ADDIS ABABA UNIVERSITY
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DEMOGRAPHIC AND SOCIOECONOMIC DETERMINANTS OF HOUSEHOLD ENERGY USE IN DILLA TOWN

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Demographic and Socio-economic Determinants of Household Energy Use in Dilla Town

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Acronyms

ARI	Acute Respiratory Infections
BFED	Bureau of Finance and Economic Development
COPD	Chronic Obstructive Pulmonary Disease
CSA	Central Statistical Agency
DESA	Department of Economic and Social Affairs
EEA	Ethiopian Energy Authority
EEPCO	Ethiopian Electric Power Corporations
FDRE	Federal Democratic Republic of Ethiopia
GJ	Giga Joule (10^9)
HH	Household
IAP	Indoor Air Pollution
ICSU	International Council for Science
IEA	International Energy Agency
IPAT	Impact Population Affluence Technology
LPG	Liquefied Petroleum Gas
MJ	Mega Joule (10^6)
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
PPS	Probability Proportional to Size
SNNP	Southern Nations Nationalities and People
TJ	Tera Joule (10^{12})
UN	United Nations
UNDP/WB	United Nations Development Program/World Bank
VIF	Variable Inflation Factor
WHO	World Health Organization

Chapter One: Introduction

1.1. Background of the Study

Population growth and economic development are the main driving forces for the demand of energy in developing countries. The rapid growth of population influence the magnitude of energy consumed in such a way that as population increases, more total energy is required and the magnitude of the total energy is determined by the per capita energy consumption (Sokona, 1997; Hadgu, 2002). The longitudinal analysis for the period 1890-1990 indicated that 49% of the growth in world energy demand was due to population growth and the remaining 51% due to increasing energy use per capita (Reddy, 2002).

On the other hand, energy plays an important role in the interrelationship among population, environment and development. Woldegiorgis (2002) have noted that:

rapid population growth has created higher demands for energy in its cheapest form and most accessible form i.e. fuel wood. This demand has placed pressure on biomass resources and arable land in an already deteriorating environment. Such pressures have adverse impacts and jeopardize economic growth and have placed the poorest and most vulnerable groups of the population i.e. women and children, at risk (Woldegiorgis, 2002).

Urbanization is also an important factor that affects the pattern of energy consumed in developing countries. As a given area becomes urbanized, the level of household energy consumption also increases. This level may be accompanied by increases in income that comes together with urbanization. However, the use of traditional fuels in many urban areas of developing countries is still high especially among low income groups. Furthermore, instead of shifting to modern fuels, people are consuming multiple types of energy sources that constitute both traditional and modern fuels (Dzioubinski and Chipman, 1999; Reddy, 2002).

Therefore, the major issue regarding the pattern of energy use in developing countries is concerned with its amount and type. By far developing countries consume less energy than the developed countries. For instance, the average per capita household energy use in developing countries is about nine times lower than in developed countries. On the other hand, large share of the energy in developing countries is derived from traditional fuels like fuel wood and other biomass sources. This reflects that the quality of energy consumed by developing countries is poor or has lower energy efficiency (Dzioubinski and Chipman, 1999). Generally, the consumption pattern of energy in developing countries is characterized by over consumption of traditional energy sources like fuel wood, and non woody biomass on the one hand, and the under consumption of highly efficient modern fuels like coal, LPG and natural gas, on the other (Sokona, 1997).

In Ethiopia, the household is the major consumption unit of energy sources. The household consumes about 91.3% of the total final energy of which 98.5% constitute biomass fuels and 1.5% constitutes modern fuels. There is some variation in terms of the level of energy consumption between rural and urban areas. In the rural area households consume 92% of the total energy of which 99.5% constitute traditional fuels and only 0.5% of the energy constitutes modern fuels. On the other hand, the urban households consume 8% of the total energy of which 86.7% accounts for the traditional fuels and 13.3% accounts for the modern fuels (Woldegiorgis, 2002).

1.2. Statement of the Problem

The amount of energy households consume is an indication of the level of their standard of living. As indicated above the consumption of energy in the households of developing country is very low. In Ethiopia, the total energy demand in urban households is low compared to the rural households. On the other hand the consumption of traditional fuels in the urban area is still very common. Despite its dominance, traditional fuels are not the only fuels used in urban areas and there are a number of modern fuels available in urban areas. Hosier (1986) indicated that electricity and kerosene are commonly used in urban households.

This high demand of traditional fuels puts high pressure on the resources found in and around the urban centers. For instance, in India urban households use logs that usually require the felling of trees. Thus, urban fuel wood uses have a considerable negative impact on the environment (Reddy, 2004).The use of these traditional fuels has also an immediate consequence of indoor air pollution that affects the health of people in the house (Heltberg, 2005). The burning of solid fuels also contributes to outdoor air pollution and this is mainly the problem in densely populated urban areas (Heltberg, 2005).

A number of factors influence the type of energy sources used by households among which household income is the most significant factor. In general, the higher the household income, the higher the amount of energy used and the chance of using modern fuels. 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). However, there is little research in Ethiopia with regard to demographic and socioeconomic variables as a determinant for the pattern of energy use in urban areas. In fact some studies like Dirirsa (1998) and Faye (2002) included only household size as a demographic element in their analysis. The reason for this gap is due to shortage of studies that shows the demographic and socioeconomic variables have influence on energy use.

Understanding the demographic and socioeconomic determinants of energy use can help assess the demand of energy across different households, explained by these variables. This can also help assess the variation in type and amount of energy use among the households and identify the major factors that cause such variation. In general, studies conducted in the significance of both demographic and socioeconomic issues in household energy use can assist further studies and energy planning in the area. Therefore, the purpose of this research is to assess the demographic and socioeconomic factors that determine the type and amount of household energy use in Dilla town.

Specifically this research answers the following questions:

1. What is the type and amount per capita of energy use per month in households?
2. What is the relationship between energy use and some of the predictor variables?
3. What are the demographic and socioeconomic factors that determine the type and amount of energy use?
4. Why households prefer to use a certain type of energy sources?

1.3. Objectives of the Study

The general objective of this study is to assess factors that determine household energy use in Dilla town. The specific objectives of the study are to:

1. Identify the type and amount of energy use per capita per month
2. Describe the relationship between energy use and some of the predictor variables
3. Assess the demographic and socioeconomic factors that determine the type and amount of energy use
4. Examine why households prefer to use a certain type of energy sources

1.4. Scope of the Study

This study seeks to explain the demographic and socioeconomic factors that determine the type and amount of energy use in the households. The type of energy assessed is the use of direct residential energy sources that refers to all fuels and electricity. This study also considers only cross-sectional variation in energy use among households. On the other hand, the results of the study may not be applicable in other areas due to the use of small sample size and uniqueness of the study area. Finally, this study does not assess the impact on natural resources or the environment at large that occur as a result of the current pattern of energy use.

1.5. Limitation of the Study

The first problem faced at the beginning of the survey was to prepare the sampling frame of the study. The administrative classification of the town has been changing from time to time in recent years. Currently the town is classified in to three sub cities and nine kebeles. However, according to this classification it became very difficult to prepare the sampling frame due to shortage of information. As a result the classification used by the 2007 census was preferred as a sampling frame that divides the town in to three kebeles and provides the number of households in them.

Another minor problem faced in this study is concerned with the calculation of amount of energy consumed. Households provide only the amount in litre per month for their kerosene consumprtion because it was easy for them to remember. However, the amount of energy consumed for electricity was estimated by the tariff category and amont of expenditure per month and the amount of charcoal and firewood consumption were estimated by their market price and the expenditure by the households. As a result there may be some inaccuracies in the calculation of the amount of energy consumed by the households but much care had been taken to consider all the possible means of alleviating this problem.

1.6. Ethical Consideration

Both written and oral informed consent was requested from officials and respondents of the study. A statement was read by the data collectors for the respondents about the purpose, expected duration and procedure of the data collection process. The respondents were also required to participate voluntarily and allowed to discontinue their participation. The responses given by the respondents were used only for the purpose of the study.

1.7. Organization of the Study

This thesis consists of five chapters. The first chapter deals with the introduction of the thesis that inludes the background, statement of the problem, objectives and scope of the study. In addition to this the limitations that explaines the problem faced during the study, the ethical considerations and operational definition of terms used in the study are included.The second chapter deals with the literaturte review and contains general and factual information about energy use at different level of the economy and sectors, the theoretical background of the study and the current state of kowledge with regard to the determinants of energy consumption.

The third chapter explains the methodology used in the study and description of the study area. It includes basic characteristics of the study area, the data source, type and collection tools, sampling, field work, measurements and conversions, data analysis and description of variables of the study. The data analysis section specifically explains the type of models selected for the analysis and how the results are going to be interpreted.

Chapter four demonstrates the results and discussion of the study. This chapter shows the results of descriptive analysis, the multivariate analysis performed to identify the determinant factors on the amount and type of energy use. Moreover, the preference of households on the type of energy sources is explained. The last chapter deals with the major conclusions drawn from the study and the recommendations for policy measures.

Chapter Two: Literature Review

2.1. Household Energy Use Pattern

Energy has long played a central role in the development and function of the economy. It is an essential input for economic activities. Reliance on energy is highly related with increase in populations and improvements in the standards of living, especially in cities (Phdungsilp, 2006). As a result, there is a huge gap in the world on the extent of energy consumed. Sub-Saharan countries are the lowest consumer of energy. An African uses only one eleventh, one sixth, and one half of the energy used by a North American, a European, and a Latin American, respectively (IEA, 2002, cited in Davidson, 2007).

The household sector is responsible for about 15 to 25 per cent of primary energy use in OECD countries and for a higher share in many developing countries. Average per capita household energy use in developed countries is about nine times higher than in developing countries, even though in developing countries a large share of household energy is provided by non-commercial fuels. Figure 1 shows the per capita household energy consumption by energy type in 1994 for the major regions of the world.

