. (2009) 'Aggregate demand for electricity in South Africa: An analysis using the bounds testing approach to cointegration', Energy Policy, 37(10), pp. 4167–4175. doi: 10.1016/j.enpol.2009.05.016.

Anderson, K. P. (1973) Residential demand for Electricity: Econometric Estimates for California and the United States. Santa Monica, CA.

Ane, P. and Ramy, H. (2015) 'What level of electricity access is required to enable and sustain poverty reduction?'Practical Action Consulting. Available at: https://www.ids.ac.uk/files/dmfile/UtilisingElectricityAccessforPovertyReduction-LiteratureReview.pdf.

Arthur, M. de F. S. R., Bond, C. A. and Willson, B. (2012) 'Estimation of elasticities for domestic energy demand in Mozambique', Energy Economics, 34(2), pp. 398–409. doi:

10.1016/j.eneco.2011.08.006.

Asmerom, K. (1991) ‘Demand for energy in rural and urban centres of Ethiopia. An econometric analysis’, Energy Economics, 13(2), pp. 130–134. doi: 10.1016/0140-9883(91)90045-2.

Baker, K. J. and Rylatt, R. M. (2008) ‘Improving the prediction of UK domestic energy-demand using annual consumption-data’, Applied Energy, 85(6), pp. 475–482. doi: 10.1016/j.apenergy.2007.09.004.

Bedir, M., Hasselaar, E. and Itard, L. (2013) ‘Determinants of electricity consumption in Dutch dwellings’, Energy and Buildings, 58, pp. 194–207. doi: 10.1016/j.enbuild.2012.10.016.

Berman, M. B., Hammer, M. J. and Tihansky, D. P. (1972) Impact of Electricity Price Increase on Income Groups: Western United States and California. California State.

Beyene (2018) The Challenges and Prospects of Electricity Access in Ethiopia. Addis Ababa.

Birhane, K. (2016) Patterns and Determinants of Household Energy Consumption Among Destitute Families in Althad Village of woreda 8, Bole sub-city, Addis Ababa. Addis Ababa University.

Brooks, C. (2008) Introduction Econometrics for Finance. Second. New York: Cambrdge Univercity Press.

Brounen, D., Kok, N. and Quigley, J. M. (2012) ‘Residential energy use and conservation: Economics and demographics’, European Economic Review, 56(5), pp. 931–945. doi: 10.1016/j.euroecorev.2012.02.007.

Brounen, D., Nils, K. and Quigley, J. M. (2012) ‘Residential energy use and conservation: Economics and demographics’, European Economic Review, 56(5), pp. 931–945. doi: 10.1016/j.euroecorev.2012.02.007.

Carter, A. (2011) Price Reform and Household Demand for Electricity. BB11000, Barbados. Bridgetown.

Carter, A., Craigwell, R. and Moore, W. (2012) ‘Price reform and household demand for electricity’, Journal of Policy Modeling, 34(2), pp. 242–252. doi: 10.1016/j.jpolmod.2011.08.006.

Casey, P. J. and Scott, K. (2006) ‘Environmental concern and behaviour in an Australian sample within an ecocentric - Anthropocentric framework’, Australian Journal of Psychology, 58(2), pp. 57–67. doi: 10.1080/00049530600730419.

Cayla, J. M., Maizi, N. and Marchand, C. (2011) ‘The role of income in energy consumption behaviour: Evidence from French households data’, Energy Policy, 39(12), pp. 7874–7883. doi: 10.1016/j.enpol.2011.09.036.

Central Statistical Agency (2016) ‘Ethiopian welfare monitoring survey 2016’, II(April), p. 207.

Damsgaard, N. (2003) Deregulation and regulation of electricity markets. Available at: http://www.worldcat.org/oclc/186037766%5CnDamsgaard 2003 - Deregulation and regulation of electricity.pdf TS - WorldCat.

Dzioubinski, O. et al. (1999) ‘Trends in Consumption and Production: Household Energy Consumption’, United Nations DESA Discussion Paper, (6), p. 21. Available at: http://www.un.org/esa/papers.htm.

EEU (2017) Ehiopian Electric Utility (Eeu). Addis Ababa. Available at: http://www.eeu.gov.et/index.php/about/our-history.

El., K. et (2002) ‘Can the urban poor afford modern energy? The case of Ethiopia’, Energy Policy, 30(11–12), pp. 1029–1045. doi: 10.1016/S0301-4215(02)00056-3.

Faruqui, A. and George, S. (2005) ‘Quantifying customer response to dynamic pricing’, Electricity Journal, 18(4), pp. 53–63. doi: 10.1016/j.tej.2005.04.005.

Filippini, M. (2011) ‘Short- and long-run time-of-use price elasticities in Swiss residential electricity demand', Energy Policy, 39(10), pp. 5811–5817. doi: 10.1016/j.enpol.2011.06.002.

Filippini, M. and Pachauri, S. (2004) 'Elasticities of electricity demand in urban Indian households', Energy Policy, 32(3), pp. 429–436. doi: 10.1016/S0301-4215(02)00314-2.

Flaig, G. (1990) 'Household production and the short- and long-run demand for electricity', Energy Economics, 12(2), pp. 116–121. doi: 10.1016/0140-9883(90)90045-H.

Gamtessa, S. F. (2003) Household's Consumption Pattern and Demand for Energy in Urban Ethiopia, International Conference on African Development Archives. 76. Addis Ababa University. Available at: https://scholarworks.wmich.edu/africancenter_icad_archive/76.

Gujarati, D. N. (2003) BASIC Econometrics. Fourth Edi. Edited by L. Sutton. New York: The McGraw-Hill Companies.

Hadgu, G. et al. (2013) 'Trend and variability of rainfall in Tigray , Northern Ethiopia : Analysis of meteorological data and farmers ' perception', Academia Journal of Agricultural Research, 1(6), pp. 88–100. doi: 10.15413/ajar.2013.0117.

Halvorsen, B., Larsen., B. M. . and Runa Nesbakken (2001) 'Possibility for hedging from price increases in residential energy demand', (347).

