The Energy-Gender Nexus: A Case Study among Urban and Peri-urban Female Headed Households in Arba-Minch Town, Southern Ethiopia

Ahmed Mustefa[1] and Tebarek Lika[2]

Abstract

The study was conducted in Southern Ethiopia with the objective of investigating the linkages between energy and gender among urban female-headed households (FHHs) residing both in and surrounding parts of Arba-Minch Town. The research design is mainly based on the quantitative methods and complemented with the qualitative ones. 272 sample FHHs were selected based on random sampling technique and data were collected using questionnaires, focus group discussions and key informant interviews. To determine the relationship and identify factors explaining households' cooking fuels consumption, correlation and linear regression models were used. Data on the consumption of energy sources were gathered in terms of expenditures which were later converted to energy heat values measured in terms of Mega Joule. Results of the study reveal that regardless of their economic status, the majority of FHHs depended on wood fuels as their primary source of cooking energy. In the study area, commercial cooking fuels have become increasingly scarce and expensive, and the costs of modern cooking appliances are beyond the purchasing ability of most of FHHs. It is becoming increasingly difficult for FHHs to obtain affordable energy technologies that convert energy to useful services. A significant portion of FHHs continue to suffer as their incomes have not kept pace with the rising prices. Increasing end-use efficiency should be given greater emphasis as an important prerequisite by employing proper end-use technologies to change FHHs' cooking practices so that household energy-related problems be tackled and energy can lead to more gender- equitable sustainable livelihoods.

Keywords: *Gender, energy poverty, fuel stacking, Arba-Minch, Southern Ethiopia*

[1] Assistant Professor, Mizan Tepi University

[2] Assistant Professor, Department of Geography and Environmental Studies, Addis Ababa University

Introduction

Background of the Study

Energy is one of the most essential inputs for sustaining people's livelihoods and without energy modern life would generally cease to exist (Clancy, Skutsch and Batchelor 2003). Cecelski (2004) pointed out despite many efforts, energy poverty is widespread, and gender inequality exits at every level of the energy sector. High incidences of poverty have been reported among FHHs all over the world (FAO 2008). The risk of poverty is greater for women and they are at the receiving ends of energy poverty because of their low social and economic status (Cecelski 2000 and Clancy 2006). Researches carried out in Ethiopia (such as Meron 2005; Emebet 2008; Berhanu 2011 and MoFED[3] 2011) reveal that there are higher proportions of poor FHHs than MHHs in urban areas. It was indicated that FHHs are viewed as being at greater economic disadvantage than Male Headed Households (MHHs) as they were found to be relying more on low paying and insecure income source than their male counterparts.

In spite of the improvement of level of access to clean fuels in the last few years, prices for commercial cooking fuels are already very high in the market for the majority of urban FHHs. As Clancy (2006) noted for many urban households in developing countries, energy costs constitute a significant part of household budgets, with FHHs considered to be in a worse position than MHHs. A substantial portion of the urban FHHs in the study area continue to suffer as their incomes have not kept pace with the rising prices and face higher financial burden to meet their cooking demands.

According to Farsi, M., Filippini, M., and Pachauri, S. (2005) there appears to be a clear order of preference and progression in terms of the switching and substitution behavior of households in their choice of cooking fuel. Others (see Massera *et al*. 2000; Bereket 2000; Alemu and Kholin 2008; Kammen and Kirubi 2009; Abebe and Koch 2011; and Yonas *et al*. 2013) are more concerned with fuel stacking hypothesis. These writers evaluate and criticize energy switching hypothesis as it fails appropriately to account for other factors that are likely to affect household switches to modern energy services.

[3]Ministry of Finance and Economic Development

Although urban energy has recently become one of the major research topics attracting the attention of many researchers, many previous studies (for instance, ESMAP 2006; Nebiyou 2009; Shanko *et al.* 2009; TERI[4] 2010; DFID[5] 2011 and Dawit 2012) emphasized the rural side and little research looked at the urban dimension. So far, no studies to our knowledge have explored gender disparity in the access to and end-use consumption of different energy sources in small and medium sized towns of the country. The extent of the problem to urban FHHs compared to their male counterparts implies that FHHs should be given due attention in the effort of poverty alleviation. As women are often held responsible for arrangement and usage of energy fuels, it is important that special attention be given to women while addressing energy poverty. Thus, the findings of this paper could be used to help, from the viewpoint of supporting gender equity and gender empowerment through energy solutions. The study helps to recognize and value women's roles with respect to energy in all its dimensions and promotes a more equitable distribution of responsibilities and benefits related to energy use, management and access.

Methods and Materials

Arba-Minch, which is one of the largest towns in south-western Ethiopia, lies astronomically between 06°05′N latitude and 37°38′E longitude. It is located in the western side of the Great Rift Valley and situated between the two major rift valley lakes of Abaya and Chamo. The natural barrier that separates the two lakes is locally known as "*Yegzer Dildiy*" (Bridge of God). The town consists of two settlements, *Secha* (the uptown, where almost all administrative offices are located) and *Sikela* (the downtown, which is the business centre of the city) with a total of twelve *kebeles*[6]. The target population for the study was the entire urban households residing within the town and Kola-shara *kebele*, which was taken to be one of the sample *kebeles* with the intention to represent peri-urban area. A total of 272 sample female households were selected by applying random sampling

[4]The Energy and Resources Institute
[5]Department for International Development (UK)