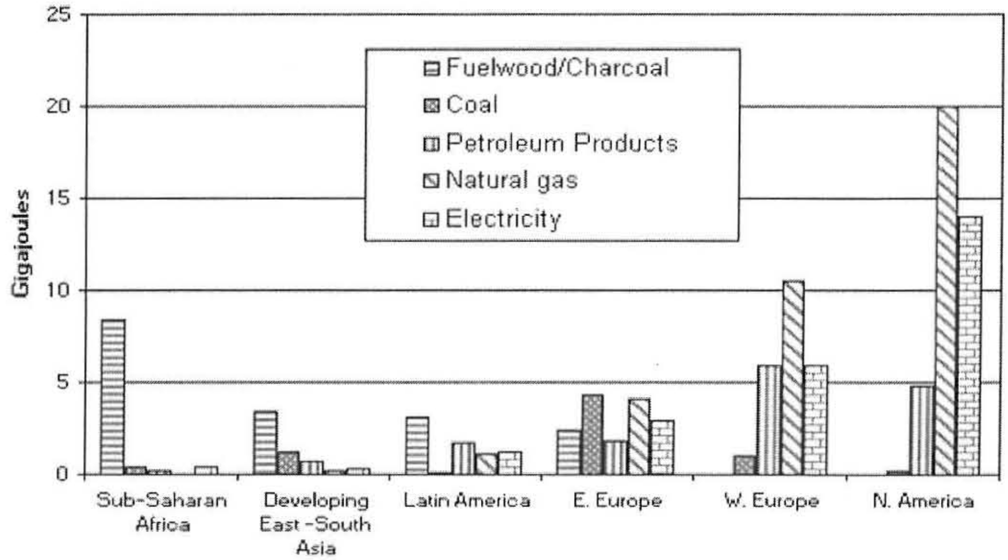

Figure 1: Per capita household energy consumption by energy type in 1994

Source: UN Statistics Division (cited in Dzioubinski and Chipman, 1999)

Figure 1 indicates that there is a higher share of fuel wood and other biomass as energy sources in Africa compared to Asia and South America and consequently lower energy efficiency. Disparities in household energy use also exist between rural and urban populations, between high and low income groups within a country, and among countries (Dzioubinski and Chipman, 1999).

2.1.1. Household Energy Use in Urban Areas of Developing Countries

The dramatic growth of urban populations in developing countries has caused a rise in the demand for energy, food, water and other resources. The growth is caused by high birth rates and extensive migration from rural areas. The migrants from rural areas bring with them their accustomed patterns of energy use, which are mainly based on the use of traditional fuels. In urban areas demand for wood products is highly concentrated, creating difficulties such as environmental problems associated with harvesting trees around urban centers. However, the urban demand for fuels also creates opportunities for possible economies of scale in the distribution of modern fuels.

Rapid increase in demand for energy resources have been the basis for many energy related problems in urban areas. One of them is high concentration of using traditional fuels due to lack of choices to use other fuels (Barnes and Qian, 1992). The poor also uses fuel wood as the major cooking fuel. They are obliged to rely on fuel wood as they don't have the resources to switch to other systems (Dunkerley, et al., 1990).

The factors that influence energy transitions in various ways include access to modern fuels, income, wood availability, fuel prices and government policy (Barnes and Qian, 1992). In addition to this the variation in total consumption of cooking fuels by household and the mix of fuels are influenced by the level and distribution of household income and size, accessibility and prices of the various forms of energy, differences in climate, resource endowment, size of city, household fuel preference, social characteristics of the population and food habits and regional cooking styles (Dunkerley, et al., 1990).

There is a strong relationship between size of the city and the energy transition. Table 1 shows this relationship by the size of cities and other characteristics. The size of cities are classified in to three based the area coverage, population size and the availability of infrastructure and services.

Table 1: Size of city and the energy transition

Size of cities	Level of HH income	Level of wood use	Wood resource around city	Wood energy prices	Availability of modern fuels
Small	Low	Extensive	Abundant	Low	Limited
Medium	Inter-mediate	Inter-mediate	Moderate	Equal or below modern fuels	Undeveloped modern fuel markets
Large	High	Low	Scarce	Competitive with modern fuels	Developed modern fuel markets

Source: Barnes and Qian, 1992

Patterns of urbanization, such as urban population density, the structure of urban functions, urban geography, and land use patterns, are important determinants of energy use in a city. These basics have to meet the fundamental needs of the growing urban population and its quality of life while using natural resources in a sustainable way. For example, a compact city may have lower per capita energy consumption due to its compact infrastructure and lower per capita building floor space, both traits that reduce energy consumption (Phdungsilp, 2006).

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In the case of Ethiopia, the analyses on household energy consumption in urban areas have reflected different situations. It was found out that domestic urban consumers utilize a wide variety of fuels, both traditional and modern. The households often have three or more different types of cooking appliances that satisfy specific purposes and utilizes separate fuels. Consumers in urban areas have evolved a remarkable number of energy management measures and are responsive to suggestions for improving cooking efficiency. Kerosene and other modern fuels have assumed major importance in most urban household economies. Fuel switching in the urban household is prevalent driven by availability and pricing (EEA, 1990).

2.1.2. Health Impacts of Household Energy Consumption

Energy from traditional biomass fuel is thought to account for nearly one-tenth of all human energy demand today in the world (more than hydro and nuclear power together), and wood-based fuels probably make up some two-thirds of household use. In developing countries biomass fuel is the major source of indoor air pollution (IAP). Biomass fuels are burned for cooking, heating and lighting homes and are the energy source for the poor (WHO, 2005).

In poor households of the developing country, wood, charcoal and other solid fuels (mainly agricultural residues and coal) are often burned in open fires or poorly functioning stoves (Smith, 2006). These stoves do not allow enough airflow into and through the stove, limiting the amount of oxygen available for combustion. Incomplete combustion leads to the release of small particles and other constituents that have been shown to be damaging to human health in the household environment. As a result, a primary pathway through which traditional biomass fuel use affects health is through indoor air pollution (Yeh, 2004).

Indoor air pollution from household use of biomass and coal is a leading environmental health risk in many developing nations, and directly or indirectly

linked to a number of the Millennium Development Goals, such as environmental sustainability, reducing child mortality, and gender equity (Jin et al., 2005).
Exposure to indoor air pollution from the combustion of solid fuels has been implicated, with varying degrees of evidence, as a causal agent of several diseases in developing countries. The World Health Organization ranks indoor air pollution from solid fuels the world's eight largest health risk, causing 2.7 percent of global loses of health life (Heltberg, 2005 cited in WHO 2002). The diseases associated with indoor air pollution include acute respiratory infections (ARI), otitis media (middle ear infection), chronic obstructive pulmonary disease (COPD), lung cancer (from coal smoke), asthma, nasopharyngeal and laryngeal cancer, tuberculosis, perinatal conditions and low birth weight, and diseases of the eye, such as cataracts and blindness.

The magnitude of the health loss associated with exposure to indoor smoke and its concentration is high among marginalized socioeconomic and demographic groups like women and children in poorer households and the rural population (Ezzati and Kammen, 2002).

2.1.3. Household Energy Consumption in Ethiopia

Household as the basic consumption unit of energy faces a number of problems. Among which the shortage of wood fuels for cooking is the most important energy problem facing Ethiopia (UNDP/WB, 1984). Similarly, Kassie (1996) has identified four major characteristics of the household energy consumption pattern. First, there is high dependence on biomass especially on wood fuel both in rural and urban areas. The major problem of using traditional sources in high amount is that at the current rate of consumption level it may no longer be sustainable for constant supply due to scarcity and deforestation.

Second, the traditional energy sources that are consumed contain high inefficiency. This resulted in a high proportion of national energy consumed at the household level as compared to other energy sectors. Third, the rural population consumes most of the energy in household sector and follows a settlement pattern that is widespread, scattered and dispersed. Finally, there is urban-rural polarity in type of energy consumption. This means that urban households use mainly modern fuels like LPG, electricity and kerosene and commercialized traditional fuels like charcoal and wood fuel. On the other hand, rural households consume mainly freely collected traditional energy sources of fuel wood, agricultural residue and cattle dung (Kassie, 1996).

The pattern of energy consumption by sectors for three years i.e. 1997-1999 shows that on average the household accounts for 91.3% of the total final energy consumption. Agriculture uses about 0.2%, transport accounts 1.2%, industry 3.8% and services 3.5%. The pattern of energy consumption is almost constant throughout the period examined. Furthermore, Table 2 shows specifically the consumption of traditional and modern fuels in the household. As indicated in the Table, biomass fuel is the dominant fuel type both in urban and rural areas. Next to this petroleum is used as the second source of energy in both areas. Electricity is available only in the urban areas.

Table 2: Traditional and modern energy consumption in the household sector (tera- joule)

Fuel type	Year					
	1997		1998		1999	
	Urban	Rural	Urban	Rural	Urban	Rural
Biomass	44,979	585,698	45,929	597,473	46,912	609,695
Petroleum	6,147	2,988	4,915	3,078	4,161	3,170
Electricity	2,099	0.0	1,924	0.0	1,832	0.0
Total	53,225	588,686	52,768	600,551	52,905	612,865

Source: Woldegiorgis, 2002

2.2. Theoretical Background

2.2.1. IPAT Model

A common method of evaluating the contributions of population growth or other demographic factors to energy use and CO_2 emissions has been the IPAT equation. IPAT describes the environmental impact (I) of human activities as the product of three factors: population (P), affluence (A), and technology (T). It was developed in the early 1970s during the course of a debate between Barry Commoner and Paul Ehrlich and John Holdren (O'Neill and Chen, 2002).

The original formulation of the equation was to show in particular the role of population growth. However, the strength of the elements in contributing to the impact is different in different parts of the world's regions. In the developed countries there is relatively clean technologies and stable population; the problem is affluence. In the Second World there is moderate affluence but pollutedtechnologies and, for some, population. For the Third World there is very little affluence, some unclean technology and high population.

Sometimes, because of the difficulty in estimating A and T, per capita impact F is employed as a substitute for their product. Thus, the equation I=P*F where I=total impact, P=population size and F=impact per capita was evolved. This equation makes population central to the impact prevailed. The variable F is related to per capita consumption of, for example, food, energy, fibers, and metals. On the other hand it is related to the technology used to make the consumption possible and whether that technology creates more or less impact (Chertow, 2001).

This model has a number of problems but here only some of them can be mentioned. First, the level of aggregation at which analysis is performed can strongly influence the results. Second, the results are difficult to interpret when not all variables move in the same direction. Third, there is bi-directional relationship among all the variables. Finally, when the results are aimed at for the purposes of policies, it suffers from the shortcoming of not taking in to account how much change in a particular variable is plausible (Stern et al., 1997; O'Neill and Chen, 2002).

2.2.2. Household Fuel Choice Models

The 'energy ladder' concept is the major theoretical explanation given for household fuel choice. The driving force in this concept is income and it involves a three stage process. In the first stage, households that are characterized by earning low level of income show heavy reliance on biomass fuels such as firewood, dung and crop residue. In the second stage, which is also called the 'transition' period, households with relatively better incomes consume fuels such as kerosene, coal and charcoal. In the last stage, due to the highest income earned, households consume more expensive energy sources like electricity and LPG (Dzioubinski and Chipman, 1999; Reddy, 2002; Heltberg, 2005).

The related concept to the above is termed as fuel 'switching' that explains introducing an efficient and modern fuel type will phase out the inferior traditional fuels (Heltberg, 2005; Farsi et al., 2007; Mekonnen and Köhlin, 2008). Specifically, Heltberg (2005) suggests that the strength of these models is their simplicity to explain the dependency of fuel choices on income. However, these models have also serious drawbacks that a move to more efficient fuel is not at the same time with a move away from traditional fuels.