Heckman, J. J. (2015) 'Introduction to A Theory of the Allocation of Time by Gary Becker', Economic Journal, 125(583), pp. 403–409. doi: 10.1111/ecoj.12228.

Heltberg, R. (2005) 'Factors determining household fuel choice in Guatemala', Environment and Development Economics, 10(3), pp. 337–361. doi: 10.1017/S1355770X04001858.

Hosier, R. H. and Kipondya, W. (1993) 'Urban household energy use in Tanzania. Prices, substitutes and poverty',Energy Policy, 21(5), pp. 454–473. doi: 10.1016/0301-4215(93)90035-E.

Huang, W. H. (2015a) 'The determinants of household electricity consumption in Taiwan: Evidence from quantile regression', Energy, 87, pp. 120–133. doi: 10.1016/j.energy.2015.04.101.

Huang, W. H. (2015b) 'The determinants of household electricity consumption in Taiwan: Evidence from quantile regression', Energy, 87, pp. 120–133. doi: 10.1016/j.energy.2015.04.101.

Kashian, R., Heinrich, J. and Kueffer, A. (2016) 'An Estimation of the Elasticity Demand for Tap Water', The International Journal of Sustainability in Economic, Social, and Cultural Context, 12(2), pp. 1–16. doi: 10.18848/2325-1115/cgp/v12i02/1-16.

Kebede, B., Almaz, B. and E. K. (2002) 'Can the urban poor afford modern energy? The case of Ethiopia Energy Policy, 30(11–12), pp. 1029–1045. doi:10.1016/S0301-4215(02)00056-3.

Krishnamurthy, C. K. B. and Kriström, B. (2015) 'A cross-country analysis of residential electricity demand in 11 OECD-countries', Resource and Energy Economics, 39, pp. 68–88. doi: 10.1016/j.reseneeco.2014.12.002.

Linderhof, V. G. M. (2001) Household demand for energy, water and the collection of waste: a microeconometric-analysis.Availableat: https://www.rug.nl/research/portal/publications/household-demand-for-energy-water-and-the-collection-of-waste (21042f5e-4a24-4895-a532-aac3f4633997).

Louw, K. et al. (2008) 'Determinants of electricity demand for newly electrified low-income African households', Energy Policy, 36(8), pp. 2812–2818. doi:10.1016/j.enpol.2008.02.032.

Lutzenhiser, L. (1993) 'Social and Behavioral Aspects of Energy Use', pp. 315–332. doi: 10.1007/978-3-319-64182-9_15.

McFadden, D. L. (1977) 'Economic Choices', American economic review. California: Economic

Sciences, pp. 330–366. Available at: https://www.nobelprize.org/prizes/economic-sciences/2000/mcfadden/lecture/.

Meier, H., Jamasb, T. and Orea, L. (2013) ‘Necessity or luxury good? Household energy spending and income in Britain 1991-2007’, Energy Journal, 34(4), pp. 109–128. doi: 10.5547/01956574.34.4.6.

Meier, H. and Rehdanz, K. (2010) ‘Determinants of residential space heating expenditures in Great Britain’, Energy Economics, 32(5), pp. 949–959. doi: 10.1016/j.eneco.2009.11.008.

Mekonnen, A. and Köhlin, G. (2008) ‘Determinants of Household Fuel Choice in Major Cities in Ethiopia’, EfD Discussion Paper, (August), p. 23.

Mekonnen, B. (2009) Households’ Energy Demand and Energy UsePattern in Urban Ethiopia; An Application of Almost Ideal Demand System. Addis Ababa University.

Miah, M. D. et al. (2011) ‘Domestic energy-use pattern by the households: A comparison between rural and semi-urban areas of Noakhali in Bangladesh’, Energy Policy, 39(6), pp. 3757–3765. doi: 10.1016/j.enpol.2011.04.004.

Michael, R. T. and Becker, G. S. (1973) ‘On the New Theory of Consumer Behavior’, The Scandinavian Journal of Economics, 75(4), pp. 378–396.

Moshiri, S. (2015) ‘The effects of the energy price reform on households consumption in Iran’, Energy Policy, 79, pp. 177–188. doi: 10.1016/j.enpol.2015.01.012.

Moshiri, S. and Martinez Santillan, M. A. (2018) ‘The welfare effects of energy price changes due to energy market reform in Mexico’, Energy Policy, 113(November 2017), pp. 663–672. doi: 10.1016/j.enpol.2017.11.035.

MoWIE (2017) National Electrification Program 2.0. Addis Ababa, Ethiopia.

MoWIE (2019) Energy Balance and Statistics report for the 2017/18. Addis Ababa, Ethiopia.

Narayan, P. K., Smyth, R. and Prasad, A. (2007) 'Electricity consumption in G7 countries: A panel cointegration analysis of residential demand elasticities', Energy Policy, 35(9), pp. 4485–4494. doi: 10.1016/j.enpol.2007.03.018.

Ndiaye, D. and Gabriel, K. (2011) 'Principal component analysis of the electricity consumption in residential dwellings', Energy and Buildings, 43(2–3), pp. 446–453. doi: 10.1016/j.enbuild.2010.10.008.

O'Doherty, J., Lyons, S. and Tol, R. S. J. (2008) 'Energy-using appliances and energy-saving features: Determinants of ownership in Ireland', Applied Energy, 85(7), pp. 650–662. doi: 10.1016/j.apenergy.2008.01.001.

O'netll Brian C. and Chen Belinda S. (2002) 'Demographic Determinants of Household Energy Use in the United States', pp. 53–88.

OECD (2008) 'Household Behaviour and the Environment - Reviewing the Evidence'. Available at: http://www.oecd.org/greengrowth/consumption-innovation/42183878.pdf.

Pachauri, S. (2004) 'An analysis of cross-sectional variations in total household energy requirements in India using micro survey data', Energy Policy, 32(15), pp. 1723–1735. doi: 10.1016/S0301-4215(03)00162-9.

Padam, G. et al. (2018) Ethiopia Beyond Connections, Energy Access Diagnostic Report Based on the Multi-Tire Framwork. Washington DC. doi: 10.1596/30102.