[6]The smallest administrative unit under city or town administration

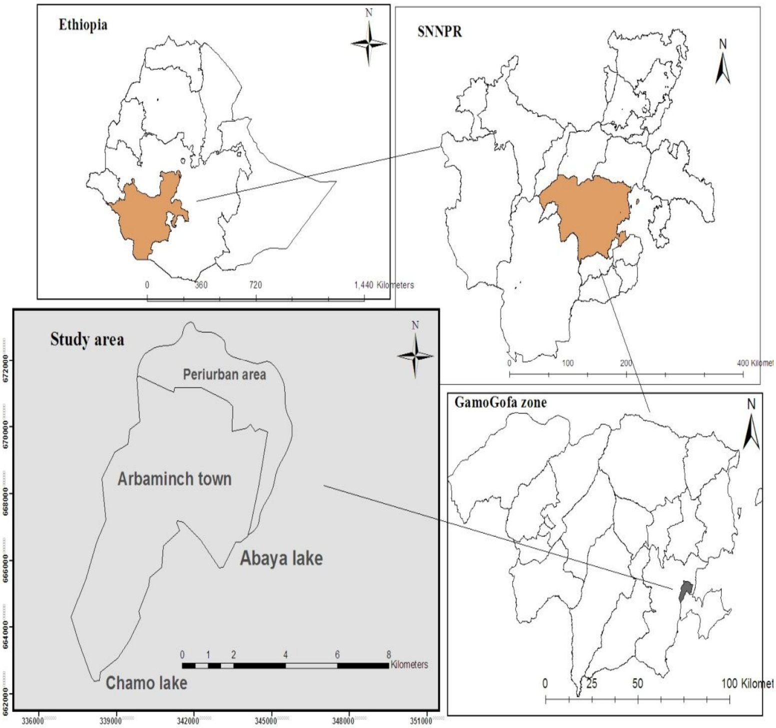
method based on the total FHHs list available in each *kebele*. The number of sample FHHs for each *kebele* is proportional to the total number of FHHs in each sample *kebele* administration (Table 1).

Table 1: sample *kebeles* and household size in the study area

kebele	Kulfo	Chamo	Bire	Mehal-ketema	Dilfana	Kolla-shara	Total
FHH size	427	421	318	306	225	132	1830
Sample FHHs	64	63	48	46	34	18	272

Source: Arba-Minch Town Administration Office, 2014 and field survey, 2014

For primary data acquisition, this research used household survey method as the main methodological approach to collect information from selected households. Structured questionnaires were used to collect such quantitative data. Qualitative data were collected using Focus Group Discussions (FGDs) and in-depth interviews to triangulate the finding of the quantitative study. Data were collected by using a cross-sectional survey of urban households that was carried out over three months from August to October, 2014.



Source: Authors, 2014
Figure 1: Location map of the study area

In the field work conducted, data on the consumption of energy resources for this study were gathered in terms of expenditures. Then the expenditure on household energy was converted to the unit of energy resources consumed by a household and data results have been organized and summarized by descriptive statistics. In the present study there is obviously one continuous dependent variable, which is cooking fuels consumption and a number of continuous and dichotomous independent variables.

To determine the relationship and to identify factors explaining household's cooking fuels consumption, Pearson correlation, biserial correlation and linear regression model were used. Pearson correlation has been run because the point-biserial correlation is simply a special case of

Pearson's product-moment correlation (NCSF[7] 2012 and Becketti 1994). Computing the point-biserial correlation is equivalent to computing the Pearson correlation when one variable is dichotomous and the other is continuous (DeCoster 2004). Since all the variables meet all the assumptions for biserial correlation (one of the variables should be measured on a continuous scale, the other variable should be dichotomous, there should be no outliers and the continuous variable should be approximately normally distributed), the present study uses biserial correlation coefficient which is appropriate statistical parameter when interested in the degree of relationship between a categorical independent variable and a continuous dependent variable. Linear regression model is estimated to identify factors explaining household's end use cooking energy consumption. The study identifies the different independent variables in order of their importance as predictors of cooking energy consumption with the help of beta coefficients.

Theoretical Considerations

In an investigation into gender, Cecelski (2004), Clancy (2006), Wickramasinghe (2007) and Aduosi (2012) have consistently shown that women in general, and FHHs in particular are more likely to experience persistent poverty due to domestic chores, scarcity and insecurity of income, higher rates of unemployment, oppression by the gender division of labor both inside and outside home and the associated ideologies and behavioral norms, illiteracy, poverty, early marriage, likelihood of being a single parent and likelihood of having a large family. Köhlin *et al.* (2012) pointed out in sub-Saharan African countries, FHHs are more likely to be poor and thus less able to afford the up-front cost of new stoves or electricity connections, For example, in Kenya, FHHs constitute a higher proportion of the poor both in the rural (54.1% female vis-à-vis 52.5% for male heads) and urban areas (63.0% female vis-à-vis 45.9% for male heads). The findings of studies by Genet (1996); Girma (1997) and Tizita (2001) have revealed that the trend and extent of poverty is worse among women in association with the growth of female headship of households.

[7]National Council for Strength & Fitness

As Clancy (2006) noted, for urban households energy costs can form a significant part of household budgets, with FHHs considered to be in a worse position than MHHs. In urban households' survey in Tanzania, it was found that FHHs use a higher average percentage of their income than MHHs for purchasing energy. The implication of such a finding is that FHHs suffer more than MHHs from rapid energy price rises. The high and direct dependence on biomass fuels coupled with low efficiencies in its end use at household level, mainly for cooking purposes, are contributing to unnecessary high level of forest resource removal which has resulted in serious shortage of biomass fuels and higher wood and charcoal prices, hitting adversely all urban households but most critically the FHHs. Women are most vulnerable groups to the negative impact of energy poverty and suffer disproportionately from the impacts of scarcity of fuels, air pollution and environmental degradation (Clancy *et al.* 2003). The responsibility for household energy provision affects women's health disproportionately since they are generally engaged in household cooking and hence most likely to suffer serious smoke-related health hazards. As Meikle and Bannister (2005) pointed out burning of traditional biomass over open fires or in inefficient stoves contributes to health-threatening indoor air pollution which causes a variety of respiratory illnesses such as chronic obstructive pulmonary disease, asthma, bronchitis, and pneumonia.

There are two quite commonly-used measures of energy use: gross and end-use energy. Clancy *et al.* (2003) use the term 'gross energy' to refer to the amount of total input of energy that is burned for cooking regardless of the efficiency of the appliances that people use. Whereas the term end-use energy refers to the amount of energy effectively used to perform the task required by the end user (Barnes *et al.* 2004). A further definition is given by Kahndker *et al.* (2010) who describes useful or 'delivered' energy as the energy that is adjusted for the efficiency of the appliance, technology and mode of use by the household.

In exploring the changing patterns of energy use in the household, researchers such as Alam *et al.* (1998), Barnes *et al.* (2004), Reddy (2004) and Nkomo (2007) have developed the notion of an energy switching hypothesis as a model to explain the shift between traditional solid fuels and modern non-solid fuels in order to meet household's energy needs as the household pass certain income thresholds. These writers consistently indicate a strong correlation between household income levels and the types and amounts of fuel used for cooking. The central idea of energy ladder hypothesis is to describe urban families are able to switch from lower-efficient biomass fuels to higher-energy-value modern fuels and equipment for cooking and heating with rising incomes. However, other studies by Masera *et al.* (2000), Heltberg (2005), Ntobeg (2007), Gundimeda and Köhlin (2008), and Alemu and Köhlin (2008) challenged the energy switching hypothesis and suggested the fuel stacking model which shows the use of multiple fuels rather than completely switching from one fuel to another. According to them, modern fuels are not coming as a replacement for the traditional fuels as such, but merely as supplement.