The third perspective in fuel use is that of multiple fuel use or fuel stacking. The idea in this concept is that instead of switching to modern fuels or moving up the energy ladder, households use different combination of energy sources from a menu or portfolio of energy at different stage of the energy ladder (Heltberg, 2005; Mekonnen and Köhlin, 2008).

In relation to this, Chambwera and Folmer (2007) adopted an energy mix model and hypothesized that a household use a mix of fuels in different amount. This model identified that a number of household characteristics and fuel characteristics shape the total mix of energy consumed by the households (See figure 2). As a result it incorporates the major factors that influence household energy use.

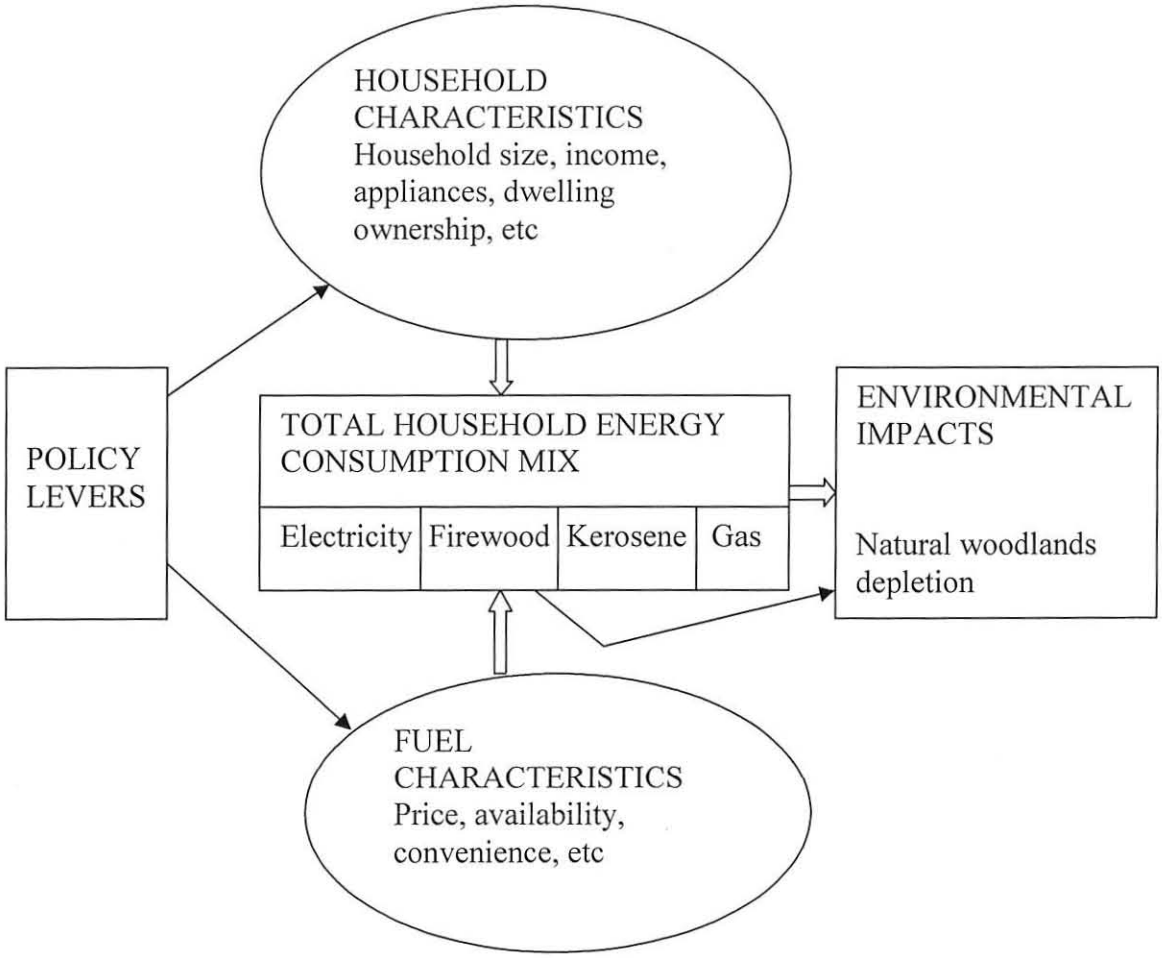

Figure 2: Conceptual framework of the energy mix model (Chambwera and Folmer, 2007)

2.3. Current State of Knowledge

This part of the literature explains the empirical findings of other researches on the relationship between demographic, economic and social factors with that of energy use.

2.3.1. Demographic Factors and Energy Use

In the previous studies only population size was emphasized as an important demographic factor in energy use. However, the number of households could be a more important determinant of energy use than population (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'Neil and Chen, 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 also on a per capita use. 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'Neil and Chen, 2002). Another study indicates that an increase in household member by one results in significant decrease in the per capita energy use except with a household size of two members (Pachuri, 2004).

The age of the head of household is also an important factor for the variation in energy use across households. Pachuri (2004) identified significant result on an 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 whereby 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 place of residence, dwelling attributes and demographic characteristics of the household increases the value to 66.4%. This suggests that in addition to the economic variable, demographic, geographic, dwelling and family characteristics also influence the total per capita energy use.

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). Similarly households with members having higher levels of education are more likely to use modern fuels where as illiterate or low levels of education in the household increases the chance of using traditional fuels (Heltberg, 2005; Farsi et al., 2007; Mekonnen and Köhlin, 2008).

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 other external factors that influence the supply side. Energy policy also put its own influence on choices, innovation, cost effectiveness, subsides and access of energy sources (Hadgu, 2002; Heltberg, 2005).

Finally, studies suggest that in order to accommodate the influence of household size on energy use, which is a demographic variable, comparison of income or expenditure level and other economic factors with the different household categories are important (O'Neil and Chen, 2002; Pachuri, 2004).

2.3.3. Social Factors and Energy Use

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 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 (Pachuri, 2004; Alemu Mekonnen and Köhlin, 2008).

2.4. Conceptual Framework of the Study

Based on the above review, we can say that there are a number of factors that determine household energy use. Therefore, the relationship between the independent variable i.e. demographic and socioeconomic variable and the dependent variable i.e. per capita energy use and type of energy can be linked in Figure 3.

This study uses the household as a unit of analysis and the aim of the study is to assess the effect of demographic, socioeconomic and other factors on the per capita and type of energy use. The influence of the independent factors on the dependent variable may acts directly or through the proximate factors. The independent variables that include the size and composition of the household, marital status, housing condition, income, employment status, educational level, availability, price and energy policies influence the amount of expenditure the household spend on energy sources. The same independent variables also determines the type and amount of energy households use based on the appliances they own and the end-use of those energy sources. The independent variables also act on the preferences and tastes, and food and cooking habits of households to determine the per capita and type of energy use.

However, all of the above independent variables are not included in the multiple and multinomial logistic regression equations indicated in chapter three. This is mainly because of three reasons. The first one is that the variables don't give a significant value to determine the type and amount of energy the households use. The second reason is that not adequate information was collected about the variable. The last one is that the variable was not the interest or purpose of this investigation.

Figure 3 also shows that per capita energy use was used as one of the dependent variable. The assumption in this approach is that if there is variation in the per capita energy use across household with different demographic and socioeconomic characteristics, it can be deduced that changes in the characteristics of households would affect the per capita energy use. The types of energy included in the dependent variable are selected based on the dominant sources of energy for the households in the study area.

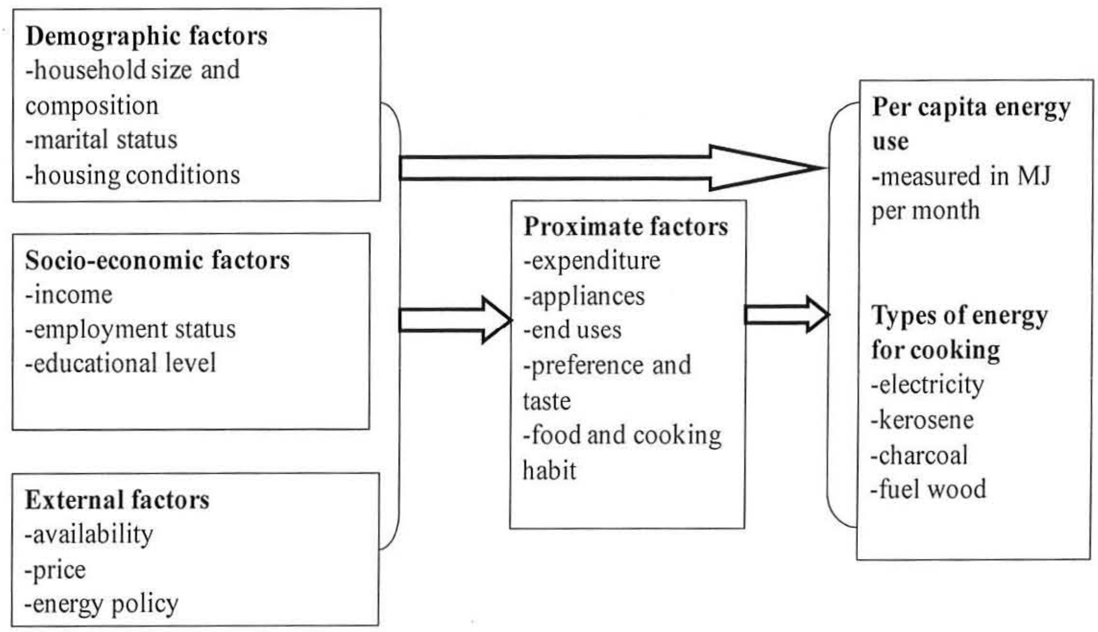

Figure 3: Conceptual framework of the study (developed by the author based on literature review)

2.5. Operational Definition of Terms

Household: refer to all people that lives under the same roof permanently and share resources among themselves like energy, water, food etc.

Household energy: refers to the energy consumed by the household sector for residential or domestic purpose like cooking, lighting, cooling, heating etc.

Per capita energy expenditure: indicates the total expenditure on energy per person.

Per capita energy consumption: indicates the total use of energy per person.

Traditional fuels: refer to fuels that have low efficiency like biomass fuels. In this thesis traditional fuel refers to fuel wood and charcoal.

Modern fuels: are fuels that have high efficiency compared to the traditional fuels. In this thesis modern fuels refer to electricity and kerosene.

Mix of traditional and modern fuels: is also termed as multiple fuel or fuel stacking and composed of both the traditional and modern fuels. In this thesis the category includes either two, or three or four combinations of traditional and modern fuels.