Passey, R. et al. (2017) 'Designing more cost re fl ective electricity network tari ff s with demand charges', 109(April), pp. 642–649. doi: 10.1016/j.enpol.2017.07.045.

Peter, F., Cilve, O. and Stevenson, D. (1992) 'Endogeneous grouth of persistently active volcanoes', Nature Publishing group, VOL 366.

Phdungsilp, A. (2006) Energy analysis for sustainable mega-cities. Available at: http://www.diva-portal.org/smash/record.jsf?pid=diva2:10708.

Rahut, D. B. et al. (2014) 'Determinants of household energy use in Bhutan', Energy, 69, pp. 661–672. doi: 10.1016/j.energy.2014.03.062.

Reddy, B. S. (2004) 'Economic and social dimensions of household energy use: a case study of india', Energy, pp. 469–477.

Rehdanz, K. (2007) 'Determinants of residential space heating expenditures in Germany', Energy Economics, 29(2), pp. 167–182. doi: 10.1016/j.eneco.2006.04.002.

Reiss, P. C. and White, M. W. (2005) Household Electricity Demand, Revisited. No. 8687. California.

Robert H. (1975) 'Residential Demand for Electric Energy: The Review of Economics and Statistics', 85(2), pp. 12–18. Available at: http://www.jstor.org/stable/1937858.

Romero-Jordán, D., Peñasco, C. and Del Río, P. (2014) 'Analysing the determinants of household electricity demand in Spain. An econometric study', International Journal of Electrical Power and Energy Systems, 63, pp. 950–961. doi: 10.1016/j.ijepes.2014.06.005. Sanstad, A. H. (2011) 'Notes on the Economics of Household Energy Consumption and Technology Choice'.

Sardianou, E. (2007) 'Estimating energy conservation patterns of Greek households', Energy Policy, 35(7), pp. 3778–3791. doi: 10.1016/j.enpol.2007.01.020.

Schulte, I. and Heindl, P. (2017a) 'Price and income elasticities of residential energy demand in Germany', Energy Policy, 102(July 2016), pp. 512–528. doi: 10.1016/j.enpol.2016.12.055.

Schulte, I. and Heindl, P. (2017b) 'Price and income elasticities of residential energy demand in Germany', Energy Policy, 102(July 2016), pp. 512–528. doi: 10.1016/j.enpol.2016.12.055.

Shi, G., Zheng, X. and Song, F. (2012) 'Estimating elasticity for residential electricity demand in China', The Scientific World Journal, 2012. doi: 10.1100/2012/395629.

Tiwari, P. (2000) 'Architectural, Demographic, and Economic Causes of Electricity Consumption in Bombay', Journal of Policy Modeling, 22(1), pp. 81–98. doi: 10.1016/s0161-8938(98)00003-9.

Walter, N. and Snyder, C. (2007) Microeconomic Theory: Basic Principles and Extensions. Tenth Edit. Mason: USA: Thomson South-Western.

Ye, Y., Koch, S. F. and Jiangfeng, Z. (2018) 'Determinants of residential electricity demand in South Africa', Energy Economics. doi: 10.1016/j.eneco.2018.08.005.

Yemane, T. (1967). *Sampling Theory*: Englewood Cliffs, N.J.: Prentice-Hall

Yohanis, Y. G. et al. (2008) 'Real-life energy use in the UK: How occupancy and dwelling characteristics affect domestic electricity use', Energy and Buildings, 40(6), pp. 1053–1059. doi: 10.1016/j.enbuild.2007.09.001.

Zenebe et al. (2010) 'Environment for Development Urban Fuel Demand in Ethiopia An Almost-Ideal Demand System Approach', Environment for Development, (Discussion Paper Series).

Zenebe G. (2007) Household fuel consumption and resource use in rural-urban Ethiopia, PhD Thesis Wageningen University. Available at: http://www.efdinitiative.org/publications/household-fuel-consumption-and-resource-use-rural-urban-ethiopia.

Zhang, F. (2011) 'Distributional Impact Analysis of the Energy Price Reform in Turkey', Europe, (October).

Zhou, S. and Teng, F. (2013) 'Estimation of urban residential electricity demand in China using household survey data', Energy Policy, 61(2013), pp. 394–402. doi: 10.1016/j.enpol.2013.06.092.

Appendix

Regression Model assumption Tests

Appendix 1: Heteroscedasticity Test

estat hettest
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance
Variables: fitted values of MonthlyusedKWh
chi2(1) = 1.94
Prob > chi2 = 0.1642

Appendix 2: Correlation Test
Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey LM test for autocorrelation

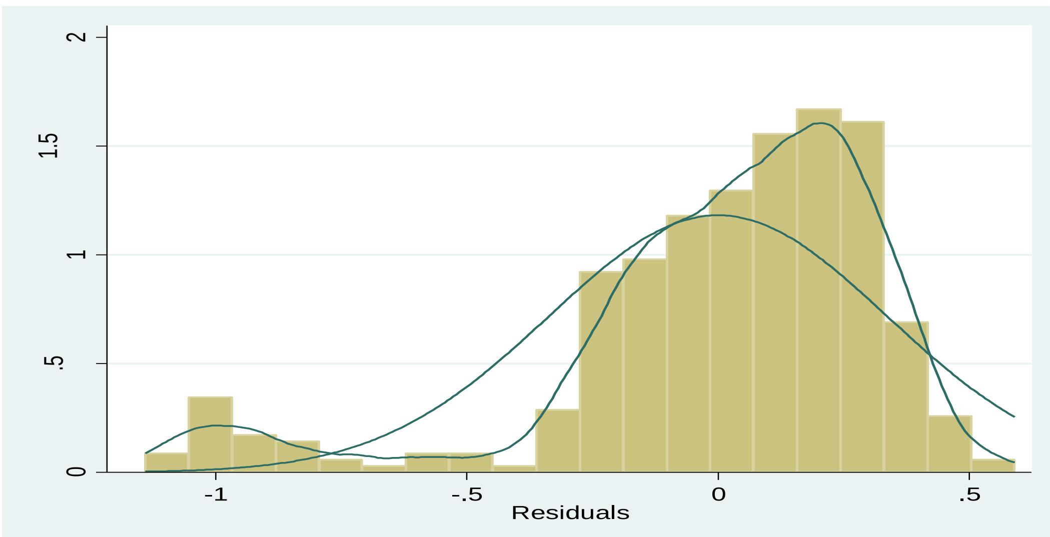
lags(p)	chi2 df	Prob > chi2
1	3.786 1	0.0517