Surveys, such as that conducted by Samuel (2002), have shown that the energy transition hypothesis is confirmed in urban Ethiopia. It is wrong to assume that electricity substitutes biomass use in urban areas, in spite of the fact that there are substantial number of urban households with access to electricity. The most important issue is not electrification alone since the majority makes no use of electricity for cooking. Instead of moving up the ladder step by step as income rises, most households tend to consume a combination of fuels for cooking purpose depending on many more factors. Even the majority of higher incomes households do not currently substitute wood fuels for other conventional fuels for the purpose of baking and cooking.

Overall, there seems to be some evidence to indicate that energy can be a vital entry point for improving the position of women in households and societies. Their lack of access to energy services is a serious impediment to assuring livelihood security. This reinforces gender inequality and therefore contributes to poverty. Therefore, women should be focus of energy expansion plans; bringing energy to women and meeting their energy needs will help to empower them and lift communities out of poverty. Greater attention to the needs and concerns of women in these areas could help governments promote overall development goals like poverty alleviation, employment, health, and education through improved energy policies.

Results and Discussion

Demographic and Socio-Economic Characteristics of Respondents

The incidence of households headed by female is very likely to grow in the study area due to various causes. The termination of marriage either through divorce or widowhood or separation is the major factor that brings women in the forefront of heading the households. Widowhood was the most common reason for being the breadwinner of the household for the majority of women (62.9%). The proportion of divorced female heads take the second position (21.6%) followed by separated women heads with the percentage share of 13.1 percent while only 2.1 percent were single.

The majority of the sample respondents (47%) have reported to have family size of less than 3 and below family members and 29.4 percent have between 4 and 7 family members while nearly a quarter of them (23.5%) have between 8 and above members. The average family size in the FHH was 6. The total family members in the sample are 1,259 of which there are more female members of the family (52.49%) than male members (47.51%). The result shows the maximum age observed from the sample respondents was 66 while the minimum 25. The majority of the respondents (36.8%) are found between 31 and 40 age range, 15.4 percent are in the range of 21-30 years, 33.8 percent are between 41-50 years, 13.9 percent are 51 and above years. The educational status of the surveyed FHHs shows that almost three fourth of the sample FHHs (74.4 %) have attended formal education and are literate. Respondents having diploma and above constitute 34.9 percent of the total sample FHHs while 27.6 percent and 13.2 percent had attended secondary and primary level education, respectively. Only 12.5 percent of them have never attended formal education but can read and write.

With respect to dwelling ownership of the sample FHHs, currently 43 percent of the sample FHHs live in their own houses. While nearly one third (34.1%) and 22.8 percent of the respondents rented from *kebele*s and private owners respectively. Those lacking own houses live in an overcrowded rooms with poor housing conditions and a serious lack of basic facilities. Many of the FHHs were found to be not only lacking their own houses but also living in overcrowded rooms and poor housing conditions with a serious lack of basic facilities. Regarding housing conditions, the majority of the residential units (92%) are made of mud, wood and corrugated sheets while only a small share (8%) of the residential units are built using hollow blocks or concretes.

FHHs' Incomes and Energy Expenditures

Almost two-thirds of sample FHHs (66.5 %) do not earn a regular income or salary. They are totally dependent on other sources of income-generating activities. The majority (36.7%) were found to be relying on low paying and insecure income sources such as petty trades[8] to make their living. The lowest monthly income for the sample FHHs was 500 ETB, while the highest was as high as 4,500 ETB[9] per month. Mean monthly income for FHHs was 1,799.08 ETB. Out of the total survey FHHs, nearly a quarter of the sample FHHs (23.53%) were having an income greater than 2801 ETB per month and belong to high income category, 38.97 percent were earning in between 1201 and 2800 ETB and belong to the medium income households, and 37.5 percent have monthly income of below 1200 ETB and belong to the low income category (Table 2). Such income categorization cannot be generalized and hence is not a representation of the situation in the entire country. It may differ from region to region and from locality to locality.

As shown in Table 2, the average monthly cooking fuel expenditure for the sample FHHs, which is 101.70 ETB, making up 5.65 percent of the family mean monthly income. The lowest monthly expenditure for the sample FHHs was 55.00 ETB, while the highest monthly expenditure was as high as 169.00 ETB. The disparity in expenditure among sample FHHs, which can be explained by coefficient of variation of 17.84 percent, is smaller. The average monthly income for low income FHHs was 823.04 ETB and the mean monthly expenditure on cooking fuels was 90.53 ETB. Low income FHHs have to allocate 10.99 percent of their income for purchasing energy which creates a higher financial burden on their budgets. In the medium income FHHs, the mean monthly income was 1,811.32 ETB

[8]Such as Areki, Tella, Chakka (all are sorts of homemade / locally brewed alcoholic beverages)

[9]Ethiopian Birr (One USD was equivalent to 18.5 ETB at the time of the survey)

and the average expenditure on cooking fuels was 102.90 ETB per month which constitutes 5.68 percent of the average income of the group. In the high income FHHs, the average monthly income was 3,334.38 ETB and the average monthly expenditure on cooking fuels was 117.53 ETB which constitutes 3.52 percent. Increasing income of the FHHs dictates more expenditure and more cooking fuel is consumed with less significant strain on their budgets.