Chapter Three: Materials and Methods

3.1. Description of the Study Area

Dilla is one of a market town in southern Ethiopia. It is located at around 360km south of Addis Ababa in Gedeo Zone of the Southern Nations, Nationalities and Peoples Region. It is the major and second highest town in the region. Dilla was established in 1904 as a centre of trade mainly for coffee market but it was organized under the municipality administration since 1937.

Dilla had been located in the southern end of the all-weather road from Addis Ababa until the completion in the early 1970s of the asphalt road to the Kenya border. Dilla was the major transfer and marketing point for coffee grown farther south, particularly of the much-prized Yirga Chefe varietals. It remains a major center of the coffee trade. Currently the town is divided in to 3 sub-cities (Misrak, Ayer Tena and Edget Besira) with 9 kebeles, 15 sub kebeles and 77 villages.

According to the recent population program report of the Gedeo Zone Bureau of Finance and Economic Development, the total area of the town is 7.16 Km^2. The town is located at latitude and longitude of 6°24'36"N and 38°18'36"E coordinates respectively with an elevation of 1570 meters above sea level.

Dilla is one of the most highly populated towns in Ethiopia. According to the 2007 census preliminary result Dilla ranks as the 2^{nd} highest next to Hawassa in the size of population with in the region. The population in 2007 was 81,644 for both sexes, 42,599 for males and 39,045 for females (CSA, 2008).

Like any other part of the country there are four seasons in the town: *Bega* (December, January and February), *Belg* (March, April and May), *Kiremt* (June, July, and August) and *Tsedey* (September, October, and November). The mean annual rainfall received is 142.4mm and the mean annual temperature is 17.4^0c. The maximum and minimum mean annual temperature is 25.8 and 12.2^0c respectively.

The study area is also known for practicing agro forestry. Most of this area is covered with perennial cash and food crops that accounts for 82.13%. The remaining 8.54% is covered with annual crops and 3.96, 2.57 and 2.13% land is covered with bush, grazing land and other types. This area is commonly known for its cash crops like coffee and fruits and food crops like *enset*, maize, sorghum, teff, and barley. Shortage of land is the peculiar nature of this area, resulting in diversified cropping practices on small plot of land.

Dilla is selected as the study site for different reasons. Most part of the town and its surrounding area is evergreen and covered with trees that serve as a shade for coffee plants. This shows that there is a good practice of tree conservation in the area. On the other hand, the area between Dilla and Abaya Lake is highly deforested as most of the fuel wood and charcoal is supplied from this area to the town. Furthermore, as the town was established for a trade centre both modern and traditional fuels are provided on sale in different market situations (in loads carried by animals or people and a fixed market place). Above all, there was no previous study conducted in the area related to household energy use.

3.2. Data Source, Type and Collection Tools

A cross-sectional household survey was conducted to gather primary data on the demographic and socioeconomic characteristics of households and their energy use patterns in the month preceding the survey (In this case the month of December, 2008). This was supplemented by secondary data obtained from the study area, regional office, CSA and other institutions. Both quantitative and qualitative data was collected for the study. Quantitative information was collected by survey questionnaire after the pre-test and it was administered to all sample households. The qualitative information on attitude and preference was collected by an in-depth interview from systematically selected households.

3.3. Sampling

During the 2007 census of Ethiopia, Dilla town was subdivided in to three Kebeles known as Ayer Tena, Ediget and Misrak. The number of households in each Kebele was obtained from CSA. Then, the determined sample was distributed among the three Kebeles by PPS and systematically selected housing units were contacted for the survey and in-depth interview.

The sample size was determined by the following formula:

$n = [Z_{\alpha/2}]^2\ p\ (1\text{-}p)/d^2$

$Z_{\alpha/2}$=1.96 (critical value at 95% level of confidence interval)

p = 0.5 (proportion of the household sector energy use in Dilla town)

d^2 =0.05(standard error of estimation)

$$n= \frac{(1.96)^2 *0.5(1-0.5)}{(0.05)^2} =384$$

Contingency for non response rate=10%=38

n= 384 +38= 422

The distribution of households selected from each kebele is indicated in Table 3. The Table indicates that there are three kebeles used for selecting the samples. Based on the number of housing units they have, 100 households from Ediget, 140 households from Ayer Tena and 182 households from Misrak kebeles were selected.

Table 3: Distribution of the sample households by keble

Kebele	Total Number of Households*	Number of households selected**
Ayer Tena	4246	140
Ediget	3020	100
Misrak	5487	182
Total	12753	422

Source:

* CSA, 2008

**Field survey, 2009

3.4. Field Work

The survey for this study involved three data collectors, a supervisor and me. The recruitment of the data collectors and the supervisor was based on familiarity to the study area, educational level and previous experience in conducting related surveys. The data collectors were trained about the nature of the survey, the questionnaire and interview guide to be used and the system of conducting the data collection. During the data collection the supervisor and researcher controlled the data collection process. The response for the survey questions was recorded on the questionnaire where as the in-depth interview was recorded on the note book. At the same time the price of fuels per unit from different market situations of the town were measured. The tariff for the consumption of electricity was obtained from the EEPCo website.

3.5. Measurements and Conversions

Since the amount of energy consumed by the households may not be provided accurately, their expenditure on the different types of energy sources was used for determining the amount consumed. The price for fuel wood and charcoal per unit was collected from the different market situations that involves both from moving loads and a fixed market place. However, the amount consumed and expenditure on kerosene was obtained during the survey from the respondents and no estimation of amount was done on kerosene.

Based on the market price of the energy sources per unit and ratio of households buying the energy sources from each situation, the average price of the energy type was calculated. Then, the sum of all the average prices from different market situations was taken as the common price per unit for the specific type of energy source in the town.

The monthly expenditure for each type of energy sources reported by the households was divided by the common price per unit of the respective energy type obtained

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$$n = \frac{(1.96)^2 * 0.5(1-0.5)}{(0.05)^2} = 384$$

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Total	12753	422

Source:

* CSA, 2008

**Field survey, 2009

above in order to get the amount of energy consumed. This amount was converted into uniform physical energy units of mega joules. Finally, per capita energy use was calculated by dividing the total amount of energy consumed by the size of the household. (See annex 3 for all conversions)

3.6. Method of Data Analysis

After data collection, the responses were coded, entered and cleaned using SPSS version 15.0. Then, two sets of analyses were performed on the data. The first one involves descriptive technique to characterize the household characteristics and their energy use. Tables and graphs were used to describe the use of energy sources across the various related variables.

The second method was multiple regression analysis with dummy variables and multinomial logistic regression. The multiple regression models were fitted using per capita household energy use as a dependent variable. The independent variables of the model mainly include demographic and socio-economic characteristics of the households. The determinants of household per capita energy use can be represented by the equation:

$$E_i = f\left(Y_{i,} H_{i,} F_i\right) + \varepsilon \qquad (1)$$

Where E_i refers to the per capita energy use of the i^{th} household, f indicates the effect of the various variables, Y_i refers to the various socioeconomic variables, H_i refers to a vector of various demographic variables, F_i refers to a vector of various household dwelling attributes and ε refers to impact of other causal factors or error term.

The general model has a form of

$$\begin{aligned} \ln Y &= \alpha_0 + \beta_1 \ln \chi_1 + \beta_2 \ln \chi_2 + \beta_3 \ln \chi_3 + \\ &\beta_4 \ln \chi_4 + \beta_5 \chi_5 + \beta_6 \chi_6 + \sum_i \gamma_i \chi_i + \sum_j \lambda_j \chi_j \end{aligned} \qquad (2)$$

Where:

Y is the natural logarithmic transformation of per capita energy use

X_1 is the natural logarithmic transformation of household size

X_2 is the natural logarithmic transformation of age of head of household

X_3 is the natural logarithmic transformation of household income per month

X_4 is the natural logarithmic transformation of number of rooms in the house

X_5 is dummy variable taking the value of 1 if the head of household is female and 0 otherwise

X_6 is the dummy variable for the value of 1 if the house is owned and 0 otherwise

Xi is the dummy variable for the educational status of the head of household

X_j is the dummy variable for the marital status of the head of household

α_0 is the constant or intercept

β_1, β_2, β_3, β_4, β_5, β_6, γ_i and λ_j are slopes or regression coefficients that represent the contribution of each independent variable to the prediction of the dependent variable

For the interval/scale variables like per capita energy use, household size, and age of head of household, income and number of rooms, their log transformation were taken. This transformation is common in energy demand studies and was employed in the same manner by Heltberg (2005). The transformation also helps in meeting the assumptions of linear regression related to linearity, homoscedasticity and normality. The β coefficients have the interpretation of elasticity. This means that the estimated coefficients represent the percent change in per capita energy use as a result of a one percent change in each of the independent continuous variable.

Since it doesn't make sense to take the logarithmic transformation of dummy variables that have the value of 1 and 0, it is acceptable to enter to the equation as it is. However, the percentage effects for the dummy variables like sex, education and marital status of the head of household and house ownership can also be easily derived by exponential transformation of the coefficients (Heltberg, 2005).

The multinomial logistic regression was fitted for the choices of fuel types. As a result the type of energy was used as the dependent variables and more or less the same predictor variable was used like that of the multiple regression models. The model for multinomial logistic regression can be indicated by the following equation

Chapter Four: Results and Discussions

This chapter deals with results and discussion based on the data analysis performed by different mechanisms. The first section describes the major descriptor variables in conjunction with the dependent variables. The second section deals with the multivariate analysis that looks in to the relationship between the dependent and independent variables by using multiple regression analysis with dummy variables and multinomial logistic regression.

4.1. Household Characteristics and Energy Use

The description of the most important variables of the study would enable to see the direct relationship between the dependent and dependent variables without running the multivariate analysis. Therefore, background of the respondents, the type and amount of energy use in relation to household size, age of head of household, sex of head of household, income and expenditure; and the type of energy used for cooking and the place of cooking for solid fuels are described. Moreover, the chi square test of the association between the predictor variables and the choice of fuel type for cooking is indicated.

4.1.1. Demographic Characteristics of the Households

The major demographic characteristics of the sample households collected during the survey are presented in Table 4. According to Table 4, 66.4% of the head of households are males and 33.6% of them are females indicating that the sample is mainly dominated by households who are headed by males. In the same way the marital status of the heads of households was collected during the survey. The Table indicates that 20.1% of the household heads are never married. The heads of households that are currently married or living together account for 59.2% of the respondents. The rest 20.6% are married at least once in their life time but now they are either divorced separated or widowed.

The result also show that 42% of the households have between one and three household members and 35% have four up to six person in their households and 23% of them have seven and above persons in their household.

The age of head of households indicate that those who are in the range of 18-29 years accounts for 21% of the total. The heads who are in the range of 30-64 years accounts for 70.5% of the households. Those who are in the age 65 years and above accounts for 8.5% of the respondents. In general, the minimum and maximum age of the heads of households in this study is 18 and 90 years respectively. The mean age of the head of the households is 47 years.