H0: no serial correlation

Appendix 3: Normality Test
Histogram Normality Test

```
. sktest resid

                    Skewness/Kurtosis tests for Normality
                                                    ------ joint ------
    Variable |        Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)   Prob>chi2
-------------+---------------------------------------------------------------
       resid |        401     0.0000        0.0000          .          0.0000
```



Appendix 4: Multicollinearity Test
Correlation Matrix between independent variables

	lnPe	lnPc	lnY	lnHS	lmAD	lnEd	lnDTH	lnDHT
lnPe	1.0000							
lnPc	0.0489	1.0000						
lnY	-0.1022	0.0335	1.0000					
lnAD	0.0563	0.0387	0.0664	1.0000				
lnED	0.0484	-0.0210	0.0689	-0.0083	1.0000			
lnHS	-0.0293	-0.0484	0.1506	0.0931	-0.0826	1.0000		
lnDHT	0.0664	0.1894	0.0393	-0.1401	-0.0147	0.0445	1.0000	
lnDPP	0.0595	-0.1037	0.1535	-0.1304	0.0051	0.0052	-0.0165	0.0595

Appendix 5: Regression Result

```
. reg lMonthlyusedKWh lElecprice lCharcoalprice lLPGprice lHH_monthlyexpend lage ls
> ex ledulevel lHH_size lNolivingrooms lHH_HouseType lMetertype
note: lLPGprice omitted because of collinearity

      Source |       SS           df       MS      Number of obs   =       401
-------------+----------------------------------   F(10, 390)      =    102.85
       Model |   120.09702        10  12.009702    Prob > F        =    0.0000
    Residual |  45.5385892       390  .116765613   R-squared       =    0.7251
-------------+----------------------------------   Adj R-squared   =    0.7180
       Total |  165.635609       400  .414089022   Root MSE        =    .34171

----------------------------------------------------------------------------------
 lMonthlyusedKWh |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+----------------------------------------------------------------
      lElecprice |  -1.768054   .0644943   -27.41   0.000    -1.894854   -1.641254
  lCharcoalprice |  -.2728963   .1350896    -2.02   0.044    -.5384913   -.0073014
       lLPGprice |          0  (omitted)
lHH_monthlyexp~d |   .1520788   .0369478     4.12   0.000     .0794371    .2247205
            lage |  -.0020209     .05779    -0.03   0.972    -.1156398    .1115979
            lsex |  -.0116595   .0506934    -0.23   0.818     -.111326    .0880071
       ledulevel |  -.0004035   .0217728    -0.02   0.985    -.0432102    .0424031
        lHH_size |   .0717645   .0504974     1.42   0.156    -.0275166    .1710456
  lNolivingrooms |   .0077029    .032101     0.24   0.810    -.0554097    .0708155
   lHH_HouseType |   .0573951   .0392599     1.46   0.145    -.0197924    .1345827
      lMetertype |   .0944592    .050422     1.87   0.062    -.0046737    .1935921
           _cons |  -4.774533   .5718938    -8.35   0.000    -5.898914   -3.650153
----------------------------------------------------------------------------------
```

Appendix 6: Questionnaires for Household survey

This survey questionnaire is organized to collect data for the research titled “Estimating Elasticity for Residential Electricity Demand in Addis Ababa" The collected data will be used to make an analysis of this research paper only and the response of the respondents will be confidential.

IDENTIFICATION PARTICULARS

1	2	3	4	5	6
SUB-CITY	WEREDA	Enumeration Area	HOUSE NO.	HH Identification No.	Dwelling Type

NB. Type of Dwelling: 1. Villa 2. Shanty/Condominium

Part one

7		8	9	10	11	12	13	14
Household members		What is the relationship of [NAME] to household head?	What is [NAME]’s marital status?	Sex	Age	What is the highest educational qualification acquired by HH head?	Eating at home last week	Sleeping at home last week
Record full name of all the usual members of this household. **START WITH HEAD OF HOUSEHOLD**		Head……..…1 Wife/Spouse…...2 Child/adopted child...3 Grandchild……..…4 Niece/Nephew..........5 Father/Mother…….6 Sister/Brother…….7 Son/Daughter-in-law.........8 Brother/Sister-in-law….9 Father/Mother-in-law….10 Grandfather/mother……11 Other relative….12 Servant/servant’srelative13 Other nonrelative…....14	Single ….1 Married….2 Divorced…3 Widowed...4	Male….1 Female...2	How old is [ ] in years? **If( ) is less than one year old, record 00**	Primary Grade. ….1 Secondary Grade….2 TVT education ……3 College diploma……4 BA/MSc degree….5 Master’s degree……6 Adult literacy program participation………7 Did not complete any schooling ....8 Some Church/Mosque School…………9 Other…………99	Did eat at home in the last week? Yes….1 No…...2	Did sleep at home in the last week? Yes….1 No.….2
No.	**Name**				**Year**	**Year**		
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Part Two

A. Household Electricity Demand

No.	Question	Respons e	Response code
15	Does your household have an electric meter?		Yes………...1 No………...2
16	What type of electric meter the household have?		Post-paid ……...1 Pre-paid..……...2
17	Does your household share the electric meter?		Yes….........1 No……..…2
18	How many households are sharing the meter?		Number of Households
19	What is the most common way you make your electricity bill payment?		Cash…………………………...1 Vouchers/token/pre-paid card from EECO...……………….…...…….2 Credits using mobile money……3 Pay at the utility office………..…4 Pay at the central office……........5 Lehulum………………………...6 Other (specify)……………..….99
20	**Enumerator:** If the respondent pays the energy company (EEU) or has a record of the electricity payment, ask to see the electricity bill/invoice and use it for Q.21 and Q.22.		Respondent has energy bill and shows it....1 Respondent has energy bill but refuses to show it or could not locate it……………...2 Respondent does not have an energy bill…3
21	In the last month, how much did you spend on the electric bill? [Calculate amount paid from the last bill].		In Birr
22	In the last month how much electricity did your household consume? [Calculate the consumption from the last bill].	|__|__|__| kWh	Quantity in Kilowatt Hour (kWh)
23	Is the household knowledge about the electricity tariff change?		Yes…………1 No………….2
24	If yes Q.23: Has electric use changed?		Yes…………1 No…………2
25	Is the quantity of electricity consumption the same from the previous month?		Yes……….1 No……….2
26	**Enumerator:** Only for per-paid customers: Is there any change consumption as a result of the pre-aid customers?		Yes……….1 No……….2
27	If yes Q.26: What change do you observe?		Decreasing electric consumption…………..…1 Increasing substitute fuel consumption……2 Replace inefficient electric appliances …...3