Table 2: mean monthly incomes and expenditures made by FHHs income groups (in ETB)

Income Group	Income Range (in ETB)	Sample FHHs	Income (ETB)			Cooking Fuel Expense (ETB)			As % of Income
			M	Sd	Cv	M	Sd	Cv	
Low	<1200	102	823.04	165.75	20.14	90.53	13.44	14.85	11.00
Medium	1201 - 2800	106	1,811.32	392.63	21.68	102.90	16.96	16.48	5.68
High	>2801	64	3,334.38	411.82	12.35	117.53	18.64	15.86	3.52
Average		272	1,799.08	1,012.14	56.26	101.70	19.14	17.84	5.65

Source: Field survey, 2014 M: Mean
Sd: Standard deviation Cv: Coefficient of variation

It can be seen from the data in Table 3 that biomass fuels account for 88.10 percent of total energy consumption in terms of cooking energy expenditure. Whereas, conventional fuels make up 11.90 percent of the total cooking energy consumed in terms of expenditure. Out of 24, 307.00 ETB spent for biomass cooking fuels per month by the sample FHHs, 16,005.00 ETB (57.86 per cent of the total cooking fuel expenditure) was spent on fuel wood, which also constitutes the highest share of the total expenditure for household energy. FHHs spent about 7,835.00 ETB (28.32 percent of the total cooking fuel expenditure) per month for charcoal consumption, followed by sawdust (530.00 ETB which constitutes only 1.92 percent of the total cooking fuel expenditure). Whereas the total monthly expenditure on modern cooking fuels for the sample FHHs was 3293.00 ETB. Out of 3,293.00 ETB spent for conventional cooking fuels, 2,028.00 ETB (7.33 percent of the total cooking fuel expenditure) was spent on kerosene while the share of electricity was about 1,265.00 ETB (4.57 percent of the total cooking fuel expenditure).

Table 3: total and mean percapita expenditures by cooking fuel type (in ETB)

Cooking fuel expenditure	Biomass cooking fuels				Conventional cooking fuels			Grand total
	Fuel wood	Charcoal	Saw-dust	Total	Kerosene	Electricity	Total	
Total energy (ETB)	16,005	7,835	530	24,370	2,028	1,265	3,239	27,663
Percapita (ETB)	12.71	6.22	0.42	19.35	1.61	1.00	2.61	21.96

Source: Field survey, 2014

As indicated in Table 4, the per capita monthly biomass cooking fuels consumption for the whole sample FHHs was 19.35 ETB. The per capita monthly biomass cooking fuels use was 14.72 ETB for low income FHHs. The figure rises to 22.12 ETB for the medium income FHHs and 25.91 ETB for the high income FHHs. The per capita monthly conventional cooking fuel use for the whole sample FHHs was 2.61 ETB. The per capita monthly conventional cooking fuels use was only 1.01 ETB for low income FHHs. The figure rises to 2.45 ETB for the medium income FHHs and ETB 7.07 for the high income FHHs. The total monthly consumption of cooking fuel for the whole sample FHHs was 27,663.00 ETB. The expenditure varies from 7,522.00 ETB for the high income FHHs, to 10,907.00 ETB for the medium income FHHs. Monthly per capita energy expenditures for all sample FHHs was 21.96 ETB and it varies from 15.73 ETB for the low income FHHs to as high as 32.98 ETB for the high income FHHs. This indicates that per capita energy consumption and total expenditure made on cooking energy by a family significantly increases with a rise in a family income.

Table 4: mean percapita expenditures by cooking fuel type and FHH income group (in ETB)

Income Group	Biomass Cooking Fuels				Conventional Cooking Fuels			Grand total
	Fuel wood	Charcoal	Sawdust	Total	Kerosene	Electricity	Total	
Low	9.49	5.02	0.21	14.72	1.01	nil	1.01	15.73
Medium	14.84	6.86	0.42	22.12	1.15	1.30	2.45	24.57
High	16.86	8.09	0.96	25.91	4.04	3.03	7.07	32.98
Average	12.71	6.22	0.42	19.35	1.61	1.00	2.61	21.96

Source: Field survey, 2014

Data Conversion

The amount of heat energy consumed from each specific energy source can be estimated by converting its expenditure into heat value. Therefore, for conversion mechanism, total expenditure of each FHH on fuels is multiplied by the constant to get the heat value consumed by a household. The most important of all the domestic biomass energy resources is fuel wood. With regard to the availability of fuel wood, 72.18 percent of sample households obtain it by purchasing. Fuel wood sellers are both male and female vendors who carry the fuel wood by their heads and backs, respectively. FHHs buy mainly of stems from male-vendors and twigs from female vendors. 12.10 percent of the FHHs buy fuel wood from the local market and 3.43 percent of the FHHs collect it on their own. The rest 12.3 percent go for buying and collecting. Over half of those surveyed FHHs (57.40%) are able to obtain regular supplies within one km of their residence. In the field work conducted, vendors in the form of human load serve almost all sample FHHs at an average price of 2.30 ETB for one kg of fuel wood. That means a FHH buys 0.435 kg for one ETB. One kg of fuel wood provides heat value of 15.072 MJ. Therefore, a FHH gets 6.56 MJ (15.072 MJ x 0.435) heat value of energy for one Birr (annex 1). This constant is important to convert household expenditure on fuel wood into gross heat value (MJ). For the rest of the energy sources, the constants were manipulated in the same way.

Charcoal is another important source of domestic energy in the area. Out of the total sample FHHs, the majority (86.02%) uses charcoal and only a small number of the respondents (13.98%) are non-users. Almost all charcoal is produced and traded by the informal actors. Nearly 90 percent of sample FHHs generally purchase charcoal by the sack from charcoal vendors who deliver this fuel directly to them. About 4.32 percent obtain it from retails and the rest 6.43 percent get from both market and vendors. Sacks of charcoal are offered for sale from charcoal vendors in almost all corners of the town. Sacks of charcoal typically weigh 25-35 kg each. The average price of a kilogram of charcoal was 3.25 ETB; accordingly, a FHH buys 0.308 kg of charcoal for one ETB. One kilogram of charcoal provides heat value of 29.73 MJ. So for one ETB a FHH could get 9.16 MJ (29.73 x 0.308) heat value of charcoal (annex 1). In the case of sawdust, 5.02 percent of the sample FHHs use this resource. Of the total users, only 1.22 percent got sawdust for free and the rest users normally buy the fuel from sawmill. The average price of sawdust was one ETB per kg. One kilogram of this fuel delivers 16.75 MJ heat value of sawdust. So a FHH could get heat value of 16.75 MJ (1 x 16.75) for the expenditure of one ETB on sawdust (annex 1).

All FHHs in the survey were asked their opinions about the ease of access to an electricity connection. The majority of respondents perceived electricity as readily available and the majority of those who responded to this item felt that access to electricity is not considered as a problem. The survey indicates that almost the entire sample dwelling units in the study area had access to electricity supply. The majority of sample housing units (85.56%) got their electricity directly from local Ethiopian Electricity Utility (EEU), Arba-Minch Branch through the power grid connected. While 14.44 percent of the total sample households did not source electricity directly from EEU rather they share electricity with neighbors by making use of an extension cord.