Table 4: Demographic characteristics of the households

Characteristics	Categories	Frequency	%
Sex of head of household	Male	280	66.4
	Female	142	33.6
	Total	422	100.0
Marital status of the head of household	Never married	85	20.1
	Currently married/Living together	250	59.2
	Divorced/ Separated/Widowed	87	20.6
	Total	422	100.0
Household size	1-3	177	42.0
	4-6	148	35.0
	7+	97	23.0
	Total	422	100.0
Age of head of household in broad age group	18-29	88	21.0
	30-64	298	70.5
	65+	36	8.5
	Total	422	100.0

4.1.2. Socioeconomic Characteristics of the Households

The basic socioeconomic characteristics of the heads of households is presented in table 5. Interms of employment, 93.6% of the household heads are employed and earn own income. Only 6.4% of the heads are unemployed. The distribution of household in terms of income shows that the number of households in classification of incomes that earn 300-800 and >800 birr per month are almost equal. Households that earn >800 birr per month accounts 36.5% and those who earn 300-800 birr per month accounts 37.2% of the households. Those households that earn < 300 birr per month accounts 26.3% of all the sample households.

The level of education for the head of the household is also indicated in Table 5. The Table indicates that 14.7% of the household heads are illiterate irrespective of their sex, grade level, and age. The household heads who are in primary education accounts for 47.4% of the respondents. Furthermore, the household heads who in secondary school and above accounts for 37.9% of the respondents.

Table 5: Socioeconomic characteristics of the households

Characteristics	Categories	Frequency	%
Employment status of head of household	Employed	395	93.6
	Unemployed	27	6.4
	Total	422	100.0
Income of the household	<300 birr per month	111	26.3
	300-800 birr per month	157	37.2
	>800 birr per month	154	36.5
	Total	422	100.0
Education status of head of household	Illiterate	62	14.7
	Primary	200	47.4
	Secondary and above	160	37.9
	Total	422	100.0
Religion of the head of household	Orthodox	259	61.4
	Muslim	121	28.7
	Others	42	10.0
	Total	422	100.0
Ethnic group of the head of household	Amhara	134	31.8
	Oromo	78	18.5
	Gedeo	31	7.3
	Guraghe	81	19.2
	Silte	44	10.4
	Others	54	12.8
	Total	422	100.0

Source: Field survey, 2009

Another background characteristic of the household heads deals with their religion and ethnic group. The distribution of the household heads based on their religion shows that 61.4% of the heads are followers of Orthodox Christianity. Next to this 28.7% of the household heads are followers of Muslim religion. The rest of the heads of the households are followers of other religions different from those mentioned above and accounts 10.0% of the heads.

The distribution of household heads based on their ethnic group shows that 31.8% of the heads are Amhara followed by Guraghe and Oromo that accounts 19.2% and 18.5% of the household heads. The Gedeo people who are commonly settled in the area accounts only 7.3% in this study.

4.1.3. Relationship between Household Size and Amount of Energy Use

Household size is an important determinant of the per capita and total energy use in the household sector. Figure 4 shows the amount of mean per capita energy use by the size of the household. As indicated in the Figure the mean per capita energy use is the highest for two household members. A household with two members consume more energy than a household that has a single household member. For the rest of the cases, energy consumption decreases as household size increases. This is mainly due to the effect of the scale of economies prevailed in large households.

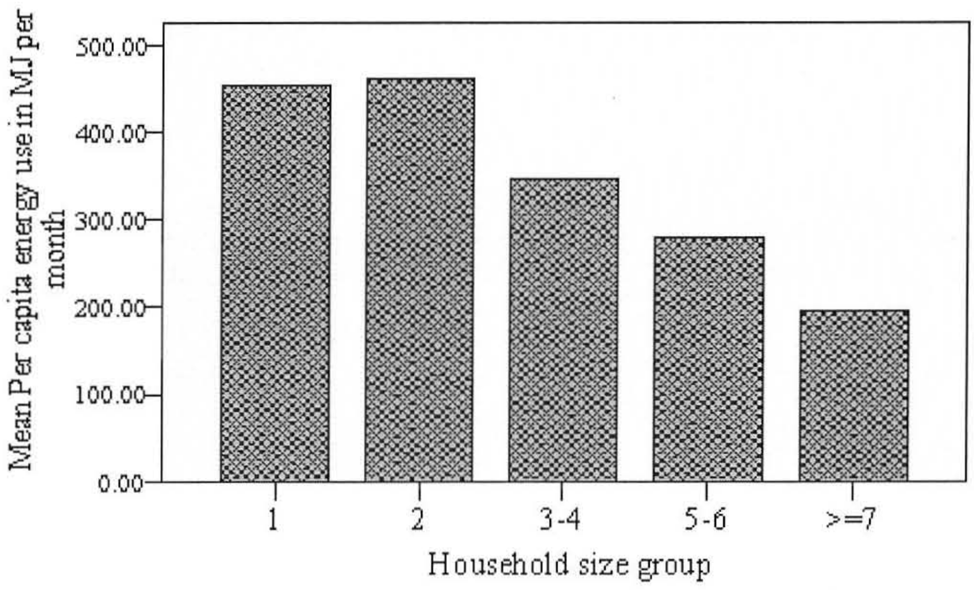

Figure 4: Mean per capita household energy use by household size group

Source: Field survey, 2009

Figure 5 shows the total amount of energy consumed as household size increases. There is a continuous increase in the amount of energy consumed as household size increases. The amount of energy consumed by two persons household is about two times higher than that of one person households. For the households having seven and above persons the amount of energy consumed reaches about 1500 MJ per month.

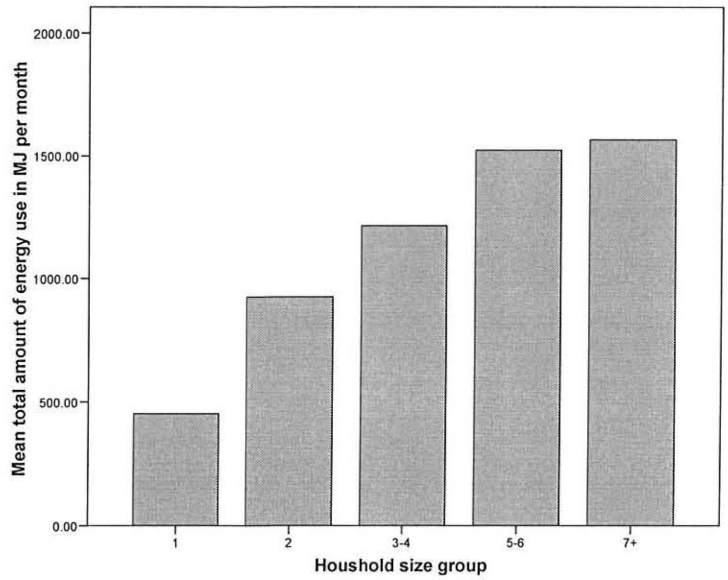

Figure 5: Mean total household energy use by household size group

Source: Field survey, 2009

4.1.4. Relationship between Household Head Age and Amount of Energy Use

As mentioned in the literature (Frizsche, 1981), the consumption of energy generally increases as age of the household head increases, despite the amount of energy use at later age (65+) decline at slower rate but remains higher than the lower age (15-19). As Figure 6 indicates that the mean per capita energy use decreases as the age of head of household increases in the same manner indicated above. This may be associated with the increase in the size of family members as the age of head of household increases.

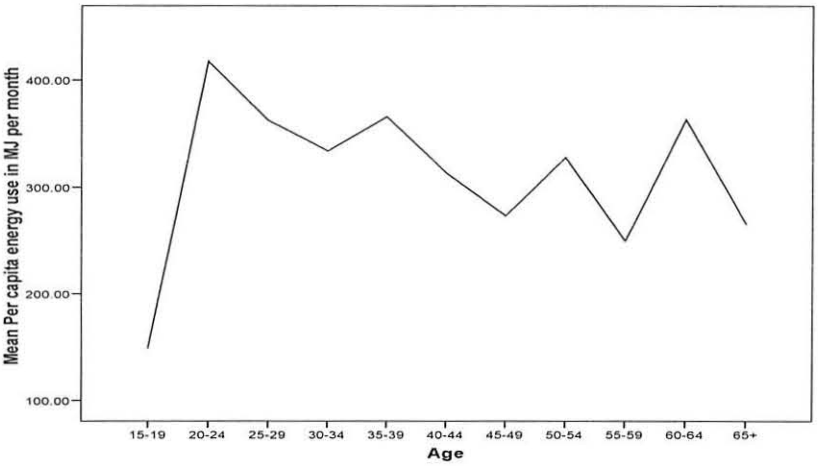

Figure 6: Per capita household energy use by age of head of household in five year groups

Source: Field survey, 2009

4.1.5. Relationship between Household Head Sex and Amount of Energy Use

The sex of head of household is one of the determinant factors for the variation in the amount energy use across households. The variation in the amount of energy use based on sex is indicated in Figure 7. The Figure depicts that female headed household's uses high amount of energy per month than male headed households.

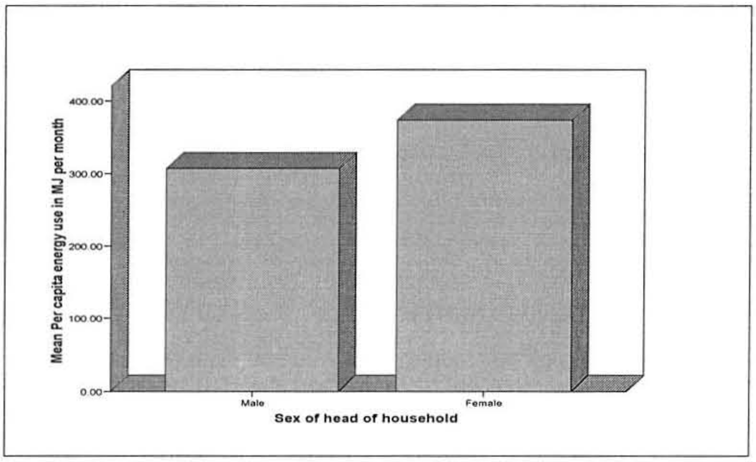

Figure 7: Mean per capita household energy use by sex of head of household

Source: Field survey, 2009

4.1.6. Household Income and Energy Use

The household income is the major economic determinant of the type and amount of energy consumed. Figure 8 indicates the mean per capita energy use by income groups and type of energy.

As indicated in Figure 8 the consumption of modern fuels is very low in the <300 and 300-800 birr per month income groups. The consumption of traditional and mix of traditional and modern is high throughout the income groups. Furthermore, multiple use of fuel is observed in the 300-800 and >800 birr per month income groups. This shows that increase in income may not necessarily lead to shifting of energy types from traditional to modern but lead to the use of multiple types of fuels for cooking.