			Other (Specify)……………………………4
28	**Enumerator**: Only for post-paid customers: Is there any change on consumption as a result of the post-aid customers?		Yes……...1 No………2
29	If yes Q.28: What change do you observe?		Decreasing electric consumption………..…1 Increasing substitute fuel consumption……2 Replace inefficient electric appliances …...3 Other (Specify)……………………………4
30	Please mention three thing that you like from the existence of electricity services.		It is chip………………1 No danger …………….2 It is clean energy……...3 It is user friendly………4 Time saving……………5 Energy saving…………6 Other (specify)…………99
31	Please mention three thing that you dislike from the existence of electricity services.		It is expensive…………1 Have danger……………2 Electric appliance is expensive…….3 Supply is not reliable.………………4 Pre-paid cards are not easy to get…...5 Way of service payment is not easy….6

B. Household Energy Demand

No.	Type of Energy source	Does this HH use [name/ energy type] last 7 days Yes......1 No.......2	Weekly consumption			How often did you use the fuel or energy sources the last week (last 7 days) for these activities?
			Unit	Quantity consumed	How much did this household pay for this fuel or energy sources last week month (the last 7 days)? (in local currency)	
32	Wood fuel		Kg			
33	Charcoal unprocessed		Kg			
34	Charcoal briquettes/pellets		Kg			
35	Animal waste/dung		Kg			
36	Sawdust		Kg			
37	Woodchips		Kg			
38	Kerosene/paraffin		Liter			
39	Liquefied Petroleum Gas (LPG)		Liter			
40	Biogas		kg			
41	Agricultural or crop residue/ grass/straw/shrubs/ corn cobs		kg			
42	Other (specify)					

Part Three

Household Dwelling Characteristics

No.	Question	Response	Response code
43	House ownership		Owen house……..1 Rent……………...2 Other…………….3
44	Does your household live in this dwelling for the entire year?		Yes…………….1 No…………….2
45	How many years have you been living in this house? [Record 1 if less than 1].		
46	What is the type of dwelling?		Villa……………….1 Condominium …….2 Appartement………3 Other (specify)……4
47	How many rooms does the household occupy?		Only for living
48	How many houses are there in this compound?		Number of houses
49	How many households share your dwelling?		Number of households

Part four

50. Households Income and Expenditure

A. Households Expenditure list

No.	Expenditure type	Unit	Expenditure Amount (in birr)
1	Household food expenditure	Birr/ month	
2	Household health expenditure	Birr/ year	
3	Education expenditure	Birr/ year	
4	Transport expenditure	Birr/ month	
5	Cloth expenditure	Birr/ year	
6	Energy (excluding electricity)	Birr/ month	
7	Electricity	Birr/ month	
8	Water	Birr/ month	
9	Relaxations (pay for others, religious & cultural activity)	Birr/ month	
10	Gift	Birr/ year	
11	Cleaning Services	Birr/ month	
12	Mobile card	Birr/ month	
13	Other Specify	Birr/ month	

B. Household Income

51. From this household members, how many of you get monthly salary? __________

52. From this household member, how many of you get income from private work? _______

Income List

No.	Income Type	Unit	Last year Income
1	From selling agricultural crops	Birr	
2	From selling domestic animals	Birr	
3	From selling animals byproduct	Birr	
4	From salary	Birr	
5	From private work	Birr	
6	Pension	Birr	
7	Gift	Birr	
8	Support by others	Birr	
9	Other specify	Birr	

53. Additional Households Income Questionnaire

No.	***Interviewer/ CAPI:*** Is [NAME] 15 years or older? Yes…1 No…2→NEXT PERSON	What was [NAME]'s main occupation for the last 12 months? Wage Employee, Non-Farm…………1 Wage Employee, Farm............2 Self-Employed Non-Farm-Business enterprise...........3 Self-Employed Non-Farm-Independent contractor, technician, professional, etc.…4 Self-Employed crop production ……5 Self-Employed - Livestock …….6 Assistance in family enterprise……….7 Casual/Day Laborer…….8 Intern/free labor/voluntary work……..9 Student….10 Retired/pensioner.11 Too old to work…12 Disabled...…….13	[NAME]'s main occupation best fits from the list of industries. INDUSTRY CODE A - Agriculture, forestry and fishing B - Mining and quarrying C - Manufacturing D - Electricity, gas, steam and air conditioning supply E - Water supply; sewerage, waste management and remediation activities F - Construction G - Wholesale and retail trade; repair of motor vehicles and motorcycles H - Transportation and storage I - Accommodation and food service activities J - Information and communication K - Financial and insurance activities L - Real estate activities M - Professional, scientific and technical activities N - Administrative and support service activities O - Public administration and defense; compulsory social security P - Education Q - Human health and social work activities R - Arts, entertainment and recreation S - Other service activities T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	Out of the last 12 months, how many months where you engaged in this activity? ***Max 12*** MONTHS	How many days per month does [NAME] work in this activity? DAYS	Please indicate the monthly income for this activity In Birr	Does [NAME] operate any non-agricultural/ business/ enterprise within this household or compound? Yes…1 No….2→Next person	How many employees does this business/ enterprise have? Number of employees including full time and Part time

		Job Seeker…….14 Unemployed…….15 Other (specify)…….99	U - Activities of extraterritorial organizations and bodies					
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

..

Appendix 1.