The price of electricity was based on fixed rate of payment for electricity consumed. The payment rates of electricity vary in slabs of the total amount of electricity consumed. The rate is a pricing structure that charges poor customers, who usually do not use much electricity (up to 50 kWh/month), a lower rate than higher income customers, who typically use more electricity. The monthly rate of payment per kWh varies from 0.273 ETB if the electric consumption was 50 kWh and less to 0.69 ETB for 501 kWh and above. That is, for example, if the total electric energy consumed is 100 kWh, the first 50B kWh is rated at about 27 cents per kWh and the second 50 kWh is rated at about 36 cents per kWh (EEU 2013) (annex 2).

As shown in Table 5, the average price of electricity paid by surveyed FHHs was 0.390 ETB per kWh. Since 0.390 ETB was equivalent to one kWh, one ETB was equivalent to 2.56 kWh. Thus, a FHH buys 2.56 kWh of electricity for one ETB. One kWh of electricity is equivalent to 3.6 MJ of energy. Therefore, for one ETB, a FHH buys heat value of 9.22 MJ (2.56 x 3.6) (annex 1). As far as kerosene is concerned, 25.08 percent of sample FHHs utilize it for cooking. Almost all kerosene users buy a liter of kerosene by 12.50 ETB from petrol station. Thus, 0.08 liter of kerosene was obtained for one ETB. One liter of kerosene delivers 33.63 MJ of heat value. Therefore, 0.08 liter of kerosene delivered 2.69 MJ (0.08 x 33.63) of heat value (annex 1). Accordingly, on average, fuel wood, charcoal, sawdust, electricity and kerosene have got a gross heat value of 6.56, 9.16, 16.75, 9.22 and 2.69, respectively (annex 1). The study here used the amount of heat energy per their respective units of energy rather than their prices as reference to find out their gross heat values (MJ).

Table 5: average price of electricity per kWh

Rate of Payment ETB/kWh	Monthly Electricity Expenditure (ETB)	Number of Users	Proportion of Users	Average Price (ETB)
0.27	Less than 51	86	0.316	0.085
0.36	51-100	114	0.419	0.160
0.50	101- 200	66	0.242	0.131
0.55	201- 300	6	0.022	0.013
Total		272	1.000	0.389

Source: Ethiopian Electric Utility, Arba-Minch branch, 2013 and field survey, 2014

As indicated in Table 6, on aggregate, the surveyed FHHs consumed a total gross cooking energy of 202,670.08 MJ per month. Of which, biomass fuels constitute 91.55 percent while the remainder (8.45 percent) was consumed in terms of conventional fuels. Of the total gross biomass energy consumed, the total fuel wood consumed was 6,962.18 kg (16,005 ETB X 0.435 kg) with a total heat value of 104,928.86 MJ, the total monthly charcoal consumed was 2,413.18 kg (7835 ETB x 0.308 kg) with a total heat energy of 71,745.10 MJ, and the total monthly sawdust consumed was 530 kg (530 ETB x 1 kg) with a total heat energy of 8,877.5 MJ. Of the total gross heat energy value received from conventional cooking fuels, electricity has a dominance share followed by kerosene. Total gross electricity consumed was 3,238.40 kwh (1,265 ETB x 2.56 kwh) with a total heat value of 11,663.30 MJ, and the total gross kerosene consumed was 162.24 liters (2028 ETB x 0.08 litre) with a total heat value of 5455.32 MJ.

From the previous discussion, it can be seen that the consumption of fuels was estimated in the total input household energy consumption regardless of the efficiency of fuels and appliances used. According to Barnes *et al.* (2004) the amount of heat that is burned for cooking is called the “input energy” and the amount that is actually absorbed by pots, pans, and or other cooking vessels is called “useful” or “delivered” energy. The amount of useful energy differs from one type of fuel to another depending upon the quality of fuels. In a study conducted by Clancy *et al.* (2003), it was shown that the efficiency of a fuel is measured by the amount of energy used for cooking compared with that which escapes from the stove without actually heating the food. For example, fuel wood used to function at the efficiency level of 10 percent. It means that out of a gross energy produced by burning fuel wood, only 10 percent is effectively utilized; the rest 90 percent is wasted away. On the other hand, conventional energy sources such as kerosene and electricity used to function at better efficiency levels of more than 50 percent (annex 1).

As can be seen from Table 6, the total monthly household end-use energy consumption in terms of heat value is 37,737.45 MJ. Out of the heat value of gross energy a household received (202,670.08 MJ), the monthly amount of end-use energy consumed was 18.62 percent. The total monthly end-use biomass and conventional fuels energy consumption were 26,262.31 MJ (69.59%) and 11,475.14 MJ (30.41%), respectively. This implies that even though the consumption of electricity shows a growth to meet the largest share of the total domestic energy requirement, the end-use of conventional sources of energy for domestic purpose is still very low in the study area as a whole.

Table 6: total gross and end use cooking energy consumption by FHHs (in MJ)

Total energy use	Biomass cooking fuels				Modern cooking fuels			
	Fuel wood	Charcoal	Sawdust	Total	Kerosene	Electricity	Total	Grand Total
Gross Energy (MJ)	104,928.86	71,745.10	8,877.5	185,551.46	5,455.32	11,663.30	17,118.62	202,670.08
Enduse energy (MJ)	10,492.89	14,349.02	1,420.40	26,262.31	2,727.66	8,747.48	11,475.14	37,737.45

Source: Field survey, 2014

Table 7 presents monthly total gross cooking energy use by income group in MJ. The total gross monthly wood fuel and charcoal consumed varies from the lowest (25,207.90 MJ and 16,894.67 MJ) for high income households to the highest (43,204.04 MJ and27, 883.07 MJ) for medium income households, respectively. The consumption of gross conventional energy increases with a rise in a household income. In other words, with the rise of the household income, there is a significant proportion of increase in the consumption of kerosene and electricity in terms of heat value. The total gross monthly kerosene and electricity energy consumed varies from 1,597.86 MJ and nil for low income households to 2,480.18MJ and 6,361.8 MJ for high income households. The study results indicate that biomass is the most important source of energy and remains to be the dominant source of energy in all income urban FHHs. Most FHHs still appear not to be benefiting significantly from modern fuel supply availability such as electricity. This implies physical access alone does not ensure that the households to benefit from the energy services. The real access to energy services can be limited by the purchasing power of the household and cost of energy using equipment.