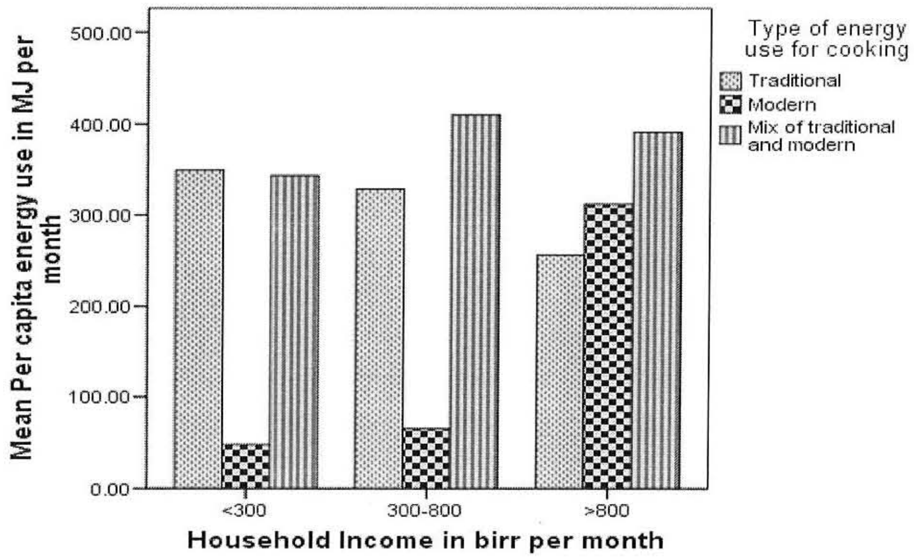

Figure 8: Mean per capita household energy use by income and type of energy for cooking

Source: Field survey, 2009

The total consumption of energy for each type of energy sources increase as income increases. Figure 9 depicts that the increase in the amount of energy consumed for traditional and mix of fuels is very small but the change of amount for modern fuels in the >800 birr per month category is very high compared to other income category.

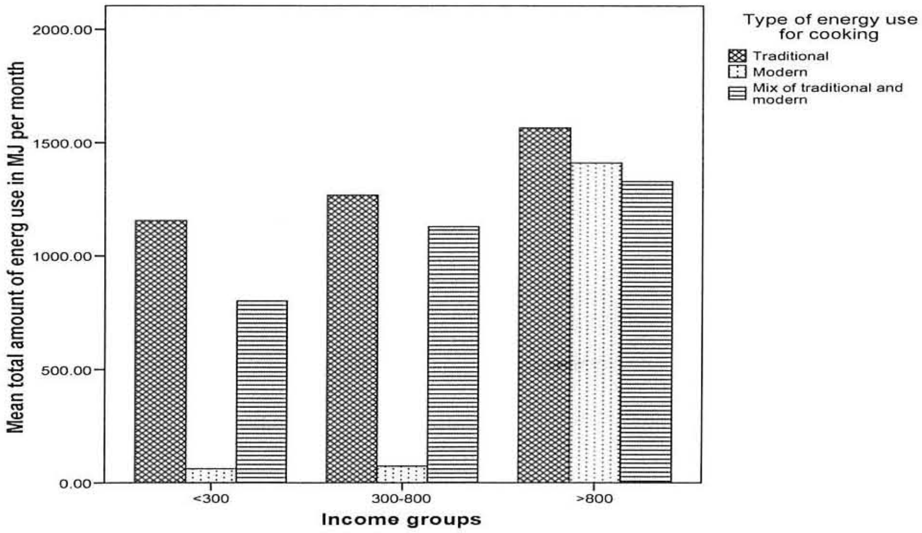

Figure 9: Mean total household energy use by income and type of energy for cooking

Source: Field survey, 2009

4.1.7. Patterns of Energy Expenditure and Use

The amount of energy consumed is highly determined by the expenditure households afford to spend on it. Thus, as indicated in Figure 10 the per capita energy use increases as the expenditure on it increases in all types of energy for cooking.

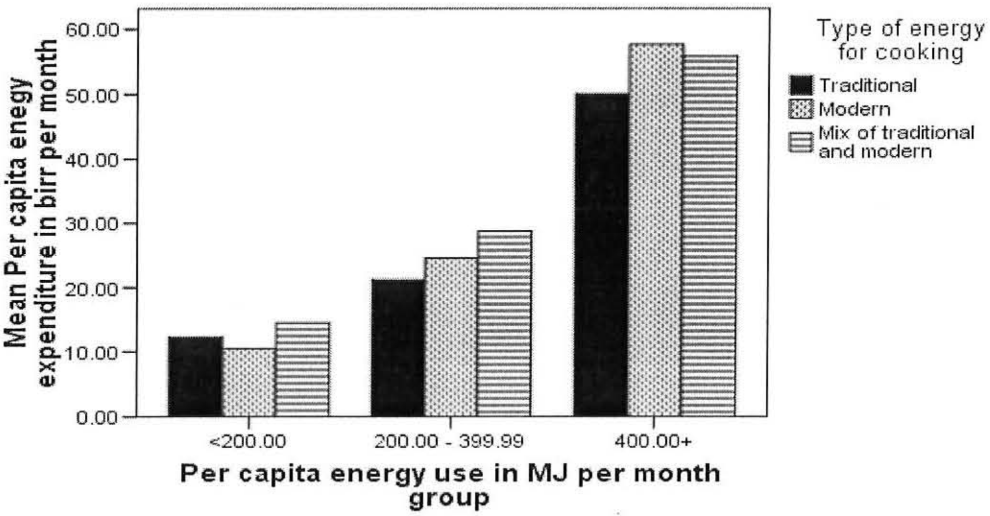

Figure 10: Mean per capita energy expenditure by per capita energy use and type of energy for cooking

Source: Field survey, 2009

The Pearson correlation estimate shows the value of 0.949 at a significance of $p<0.001$. This indicates that there is a very strong and positive correlation between per capita energy expenditure and per capita energy use.

Figure 11 indicates the distribution of amount of energy consumed by the households. The Figure shows that 47.63% of the households consume an amount of energy 200.00-399.99 MJ per month.

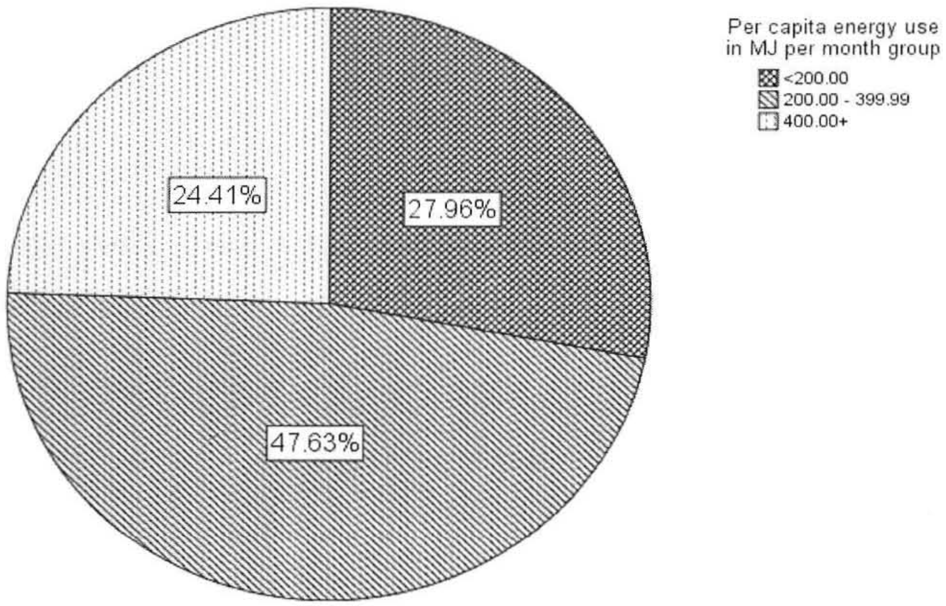

Figure 11: Distribution of amount of energy consumed in the households
Source: Field survey, 2009

4.1.8. Type of Energy for Cooking

The type of energy households' use for the purpose of cooking greatly influence the amount of energy they consume. The distribution of the number and percentage of households who uses each type of energy sources is indicated in Table 6.

The Table shows that charcoal is the major cooking fuel whereby 84.1% of the households depend on it. It is followed by fuel wood that accounts 74.2% of the households. Those households that use kerosene as one of their cooking fuel accounts 35.5% of the households. The least number of households uses electricity as a cooking fuel and it accounts for 7.1% of them.

Table 6: Type of energy for cooking by the percentage of households

Energy type	Responses	Percent
Electricity	Yes	7.1
	No	92.9
	Total	100.0
Kerosene	Yes	35.5
	No	16.6
	Total	52.1
Charcoal	Yes	84.1
	No	10.7
	Total	94.8
Fuel wood	Yes	74.2
	No	9.2
	Total	83.4

Source: Field survey, 2009

Figure 12 summarizes the pattern of use of cooking fuel. Here modern fuels include electricity and kerosene whereas traditional fuels represent charcoal and fuel wood. The Figure shows that 56% of the households use only traditional fuels for cooking.

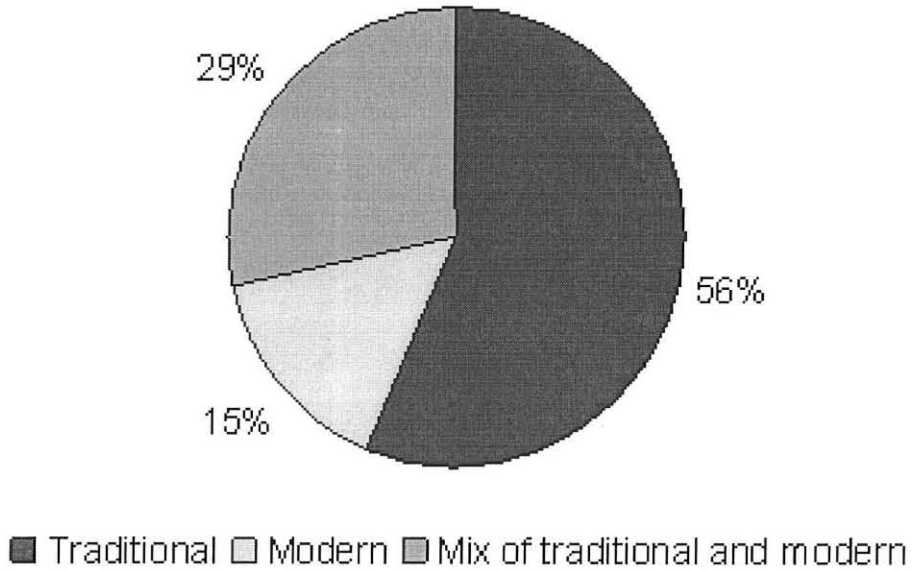

Figure 12: Distribution of energy types consumed in the households

Source: Field survey, 2009

4.1.9. Solid Fuels and the Place for Cooking

The place of cooking for solid that includes mainly charcoal and fuel wood greatly affects the extent of exposure to indoor air pollution. Table 7 below depicts the distribution of households with place of cooking for the solid fuel types. It indicates that among the households that uses fuel wood for cooking, 95% of them uses separate buildings or kitchen for cooking.