የቤተሰብ መጠይቅ በአማርኛ

ይህ የቤተሰብ መጠይቅ የተዘጋጀው '' Estimating Elasticity for Residential Electricity Demand in Addis Ababa" በሚል ርዕስ በአዲስ አበባ ለሚደረግ ጥናት መረጃ ለመሰብሰብ ይሆናል። የሚሰበሰበው መረጃ ለዚህ ጥናት ዓላማ ብቻ የሚውል ሲሆን የመልስ ሰጪው ለሚሰጠው መረጃ ሚስጥራዊነት የተጠበቀ ነው።

የጥናቱ ቦታ/ አካባቢ ዝርዝር መረጃ

1	2	3	4	5	6
ክፍል ከተማ	ወረዳ	የቆጠራ ቦታ	የቤት ቁጥር	የቤተሰቡ መለያ ቁጥር	የቤቱ አይነት

ማስታወሻ: የቤቱ አይነት ሲባል፡-   1. ቪላ   2. ኮንደሚኒየም ወይም አፓርትመንት

ክፍል አንድ

ስለ ቤተሰብ አባላት ስነ ህዝብ መረጃ								
7		8	9	10	11	12	13	14
የቤተሰብ አባላት ዝርዝር		**ለአባወራው ያለው ዝምድና?**	**የጋብቻ ሁኔታ?**	**ጾታ**	**ዕድሜ**	**አባወራው ያጠናቀቁት ከፍተና ክፍል ስንት ነው?**	**በባለፈው 7 ቀናት ውስጥ ከቤተሰቡ ጋር ከተመገበ**	**በባለፈው 7 ቀናት ውስጥ በዚህ ቤት ካደሩ**
ከአባወራው ይጀመር		አባወራ..................1 የትዳር ጓደኛ...............2 ወንድ/ሴት ልጅ.............3 የልጅ ልጅ..................4 የአባወራው የወንድም/የእሁት ልጅ ....5 አባት/እናት...............6 ወንድም/እሁት...............7 የአባወራው ወንድ/ሴት ልጅ በህግ..........................8 የአባወራው ወንድም/እህት በህግ.......................9 የአባወራው አባት/እናት በህግ ....10 ወንድ/ሴት አያት..........11 ሌላ ዘመድ..............12 የቤት ሰራተኛ...........13 ሌላ ዘመድ ያልሆነ.......14	ያላገባ ......1 ያገባ.......2 የተፋታ.....3 የሞተባቸ ው...4	ወንድ. 1 ሴት.. 2	ዕድሜው ስንት ነው? **ዕድሜው በሙሉ አንድ አመት በታች ከሆነ 00 ይሞላ (ከ97 በላይ ከሆነ 97 ይሞላ)**	አንደኛ ደረጃ..............1 ሁለተኛ ደረጃ............2 የሙያ ትምህርት.......3 የኮሌጅ ዲፕሎማ.......4 ባችለር ዲግሪ.............5 ማስተርስ ዲግሪ........6 አማራጭ ትምህርት....7 ማንበብና መፃፍ የማይችል..................8 የቄስ ት/ቤት............9 ሌላ ካለ ይጠቀስ......99	በባለፈው 7 ቀናት ውስጥ ከዚህ ከቤተሰቡ ጋር ተመገበዋል? አዎ....1 የለም...2	በባለፈው 7 ቀናት ውስጥ በዚህ ቤት አድረዋል? አዎ....1 የለም.....2
ተ.ቁ	**ስም**				**በአመት**	**በአመት**		
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

ክፍል ሁለት

ሀ. የቤተሰብ ኤሌክትሪክ ፍላጎት

ተ.ቁ	ጥያቄ	መልስ	የመልሶች ኮድ
15	ይህ ቤተሰብ የኤሌክትሪክ ቆጣሪ አለው?		አዎ...........1 የለም..........2
16	የቆጣሪው አይነት ምንድ ነው?		ድህረ ክፍያ.......1 ቅድመ ክፍይ..........2
17	ይህን ቆጣሪ ከሌላ ቤተሰብ ጋር ይጋሩታል?		አለ...........1 የለም........2
18	ከምን ያህል ቤተሰብ ጋር ይጋሩታል?		