Table 7: Monthly total gross cooking energy use by FHHs income groups (MJ)

Income Group	Biomass cooking fuels				Conventional cooking fuels		
	Fuel wood	Charcoal	Saw-dust	Total	Kerosene	Electricity	Total
Low	36,516.92	26,967.37	2,093.75	65,578.04	1,597.86	nil	1,597.86
Medium	43,204.04	27,883.07	3,098.75	74,185.86	1,377.28	5,301.5	6,678.78
High	25,207.90	16,894.67	3,685.0	45,787.57	2,480.18	6,361.8	8,841.98
Total	104,928.9	71,745.11	8,877.5	185,551.51	5,455.32	11,663.3	17,118.62

Source: Field survey, 2014

Based on the gross energy heat value constants, the mean monthly household gross energy consumption was estimated to be 715.11 MJ. Out of this, consumption of biomass fuels accounts the highest proportion (95.39%) while the rest (8.80 %) monthly household gross energy consumption was from conventional fuels. On an average, 53.95 percent of households' gross energy consumption was from fuel wood, 36.89 percent was from charcoal, 6 percent was from electricity and 2.81 percent was from kerosene. With regards to the average per capita gross energy consumption, the biomass fuels have still the greatest share (91.55%), with an average monthly per capita gross energy consumption of 147.38 MJ. While the rest 13.60 MJ (8.45 %) was the consumption of conventional fuels. Monthly average per capita gross energy consumption was 83.34 MJ (51.80%) for fuel wood, 56.99 MJ (35.40%) for charcoal, 9.26 MJ (5.75%) for electricity and 4.33 MJ (2.69%) for kerosene in terms of heat value (Table 8).

Table 8: mean monthly gross household and per capita energy consumption (MJ) by fuel type

Gross energy use	Biomass cooking fuels				Conventional cooking fuels			Grand Total
	Fuel wood	Charcoal	Sawdust	Total	Kerosene	Electricity	Total	
House hold Energy	385.77	263.77	32.64	682.17	20.06	42.88	62.94	715.11
Per capita Energy	83.34	56.99	7.05	147.38	4.33	9.26	13.60	160.98

Source: Field survey, 2014

As indicated in Table 9, the average monthly per capita cooking fuels consumed varies from the lowest for low income households to the highest for high income households. On the other hand, there is a proportional increase of per capita end use cooking fuels consumption with income of the households. The total percapita monthly biomass energy consumption was 111.72 MJ for low income FHHs. The figure rises to 167.09 MJ for the medium income FHHs and 200.82 MJ for the high income FHHs. The total percapita monthly modern energy consumption for the whole sample was 13.60 MJ. Percapita monthly modern fuel consumption varies considerably from FHH to FHH according to their income status. The total percapita monthly modern energy consumption was 2.72 MJ for low income FHHs. The figure rises to 15.04 MJ for the medium income FHHs and 38.78 MJ for the high income FHHs.

Table 9: monthly per capita cooking energy use by FHHs income groups (MJ)

Income Group	Biomass cooking fuels				Conventional cooking fuels			Grand total
	Fuel wood	Char-coal	Sawdust	Total	Kerosene	Electricity	Total	
Low	62.21	45.94	3.57	111.72	2.72	nil	2.72	114.44
Middle	97.31	62.80	6.98	167.09	3.10	11.94	15.04	182.13
High	110.56	74.10	16.16	200.82	10.88	27.90	38.78	239.60
Average	83.34	56.99	7.05	147.38	4.33	9.26	13.59	160.97

Source: Field survey, 2014

From the data in Table 10, it is apparent that the average household and per capita end use energy consumption was 138.74 MJ and 29.97 MJ respectively. On the other hand, the average monthly household and per capita end-use biomass energy consumed are 96.55 MJ and 20.85 MJ, respectively. While the average monthly end use household and per capita conventional fuels are 42.19 MJ and 9.11 MJ, respectively. In Table 10 charcoal registers the highest figure compared to other fuels with regard to the average monthly end-use energy consumption. This implies that FHHs were less likely to use modern fuels and they got lower capacity to afford appliances to use modern fuels such as electricity and kerosene at better efficiency level. Middle and higher income households are using energy combinations rather than replacing biomass fuels with conventional ones for baking and cooking purposes. This implies that wood fuels (wood and charcoal) are still the choice of the majority of urban households for baking and cooking and remains to be dominant in all income urban households.

The conditions of cooking in most FHHs are poor, with women generally cooking indoors in non-ventilated areas. Despite accessibility to electricity in urban areas, still many FHHs rely on biomass as their primary source of cooking energy. This is an indication that there is a slow long-run energy transition prospect in the town. The key question that arises here is, why is the clean sources of fuel that are accessible to the FHHs in the study area not being used for cooking? The increase in FHH's income is too slow to permit FHHs to switch from wood fuels consumption to more technologically efficient sources of energy for the purpose of cooking.

Table 10: mean monthly end use household and per capita energy consumption (MJ) by fuel type

End use energy	Biomass cooking fuels				Conventional cooking fuels			Grand Total
	Fuel wood	Charcoal	Saw-dust	Total	Kerosene	Electricity	Total	
Household Energy	38.58	52.75	5.22	96.55	10.03	32.16	42.19	138.74
Per capita Energy	8.33	11.39	1.13	20.85	2.17	6.95	9.11	29.97

Source: Field survey, 2014

Most FHHs cannot afford modern cooking fuels and proper appliances; they have less access to appliances of higher quality, because they are too expensive for them. Therefore, most FHHs cannot easily make a transition from biomass to electricity for cooking end use since the high costs of modern cooking stoves are major constraints for them. This indicates no substantial and complete switching from wood to electricity had occurred in household energy use. The majority of the households often lack the ability to optimize their consumption through improved technologies. A family has to purchase and improve domestic cooking appliances and engage in a better level of occupation in order to acquire adequate income for the healthier utilization of the available modern cooking fuels.