On the other hand, from the proportion of households that uses charcoal, 56% of them cooks in the house where as 42% of them cooks outside the house. From this percentage distribution the major source of indoor air pollution in the study area comes mainly from cooking by using charcoal inside the house.

Table 7: Place of cooking for the major solid fuel types

Solid Fuel type	Households cooking:			Total
	In the house	In a separate building (kitchen)	Outdoors	
Fuel wood	2	297	14	313
%	0.6%	95%	4.4%	100%
Charcoal	200	7	148	355
%	56%	2%	42%	100%

Source: Field survey, 2009

4.1.10. Association between the Predictor Variables and the Types of Energy

The chi-square and ANOVA test of the association between the type of energy for cooking and the predictor variables is indicated in Table 8. The dependent variable in this analysis is type of energy use for cooking which is classified in three categories as traditional, modern and mix of traditional and modern. The independent variables considered here are sex, age, household size, marital status education, income and ownership of the house.

The Table illustrates that the value of the chi-square is significant at $p<0.001$ for all the predictor variables except ownership status of the house, which is significant at $p<0.05$. This reveals that there is a significant correlation between the dependent and independent variables. The value of the ANOVA test also shows that all the variable have a significant value of $p<0.001$ except ownership status of the house, which is significant at $p<0.05$.

As income is the most significant determinant of the type of fuels used for cooking, it is strongly related with the type of energy for cooking at a Pearson chi-square value of 73.755 and F value of 95.075. Among the variables the least related variable to the type of energy for cooking is the ownership status of the house at a Pearson chi-square value of 8.960 and F value of 4.545.

Table 8: Chi-square and ANOVA test of the association between the predictor variables and type of energy for cooking

Predictor variables	Chi-square		ANOVA	
	Pearson	Sig.	F	Sig.
Sex of head of household	25.518	.000	13.483	.000
Age of head of household	34.552	.000	10.534	.000
Household size	58.826	.000	18.776	.000
Marital status of the head of households	20.657	.000	8.717	.000
Education status of the head of households	47.128	.000	25.072	.000
Income of the household per month	73.755	.000	95.075	.000
Ownership status of the house	8.960	.011	4.545	.011

Source: Analyzed based on Chi-square and ANOVA test

4.3. Determinants of the Amount and Type of Energy Use

In this section of the analysis two sets of models were fitted. The first model uses the multiple regression analysis whereby per capita energy use in its log transformation is considered as the dependent variable and the predictor variables include household size, age of the head of household, household income and number of rooms as scale variables with their log transformation and dummies of sex, education, marital status and house ownership.

The second model uses multinomial logistic regression to determine the type of fuel choice for cooking among traditional, modern and mix of traditional and modern. Thus, the dependent variable is the type of energy mentioned above and the predictor variables are sex, age, household size, educational status, marital status, ownership status of the house and income.

4.3.1. Determinants of the Monthly Per Capita Energy Use

The analysis of the determinants of the per capita energy use has been performed by using multiple regressions. The regression analysis was carried out using the Ordinary Least Square (OLS) method. A number of regressions were performed using different combination of independent variables before the most significant ones were selected. The assessments of multicollinearity between the independent variables were done by using correlation matrix, collinearity statistics and diagnostics. The variable inflation factor (VIF) in the model was less than 3 for all the variables.

Table 9 shows the results of the multiple regression analysis on the determinants of per capita energy use. Variables that are significant at $p \leq 0.001$ include *ln* household size, female as head of household and currently married/living together heads of households. The variable *ln* income is significant at $p<0.05$. These variables are the major determinants of the per capita energy use in the study.

As indicated in Table 9, the sign of the coefficient for household size is negative indicating that as household size increases the per capita energy use decreases. The value of the coefficient for log of household size is -.525, implying that a one percent increase in the size of household results in a 0.525% decease in total per capita energy consumption.

Demographic variation relating to household size has a negative effect on the per capita energy consumption. By controlling other factors constant, the per capita total household energy consumption decreases as the size of household increases. This relationship is mainly due to the economies of scale for larger households. This implies that, according to O'Neil and Chen (2002) as the household size increases, the per capita cost of maintaining a given standard of living declines. In this case the principal source is to share resources such as space, home furnishings, food, energy etc. The sharing of energy services results in lower per capita energy use in larger households.

The coefficient for the dummy of sex of head of household indicates that female headed households use per capita energy 4.4% more than that of male headed households. Therefore, female head households consume more amount of energy than male headed households. This is associated with their livelihood strategy that may depend on the trading of processed foods.

The coefficient for dummy variable of the marital status of head of households indicates that on average those who are currently married or living together use about 5.2% higher per capita energy than never married household heads.

Income has a positive coefficients indicating that as its level increases the per capita energy use also increases. The value of the coefficient for log of household income is .109, implying that a one percent increase in the income of the household results in a 0.109% increase in total per capita energy consumption. Therefore, an increase in the income of the household increases the amount of energy use slightly.

In relation to this Pachuri (2004), using per capita expenditure as a proxy for income, has noted that the economic variable dominates the other variables in explaining the variation in the per capita energy requirement. Variables relating to other characteristics were also found to have a measurable effect in explaining the variation in per capita total energy consumption. Therefore, adding variables related to geographical background, housing condition and demographic characteristics of the households increases the explaining power of the model.

Table 9: Multiple regression result of the determinants of per capita energy use

	B	SE	Beta	Sig.
(Constant)	4.247	.506		.000
ln household size	-.525	.070	-.483	.000
ln age	.194	.133	.095	.145
ln income	.109	.046	.123	.018
ln number of rooms	-.051	.070	-.039	.464
Female	.444	.084	.297	.000
Primary	.090	.103	.064	.380
Secondary and above	.185	.111	.127	.098
Currently married/Living together	.515	.099	.359	.000
Divorced/Separated/Widowed	.217	.121	.125	.074
Owned	.156	.086	.099	.070

Dependent variable: *ln* per capita energy use

ln= logarithmic transformation

B=Coefficients

SE=Standard error

Sig. = Significance

Note: For scale variables their log transformation is taken

Source: Field survey, 2009

4.3.2. Determinants of the Choice of Fuel Type for Cooking

The second type of model was fitted using multinomial logistic regression to analyze the determinants for the choice of fuel types for cooking. This regression was carried out after considering the requirements of the model that includes categorical dependent variable with more than two outcomes, independent variables either continuous or categorical, and the sample size or ratio of cases to independent variable is at least 10 to 1. These requirements are adequately satisfied in this analysis. The types of independent and dependent variable in this model are mentioned above. The ratio of valid cases (422) to the number of independent variables (9) was 47 to 1, which was greater than the preferred ratio.

In order to detect multicollinearity in the multinomial logistic regression the solution was by examining the standard errors for the b coefficients. A standard error larger than 2.0 indicates numerical problems such as multicollinearity among the independent variables. In this analysis none of the independent variables had a standard error larger than two.

The interpretation of the results was performed by comparing each of the categories of the independent variables with their reference category. This implies that, for instance sex of the head of the household uses female as the reference category and the consumption of each type of fuels by males is compared to females.

As indicated in Table 10 variables significant at $p \leq 0.001$ include *ln* income and male head of household for modern fuels and *ln* household size, *ln* income and primary education for mix of traditional and modern fuels. Variables significant at $p<0.05$ include *ln* household size and currently married/living together head of household for modern fuels and illiterate for mix of traditional and modern fuels.

Table 9 shows that in the sex category for modern fuels, male headed households are more likely to use modern fuels than traditional as compared to female headed households. In other ways female headed households mainly use the traditional fuels for cooking. Heltberg (2005) explained that gender composition of the head of households has significant effect on fuel choice.

Income is the most important determinants for the choice of fuel type for cooking. The relative risk ratio of *ln* income for modern fuel is above one and very high (32.05) indicating that as the income of the household increases there is a very high probability of using the modern fuels than the traditional fuels. Similarly, the relative risk ratio of *ln* income for the mix of traditional and modern fuels is above one (2.907) indicating that an increase in the income of the household would lead to the use of mix of fuels more probably than the traditional fuels.

In relation to income, Farsi and Filippini (2007) have noted that in urban areas economic considerations are significantly important in determining fuel choices. A higher income increases the ability of households to afford both the equipment and fuel costs of modern fuels like LPG, which are also more widely available in urban areas.

Household size is also found to be the significant factor that determines the choice of fuel type for cooking. As indicated in Table 9, the relative risk ratios for *ln* household size for both modern and mix of fuels are below one indicating that an increase in the household size would more probably lead households to use the traditional fuels as the major cooking fuels.

On the other hand, the relative risk ratio for those heads of households who had completed primary education in the mix of fuels category is below one. This indicates that household heads that completed primary education are more likely to use traditional fuels than those who have completed secondary and above education. Similarly, household heads that are illiterate are more likely to use the traditional fuels than those who have completed secondary and above education.

The relative risk ratio for household head that are currently married or living together for modern fuels is below one. This indicates that currently married/living together household heads are more likely to use the traditional fuels than the modern fuels.

Table 10: Multinomial logistic regression result of the determinants of the choice of fuel type for cooking

Type of energy*		B	SE	Sig.	Exp(B)
Modern	Intercept	-20.879	3.804	.000	
	ln age	-.928	.819	.257	.396
	ln household size	-1.134	.460	.014	.322
	ln income	3.467	.438	.000	32.050
	Male	2.497	.720	.001	12.145
	Illiterate	-.423	.791	.593	.655
	Primary education	.038	.418	.928	1.038
	Never married	1.070	.795	.179	2.916
	Currently married/Living together	-1.358	.699	.052	.257
	Own the house	-.057	.484	.906	.944
Mix of traditional and modern	Intercept	-2.057	2.045	.314	
	ln age	-.839	.526	.111	.432
	ln household size	-.984	.293	.001	.374
	ln income	1.067	.225	.000	2.907
	Male	-.031	.332	.925	.969
	Illiterate	-1.371	.485	.005	.254
	Primary	-.969	.276	.000	.379
	Never married	-.187	.478	.695	.829
	Currently married/Living together	-.367	.428	.391	.693
	Own the house	-.261	.353	.459	.770

* The reference category of the type of energy for cooking is the traditional fuels

B= Coefficient

SE = Standard error

Sig. = Significance

Exp (B) = Exponential coefficient

Source: Field survey, 2009

4.4. Preference and Attitude of Households on their Energy Consumption

The preferences of households to use a certain type of energy sources and their attitude on the determinants of the amount of energy they use were assessed by the in depth interview questions. The questions were asked for only systematically selected households in each kebele. The criteria for selecting households were based on household size, number of adults and age of head of the household head.