			በቁጥር ይቀመጥ
19	በአብዛኛው ጊዜ የኤሌክትሪክ ግልጋሎት ክፍያዎትን በምን አየነት መልኩ ነው የሚፈፅሙት?		በጥሬ ገንዘብ...................................1 በቅድመ ክፍያ ካርድ............................2 በሞባይል የአከፋፈል ዘዴ.................3 ለአገልግሎት አቅራቢው ቢሮ በመሄድ....4 በሰሁሉ አገልግሎት በመጠቀም...........5 ሌላ (ይገለጽ)..99
20	መረጃ ሰብሳቢ፡ ይህ ቤተሰብ የኤሌክትሪክ ክፍያውን ለኢትዮጵያ ኤሌክትሪክ አገልግሎት የሚፈፅም ከሆነ፤ የፈፅመበትን ቢል ይጠየቅ		መላሹ የኤሌክትሪክ ቢል አለው እና ለማሳየት ግቃደኛ ነው............1 መላሹ የኤሌክትሪክ ቢል አለው እና ለማሳየት ግቃደኛ አይደለም......2 መላሹ የኤሌክትሪክ ቢል የለውም.................................3
21	በባለፈው ወር የኤሌክትሪክ ግልጋሎት ክፍያ ምን ያህል ነው? [የተከፈለን መጠን ከቢል ላይ በማየት ወይም በማስላት ይቀመጥ]		በብር
22	በባለፈው ወር ይህ ቤተሰብ ምን ያህል ኤሌክትሪክ ተጠቀመ? [የተጠቀሙት መጠን ከመጨረሻው ቢል ላይ ያለው ይቀመጥ]	|__|__|__| kWh	Quantity in Kilowatt Hour (kWh)
23	ይህ ቤተሰብ የኤሌክትሪክ አገልጋሎት ተመን መቀየሩን መረጃ አለው?		አዎ.........1 የለም.......2
24	ጥያቄ23 አዎ ከሆነ፡ ይህ ቤተሰብ የኤሌክትሪክ አጠቃቀሙን ቀይሯል?		አዎ...........1 የለም.........2
25	የኤሌክትሪክ አጠቃቀሙ ከባለፈው ወር ጋር ተመሳሳይ ነው?		አዎ...........1 የለም.........2
26	መረጃ ሰብሳቢ፡ ለቅድመ ክፍያ ተጠቃሚዎች ብቻ የሚጠየቅ፡ የቅደመ ክፍያ ተጠቃሚ መሆንዎ በአጠቃቀምዎ ላይ ያመጣው ለውጥ አለ?		አዎ...........1 የለም.........2
27	ጥያቄ26 አዎ ከሆነ፡ ቤተሰቡ ምን አይነት ለውጦችን ተገነዘበ?		የኤሌክትሪክ አጠቃቀም መቀነስ................1 የአማራጭ ሀይል ምንጮች አጠቃቀም መጨመር........2 ሀይል አባካኝ የኤሌክትሪክ እቃዎች መቀየር..................3 ሌላ (ይገለጽ)..99
28	መረጃ ሰብሳቢ፡ ለድህረ ክፍያ ተጠቃሚዎች ብቻ የሚጠየቅ፡ የድህረ ክፍያ ተጥቃሚ መሆንዎ በአጠቃቀምዎ ላይ ያመጣው ለውጥ አለ?		አዎ...........1 የለም.........2
29	ጥያቄ28 አዎ ከሆነ፡ ቤተሰቡ ምን አይነት ለውጦችን ተገነዘበ?		የኤሌክትሪክ አጠቃቀም መቀነስ................1 የአማራጭ ሀይል ምንጮች አጠቃቀም መጨመር........2 ሀይል አባካኝ የኤሌክትሪክ እቃዎች መተካት..................3 ሌላ (ይገለጽ)..99
30	ኤሌክትሪክ አገልግሎት በመኖሩ የሚወዱትን ሶስት ነገሮች ይግለፁ		ርካሽ ነው............................1 አደጋ የለውም....................2 ከብክለት ነፃ ነው................3 ለመጠቀም ቀላል ነው........4 ጊዜ የቆጥባል.......................5 ጉልበት ይቆጥባል...............6 ሌላ (ይገለጽ)....................99
31	ኤሌክትሪክ አገልግሎት በመኖሩ የሚጠሉትን ሶስት ነገሮች ይግለፁ		ውግ ነው..1 አደጋ አለው...2 የመገልገያ ቁሳቁስ ዋጋ ውድ ነው...........3 ኤሌክትሪክ አቅርቦት አስተማማኝ አለመሆን...........4 የቅድመ ክፍያ ካርድ በቀላሉ አለመገኘጥ..................5 የአገልግሎት ክፍያ በቀላሉ መፈፀም አለመቻል........6 ሌላ (ይገለጽ).........................99

ለ. የቤተሰቡ የኢነርጂ አጠቃቀም

ተ.ቁ	የኢነርጂ መገኛ አይነት	የሳምንት ፍጆታ				በባለፈው 7 ቀናት ውስጥ ይህንን የኢነርጂ አይነት ቤተሰቡ ለምን ያህል ጊዜ ተጠቀም
		ቤተሰቡ ባለፍው 7 ቀን [ስም የኢነርጂ አይነት] ተጠቅሞ ነበር? አዎ.......1 የለም....2	መለኪ ያ	ምን ያክል? (መጠን)	በባለፈው 7 ቀናት ውስጥ ቤተሰቡ ለዚህ የኢነርጂ አይነት ምን ያህል ከፊል (ብር)	
32	የማገዶ እንጨት		ኪ.ግ			
33	በባህላዊ መንገድ የተዘጋጀ ከሰል		ኪ.ግ			
34	በዘመናዊ መንገድ የተዘጋጀ ከሰል (ፕሪኬት)		ኪ.ግ			
35	ኩበት		ኪ.ግ			
36	ሳጋቱራ		ኪ.ግ			
37	የእንጨት ቁርጥራጭ		ኪ.ግ			
38	ነጭ ጋዝ		ሊትር			
39	ሲሊንደር		ኪ.ግ			
40	ባዮ ጋዝ		ኪ.ግ			
41	የግብርና ተረፈ ምርት		ኪ.ግ			
42	ሌላ (ይገለጽ)					

ክፍል ሶስት

የቤተሰቡ የመኖሪያ ቤት ሁኔታ

ተቁ	ጥያቄ	መልስ	የመልሶቹ ኮድ
43	የቤት ባለቤትነት		የግል ቤት.......1 የኪራይ ቤት......2 ሌላ (ይገለጽ)....3
44	ቤተሰቡ በዚህ መኖሪያ ቤት ላለፈው አንድ አመት ኖሯል?		አለ...............1 የለም............2
45	ቤተሰቡ በዚህ መኖሪያ ቤት ለምን ያህል ጊዜ ኖሯል? [ከአንድ አመት ከሆነ እንድ ይፃፍ]		
46	የቤተሰቡ መኖሪያ ቤት ምን አይነት ነው?		ቪላ ቤት..............................1 ኮንደሚኒየም.......................2 አፓርትመንጥ.....................3 ሌላ (ይገለጽ).....................99
47	መኖሪያ ቤቱ ለመኖሪያነት የሚያገለግሉ ስንት ክፍሎች አሉት?		የመኖሪያ ክፍሎች ብዛት
48	በመኖሪያ ቅጥር ግቢ ውስጥ ምን ያህል ቤቶች አሉ?		የመኖሪያ ቤቶች ብዛት
49	ምን ያህል ሌላ ቤተሰብ ይህንን መኖሪያ ቤት ይጋራል?		የቤተሰብ ብዛት