Women's Role in Baking and Cooking Foods

To understand gender roles of energy management, it is essential to know the individual's involvement in baking and cooking foods. The study focused on the views of women as they have primary responsibility for cooking within the household. It may have been useful to include male heads as they are often in charge of the households' finances, and therefore likely to be influential in household decisions to fund new cooking methods. The results have shown that women have the highest exposure to indoor air pollution and suffer from negative health effects since they spend considerable time around fires in a kitchen. The study reveals that women have all the responsibility of baking and cooking activities at home. Baking *Injera* and cooking foods are traditionally women's jobs in the area. Females take the lion's share of the baking and cooking responsibility. Most actively involved groups in cooking were usually females aged over 15 years of age. Daughters, female heads and housewives respectively are usually responsible in preparing and cooking foods and drinks.

Housewives are involved in cooking frequently for making *Wot*[10] (29.23%), baking *Injera* (26.33%) and for cooking local foods such as *Kurkufa and Fosossie*[11] (9.90%). Female heads regularly make cooking to prepare *Wot* (28.15%) and baking *Injera* (25.31%). Moreover, daughters are also chief cooks to prepare *Wot* (19.78%), *Injera* (10.73%) and local foods (10.45%). While housewives, female heads and daughters are the chief cooks, at the same time, they prepare the local nutritious drink, namely *Cheka*[12]using the leafy edibles and sometime they brew local alcoholic drinks, namely *Areki*[13] and *Tella (Shameta)*[14].

[10]Sauce for *injera*
[11]Local foods made from maize or sorghum flour
[12]A homemade alcoholic beverage
[13]Local liquor

Overall, nearly all females in the FHHs are at all involved in baking and cooking. They are largely responsible for meal preparation in the household using traditional fuels. Cooking is not only women's most time- and effort-consuming energy need; it is also a very large share of household energy consumption. Since cooking is often conducted in indoor kitchen areas, the biomass combustion exposes women to high quantities of indoor air pollution which results in poor health conditions for women. Thus, the responsibility for household energy provision affects women's health disproportionately to men's. There are possibilities for improving the position of women through energy. When communities gain access to energy services, it can have a marked effect on their lives, particularly with respect to freeing up their time, improving their health and well-being, and opening up opportunities such as enabling them to improve their earnings and their living situations.

The amount of fuel consumption with traditional cooking systems and the time consumed has been an issue for all concerned. As women were always occupied with household chores including the management of household energy resources, they have very little time for other economic and social activities that could enable them to be empowered socially and economically. It is a widely held view that managing biomass energy for cooking has a significant impact on women's workload and their health, which have hindered their capabilities and opportunities for participating in economic and other social activities. Therefore, to minimize the workload of women, the dissemination of efficient, modern and appropriate improved stoves is inevitable.

Determinants in the Utilization of Cooking Fuels

The survey analyzed household end-use cooking fuel consumption as a function of several explanatory variables. Variables such as age, sex, level of education, occupation status and marital status of the head of the household, household monthly income, education, occupation, household size, ownership and quality of residential housing units, and possession and utilization of end-use equipment are important as regards to explaining household's decision to consume a particular fuel. Pearson and biserial

[14]Home-brewed alcohol

correlation formula can be used to measure the relationship between two variables by assigning numerical values to the categories of the dichotomous variable. A functional relationship was formulated to ascertain the determinants of end-use household cooking energy consumption using correlation matrix which gives an overview of the pattern of relationships between the amount of expenditure made on the consumption of end-use cooking energy (dependent variable) and other independent variables. The coefficient of correlation matrix of the model estimate was evaluated and multicollinearity could not make significant impact on the quality and stability of the fitted regression model. The highest value recorded between age and family size (0.687) was acceptable (annex 3).

As indicated in Table 11, the coefficient of correlation was computed to be 0.603 for income, 0.418 for education, 0.362 for occupation, 0.325 for house ownership, 0.541 for number of cooking end use equipment, 0.495 for quality of cooking end use equipment and 0.423 for quality of housing unit, all suggesting the existence of positive association with the consumption of cooking fuels. While the Pearson's coefficient of correlation was computed to be negative for age (-0.136), and family size (-0.144) but are not significant at 0.025 and 0.018 levels, respectively. Similarly, modern cooking fuels' expenditure is positively and significantly related with all independent variables except age (-0. 088) and family size (-0. 057). Whereas the data reveal that the association between biomass cooking fuel consumption and occupation level of the household is statistically supported at 1% probability level and other variables such as education (0.154), income of the FHH (0.151) and house ownership (0.127) are significant at $p < 0.05$. On the other hand, family size (-0.085), quality of cooking end use equipment (-0.085), age (-0.51) and number of cooking end use equipment (-0.104) are said to have negative and insignificant effect on the likelihood of expanding on wood fuels.

FHHs, where the head has a higher level of income, education and occupation, are more likely to spend more on all sorts of cooking fuels. The positive signs of these coefficients more importantly signify that FHHs with higher income have greater capacity to pay and would choose the use of modern cooking fuel. Household income has a significant positive effect on the probability of choosing all cooking fuels. There is a corresponding increase in the amount of household cooking fuel expenditures with an increase in household income as a whole. The value of correlation coefficient for the conventional end-use energy consumption, which is 0.469, signifies that FHHs with higher income have greater capacity to pay and higher probability of choosing modern cooking fuels. This implies the more income of the household means the more conventional end-use energy consumption. As household income rises, the sources of energy used by the FHH would be cleaner and more efficient due to their higher purchasing power as compared to low income households.

FHHs with a head that had large number of end use equipment had higher modern fuel adoption probability than the household with a head with lower number of equipment. The amount of conventional energy consumed is positively and strongly correlated with the number of modern cooking stoves used. The data in Table 11 reveals that adoption of more stoves increases the likelihood of using more conventional end-use energy. A correlation coefficient of 0.616 implies that the better the efficiency in the utilization of energy resources, the higher is the consumption of conventional end-use energy. This signifies the fact that the provision and adoption of modern energy technologies (such as *Lakech* and *Mirt*[15]) among FHHs has been a great success to increase end-use energy consumption. The positive coefficient for quality of cooking appliances shows the higher the consumption of modern cooking energy, the better the efficiency in the utilization of cooking energy resource while the result of simple correlation analysis shows negative and insignificant relationship between end use energy technologies and the expenditures made by the biomass cooking fuels (-0.085).