The preferences of households to use a certain type of energy arise mainly from their income. In addition to this availability of the fuel type, convenience and comfort to different end uses have important values for households to prefer a certain type of fuel. Households also prefer fuels that are cheap in price and coincide with their ability to afford to buy. The preferences of fuel type also depend on their end use purpose. For instance, electricity and kerosene are preferred mainly for lighting whereas fuel wood and charcoal is preferred for cooking.

The attitude of households on the determinants of the amount of energy they use indicates that it is highly again gravitated to income. However, there are also other factors that are mentioned by the households including household size, availability of fuels, extent of use, price, and the amount of money they expend on energy sources determine the amount they consume. Furthermore, the households mentioned that the addition of a non permanent household member and special occasions like weeding, party, holidays etc increase their energy consumption.

Chapter Five: Conclusions and Recommendations

5.1. Conclusions

This study has analyzed the factors that determine the amount and type of energy consumption in Dilla town using a household sample survey. The descriptive analysis suggests that the observed pattern in the data explain that there is a large variation in the amount of energy consumed across households. It ranges from less than one hundred mega joule per month to more than four hundred mega joules per month.

Moreover, the type of energy for cooking varies across households. More than half of the households depend on the traditional fuels as their major cooking fuels. Around one third of them use a mix of both traditional and modern fuels. Only 15 percent of the households use modern fuels for cooking. These variations in the amount and type of energy use are also explained by the characteristics of the households that includes household size, age and sex of head of household and household income.

The multivariate regression result also indicates that there is a variation in the amount and type of energy a household use. The amount of use of energy is highly determined by household size. The other variables relating to income, marital status and sex of head of household had a smaller but measurable effect on the variation in energy use. Particularly, an increase in the size of household results in a decrease in the per capita energy use per month.

The type of energy households choose for the purpose of cooking is highly influenced by income. As a result the economic variable is the major determinant factor for cooking fuel choice. In the same manner to amount of energy, the type of energy a household use is also influenced by household size, sex of head of household, education and marital status. Specifically, female headed households mainly depend on the traditional fuels for their cooking purpose.

In general, in addition to the economic variables, other socio-demographic variables are important in explaining the variation in the amount and type of energy a household use.

5.2. Recommendations

Based on the findings of the study the following points are recommended for policy measures particularly in the study area. The recommended areas mainly focus on the variable that significantly determines the amount and type of energy consumed.

1. Household size is the dominant type of demographic variable that determines the amount and type of energy use. The increase in the size of the household results in the decline of energy consumed per person as these households share the energy sources available in the house. On the other hand an increase in the size of the household leads to the use of mainly the traditional fuels for cooking Therefore, reducing the size of the household through family planning programs is important in order to acquire the desired amount of energy per person and use clean energy sources in the household.

2. It is observed that income of the household greatly influences the amount of energy use per person. The type of energy for cooking is also influenced by income. Since, income is the dominant factor in the consumption of energy efforts should be made to improve the economic status of the households.

3. Type of energy for cooking is greatly influenced by income. It is observed that households that earn a low level of income use the traditional fuels. Households that use the traditional fuels have to burn a lot of fuels since most of the heat generated is wasted. Therefore, efforts should be made to provide these households with energy saving stoves and modern energy sources at affordable price.

4. Households prefer to use a certain type of energy sources arising from their convenience and comfort. Awareness should be created for the households to use the modern energy sources and adapt energy saving technologies that are introduced for them.

5. Another factor mentioned by the households on the factors that determine their energy consumption is the availability of the energy sources. Therefore, it is important to provide households with the modern energy sources and other alternative energy sources.

6. Households should be encouraged to use fuels and technologies that have less effect on the environment, society and health. In order to achieve this, subsidization of modern fuels, promotion of higher level of education, and promotion of economic development should be made.

7. Finally, this study has tried to show that in addition to the economic variable, other socio-demographic variables are determinant factors for household energy use. However, further research is required to substantiate this finding and there is a need to explore in more detail about the behavioral aspect of household consumption of energy in relation to tastes, preferences, attitudes and food cooking habits. The effect of the present pattern of energy use on indoor air pollution, health and the wider environment needs to be investigated.

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Annex 1: Questionnaire

To be filled by heads of households

Hello, currently I am carrying out a survey on energy consumption, socioeconomic, demographic and dwelling characteristics at the household level in Dilla Town. The data generated through this survey will only be used for a study to be conducted for the partial fulfillment of Masters Degree in Population Studies at Addis Ababa University. The purpose of the study is to identify the factors that determine the type and amount of energy use in the household.

Thus, your contribution in responding to the questions is highly appreciated.
Will you participate in the survey? Yes ☐ No ☐

If your answer is yes, thank you in advance for your willingness to participate in this study.

Instruction: Respond to the questions in each section according to the format provided, by either filling the blank space or choosing the appropriate alternatives.

A. Questionnaire Identification

No	Category	Response
101	Household Identification Number	
102	Kebele	
103	Name of Interviewer	
104	Date of Interview	
105	Time of interview	Start: Finish:
106	Checked by the supervisor	Name: Sign: Date:

B. Demographic and Socioeconomic Characteristics of the Households

No	Question	Responses
201	What is your age in completed years?	
202	What is the sex of the household head?	1=Male 2=Female
203	What is your religion?	1=Orthodox 2=Protestant 3=Muslim 4=Catholic 5=Other
204	What is your marital status?	1=Never married 2=Currently married 3=Divorced 4=Widowed 5=Separated
205	What is your ethnic group?	1=Amhara 2=Oromo 3=Tigray 4=Gedeo 5=Sidama 6=Guraghe 7=Others, Specify ________________
206	Can you read and write?	1=Yes 2=No

207	If your answer is yes to question number 206, what is the highest grade you completed?	
208	How many people do live in your household permanently?	Male: ________ Female: ________
209	Number of adults age 18 and above in the household	Male: ________ Female: ________
210	Number of children age less than 18 in the household	Male: ________ Female: ________
211	Are you engaged in any kind of economic activity now?	1=Yes 2=No
212	What is your monthly income in Birr?	
213	Do you earn any income from other sources?	1=Yes 2=No
214	If your answer is 'Yes' to question '213', state the total amount of birr obtained from	Government job: ________ Private job: ________ Agriculture: ________ Trade: ________ Spouse: ________ Renting house: ________ Family member: ________ Pension: ________ Other: ________

404	How much money did you pay last month for________?	(indicate the amount in birr for each energy type)				
405	In your opinion, how do you evaluate availability of ____ compared to five years ago?	1=Easier to obtain 2=No change 3=More difficult 4=Much more difficult				
406	In your opinion, how do you rate the cost of ______ at present?	1=Very cheap 2=Cheap 3=Medium 4=Expensive 5=Very Expensive				
407	For what purpose do you use ________in your household?	(Circle appropriate alternative)	1=Cooking 2=Lighting 3=Ironing 4=Refrigerat-ion 5=Other, Specify	1=Cooking 2=Lighting 3=Other, specify	1=Cooking 2=Boiling 3=Other, specify	1=Cooki-ng 2=Heating 3=Ironing 4=Other, specify
408	What other energy sources do you use as a substitute in shortage of _____?	(List the energy types you use as a substitute)				

Annex 2: In-depth interview guide

To be responded by heads of households

Household Identification Number: ____________________

Instruction: Please give a detailed response for the following questions

1. What type of energy sources do you usually use in your household?
2. Why do you prefer to use such type of energy sources?
3. Do you get any of the energy sources freely from your compound or other places? If yes indicate from where you get it.
4. Which energy sources do you think are more efficient to use?
5. Do you use the above-mentioned type of efficient energy sources?
6. What are the barriers to their use, for the efficient energy source you do not use in your household?
7. Do you face shortage in any of the energy sources that you use usually? If yes, what would you do as a coping strategy?
8. In which time of the year and day does your household use high amount of energy? Explain the reason for this.
9. How do you evaluate the amount of energy you consume per month? Is it high or low? Give reasons.
10. How do you evaluate your household spending on energy sources per month? Is it high or low? Give reasons.
11. What do you think are the major factors in the household that determine the amount of energy you use per month?
12. Do you know the impact of the energy type you use on your household and outside environment? If yes, can you describe them?
13. What should you do to use adequate and clean energy sources in your household?

Annex 3: Conversion of expenditure in to energy units

A. Conversion of expenditure on electricity to quantity of energy used in kWh

The EEPCo has its own way of calculating the payment for the consumption of electricity in the domestic sector. The first table below shows the tariff category, the range of consumption in KWh and the corresponding rate of charge in birr/month. The second table shows the service charge based on the range of monthly consumption of electricity in kWh.

1. Domestic electricity sales price (tariff)

Tariff Category	Monthly Consumption in kWh	Rate Birr/Month
First Block	01—50	0.2730
Second Block	51—100	0.3564
Third Block	101—200	0.4993
Fourth Block	201—300	0.5500
Fifth Block	301—400	0.5666
Sixth Block	401—500	0.5880
Seventh Block	Above 500	0.6943

Source: EEPCo, 2009

2. Service charge in domestic sector single phase (220V)

Monthly Consumption on kWh	Rate Birr/Month
0—25	1.400
26—50	3.404
51—105	6.820
106—300	10.236
Above 300	13.652

Source: EEPCo, 2009

NOTE: Since the amount of kerosene consumed by households in litre/month was provided by the households no conversion of the expenditure in to quantity has been made for kerosene.

D. Conversion of quantity of energy in to uniform physical energy units of MJ

The conversion of each of the above energy types in to uniform physical energy units of MJ is important for the purpose of comparing quantities of energy consumed from each type of energy and calculating the total amount of energy. For this purpose a standard values obtained from Ethiopian energy authority is used. The following table shows the quantity of energy in uniform units of MJ for each type of fuels identified in this study according to their unit of measurement.

Fuel type	Unit of measurement	Quantity in MJ
Electricity	kWh	3.6
Kerosene	litre	35.3
Charcoal	kg	29.0
Firewood	kg	14.5

Source: EEA, 1994

Finally, the amount of energy calculated above in each type of energy sources was multiplied by their corresponding values in MJ to obtain the amount of energy consumed by each household in uniform physical energy units.

Declaration

The thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Alemayehu Agizew	[signature]	02-07-2009
Student	Signature	Date

I confirm that this thesis has been submitted with my approval as the supervisor of the same.

Tadesse Woldemariam	[signature]	02.07.09
Advisor	Signature	Date