ክፍል አራት

50. የቤተሰቡን ወጪና ገቢን በሚመለከት

ሀ. የቤተሰቡ ወጪ ዝርዝር

ተ.ቁ	የወጪ አይነት	መለኪያ	የወጪ መጠን (በብር)
1	የቤተሰቡ የምግብ ወጪ	ብር/ በወር	
2	የቤተሰቡ የጤና (ህክምና) ወጪ	ብር/ በአመት	
3	የትምህርት ውጪ (ለዩኒፎርም ለደብተርና ሌሎች)	ብር/ በአመት	
4	የትራንስፖርት ወጪ	ብር/ በወር	
5	የልብስ ወጪ	ብር/ በአመት	
6	የኢነርጂ ወጪ (ኤሌክትሪክ አይጨምርም)	ብር/ በወር	
7	የኤሌክትሪክ ወጪ	ብር/ በወር	
8	የውሀ ወጪ	ብር/ በወር	
9	የመዝናኛ ወጪ (የግብዣና ለሐይማኖት ለበአላት)	ብር/ በወር	
10	ለስጦታ	ብር/ በአመት	
11	ለንፅህና (ጽጋት) አገልግሎት	ብር/ በወር	
12	ለሞባይል/ለስልክ	ብር/ በወር	
13	ሌላ (ይገለጽ)	ብር/ በወር	

ለ. የቤተሰቡ ገቢ

51. አብሮዎት ከሚኖሩ የቤተሰብዎ አባላት ስንቱ የደሞዝ ተቀጣሪ ናቸው? ____________
52. ስንት የቤተሰቡ አባላት (በግል ስራ የሚተዳደሩ) ወይም የግላቸው የሆነ ገቢ አላቸው? ___________
53. የገቢ ዝርዝር

ተ.ቁ	የገቢ ምንጭ	መለኪያ	ያለፈው አመት ገቢ
1	ከእህል ሰብል ሽያጭ	ብር	
2	ከእንስሳት (ከቁምከብት/ከጋማእንስሳት) ሽያጭ	ብር	
3	ከእንስሳት ተዋጽኦ ሽያጭ	ብር	
4	ከደሞዝ/ከቅጥር የሚገኝ ገቢ	ብር	
5	ከንግድ ስራ (ድርጅት) ትርፍ	ብር	
6	ጡረታ	ብር	
7	ስጦታ	ብር	
8	የአደጋ ግዜ እርዳታ የተገኘ	ብር	
9	ሌላ (ይገለጽ)	ብር	

54. ተጨማሪ የቤተሰብ ገቢ ማግኛ መጠይቅ

ተ.ቁ	ጠያቂ/ ካፒ፡ [ስም] እድሜው 15ና ከዛ በላይ ነው? አዎ....1 የለም....2 [ካልሆነ ስለ ቀጣዩ ሰው ይጠየቅ]	በባለፈው 12 ወራት ውስጥ {ስም} ዋነኛ የስራ ዘርፍ ምንድ ነው? ተቀጣሪ ሰራተኛ (ከግብርና ውጪ) ....1 ተቀጣሪ ሰራተና (በግብር)................2 የግል ሥራ (ከግብርና ውጪ በሆነ ዘርፍ) ....3 የግል ሥራ (ከግብርና ውጪ፤ በተቋራጭነት፣ በቴክኒሽያንነት፣ በከፍተኛ ባለሙያነት) ....4 የግል ስራ ሰብል ማምረጥ...........5 የግል ሥራ እንስሳት ማርባጥ...6 በቤተሰብ ድርጅት ውስጥ......7 ጊዜያዊ የጉልበት ሥራ..........8 በበጎ አድራጎት ሥራ...........9 ተማሪ.......................10 በእስር ላይ የነበረ..............11 በእርጅና ምክኛት መስራት ያቆመ..12 የአካል ጉዳተኛ..................13 ሥራ ፈላጊ..............14 ሥራ አጥ....................15 ሌላ (ይገለጽ)................99	[ስም] ዋነኛ የሥራ ዘረፍ ከተዘረዘሩት ኢነዱስትሪዎች ውስጥ ከየቱ ይመደባል? የኢንዱስትሪዎች ኮድ፡ A – ግብርና፣ ደንና አሳ እርባታ B – ማዕድንና ማዕደን ፍለጋ C – አምራች ዘርፍ D – ኤሌክትሪክ፣ ጋዝና አየር ማቀዝቀዥ አከፋፋይ E – ውሁና ፍሳሽ አገልግሎት ዘርፍ F – ግንባታ ዘርፍ G – ጅምላና ችርቻሮ ንግድ፣ መኪናና ሞተር ሽያጭ ዘርፍ H – በትራንስፓርትና መጋዘን ዘርፍ I – በሆቴልና ምግብ አገልግሎት ዘርፍ J – በኢንፎርሜሽንና ኮሚኒኬሽን K – በፋይናንስና ኢንሹራንስ ዘርፍ L – በሪል እስቴት ሥራ M – ከፍተኛ ባለሙያ፣ ተመራማሪና የቴክኒካል ባለሙያ N – ማስተዳደርና ድጋፍ ሰጪ ዘርፍ O – የመንግስት ሥራ፣ ወታደርና የማህበረሰብ ሥራ P – ትመህርት Q - ጤና እና ህብረተሰብ ሥራ R – የጥበብ፣ መዝናኛ ዘርፍ S – ሌላ አገልግሎት ዘርፍ T – የቤት ውስጥ ሥራ፣ ለቤተሰቡ ጥቅም የሚውሉ ነገሮችን በቤት ውስጥ ማዘጋጀት U – ከሀግር ውጪ ከሆኑ ድርጅቶች ሥራ	በባለፈው 12 ወራት ውስጥ ለመን ያህል ወር በዚህ ሥራ ላይ ተሳተፍክ? [ከፍተኛእ 12 ነው]	ባለፈው ወር ለምን ያህል ቀን በዚህ [ስም] ሥራ ላይ ሰራህ?	እባክዎትን ባለፈው ወር በዚህ [ስም] ሥራዎ ያገኙትን ገቢ ይንገሩኝ (በብር)	በዚህ ቤት ወይም በግቢው ውስጥ [ስም] ግብርና ነክ ያልሆነ፣ የንግድ ወይም የድርጅት ሥራ ያከናውናል? አዎ.......1 የለም.....2 (ወደ ቀጣዩ ሰው የታለፍ)	ይህ ሥራ በስሩ ምን ያህል ሰራተኞችን አሉት? [ቋሚና ጊዜያዊ]
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