House ownership and the quality of housing unit are considered to be determinant factors that significantly affect the use of household's end-use conventional energy expenditures for household purposes. Modern cooking fuel use is strongly associated with house ownership status of the household. The data implies that the association between quality of housing unit and use of modern fuel is significant at 1 percent probability level. Households residing in their own housing units tend to use more electricity than those who live in rented houses. FHHs that reside in their own housing units tend

[15]Improved biomass *injera* stove

to use more clean fuels than those FHHs rented. FHHs in owner-occupied housing units are less affected by constraints of electricity compared to those who live in rented houses; this is attributed to the fact that owner occupiers are more likely to install energy-efficient appliances. One can infer from the result that residential quality is one of the prerequisites to consume modern cooking fuel. FHHs living in better housing units are able to use the readily available utilities.

Table 11: the association between cooking fuel expenditure and independent variables

Expenditures made on	**Income**	**Education**	**Occupation**	**Age**	**Family size**	**End use equipment number**	**End use equipment quality**	**House ownership**	**Housing quality**
Biomass cooking fuels	.151*	.154*	.180**	-.051	-.085	-.104	-.085	.127*	-.028
	.013	.011	.003	.407	.161	.087	.162	.036	.102
Conventional cooking fuels	.469**	.271**	.183**	-.088	-.057	.685**	.616**	.203**	.623**
	.000	.000	.002	.149	.346	.000	.000	.001	.000
All types of cooking fuels	.603**	.418*	.362**	-.136*	-.144*	.541**	.495**	.325**	.423**
	.000	.000	.000	.025	.018	.000	.000	.000	.000

Source: Computerized data from field survey, 2014

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Higher levels of education were associated with a greater probability of the household using modern fuels and a lower probability of using biomass fuels. Education of the household head was a significant determinant as far as the decision to consume conventional end-use energy is concerned. The level of education determines the preference of a household for cleaner fuel. It was found that education level of the household head has significant positive impact on all types of end-use energy consumption (0.469). In other words, the higher the educational level, the larger the probability of using clean fuel sources and the smaller the chance of using wood fuels such as firewood and charcoal. Respondents with higher education levels would have greater awareness about the health effects of biomass fuels. The result of simple correlation shows significant positive relationship (0.183) between occupation of the head and the amount of end-use conventional energy consumption whereas it shows weak positive association with a FHH's consumption of biomass fuels (0.180). FHHs whose heads have higher levels of occupation in terms of payment are more likely to spend more on conventional fuels and consume more end-use conventional energy.

For the more rigorous analysis, the study used linear multiple regression to explain the relationship between a linear combination of the dependent variable (cooking fuels consumption in terms of heat value in MJ) and independent variables which is assumed to follow normal distribution. The coefficients explain the overall degree of the fit for a regression model and determine how certain one can be in making predictions from the model. In the model summary, which gives the R-square statistic, the Coefficient of Multiple Correlation was computed to be 0.695 and the Coefficient of Determination was 0.482 (annex4). The value of 0.695 indicates that there is a very high statistical association between the exogenous variables chosen in the model and the endogenous variable of the main equation (cooking fuel consumption). The R Square and adjusted R square of 0.482 and 0.465 respectively confirmed that the model is well fitted and variables are appropriate. The coefficient of determination confirms that about 48 percent variation in the dependent variable is explained by the variables and it can be said that independent variables in the model are relevant and appropriate to explain the dependent variable, consumption of cooking energy.

Besides R-squared, we can use ANOVA (Analysis of Variance) to check how well the model fits the data. The ANOVA results of the model, with F value of 27.129, estimated at 9 and 262 degrees of freedom (and a low standard error of 14.00), gave a ρ value of 0.000 (annex 5). The overall significance test of the model, F-test, is computed to be 27.129 which is statistically significant indicating that the given predictor variables in the model are collectively important and explain the consumption of end-use cooking energy in the study area (F statistics is less than 0.05 percent), which imply that the variation explained by the model is not due to chance. The model is acceptable and is significant to explain end use energy consumption (annex 5). The statistics confirm that there is a relationship between the dependent variable and the set of independent variables and that the independent variables significantly predict the dependent variable. There is no strongly correlated independent variable with the other independent variables. A more precise test is to use the variance inflation factor (VIF). No indication of collinearity, as all VIF values (the degree to which the standard error of the predictor is increased due to the predictor's correlation with the other predictors in the model) are less than 10 (or, tolerance value is less than 0.10).

Table 12: multiple linear regression showing effects of variables on the end use cooking energy consumption

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	VIF
	B	Std. Error	Beta			
(Constant)	57.790	6.810		8.486	0.000	
Family income	0.006	0.002	0.325	3.694	0.000	2.360
Education	0.209	0.710	0.019	0.295	0.768	2.263
Occupation	2.063	0.629	0.170	3.277	0.001	2.240
Age	-0.135	0.155	-0.063	-0.870	0.385	1.382
Family size	0.118	0.495	0.018	0.238	0.812	1.292
House ownership	2.645	1.361	0.117	1.944	0.053	3.178
Number of cooking end use equipment	9.110	1.329	0.363	6.853	0.000	1.330
Cooking end use equipment quality	-0.460	0.742	-0.043	-0.621	0.535	1.420
Housing quality	-0.112	1.463	-0.005	-0.076	0.939	1.598

Source: Computerized data from field survey, 2014

After checking for the model fit and the evaluation of the F-value and R-square, then it is important to find out the coefficients which give results of the regression analysis and evaluate the standardized coefficients or betas which are used to indicate the rate of change in independent variable when independent variable is changed by one unit. The "Coefficients" table below presents the optimal weights in the regression model. It is possible to quantify the relative contribution of each predictor to the overall prediction of the dependent variable using beta weight. As presented in Table 12, income of the FHH has a significant and positive effect on the total cooking fuel consumption. This could be because higher income creates more demand for multiple energy sources and enables households to purchase different energy appliances. The beta coefficient of 0.325 recorded for family income implies that for every unit change in monthly fuel expenditure of the household, the monthly end-use energy consumption would increase by 0.325 units. The relationship or association between total energy consumption and monthly income of the household is significant at 0.000 probability level. The degree of association indicates that in urban areas where all energy sources are commercialized, access to energy is determined by the purchasing power of the families. Thus, FHHs with better income level could have better access to all sorts of energy available in the market. In other words, households with more income have better ability to use modern energy and purchase different energy appliances than those with less income.

The number of domestic appliances owned by a FHH has positive and significant correlation with the overall end-use cooking energy consumption. Statistically beta coefficient 0.363 significant at 0.00 shows there is a corresponding increase in cooking energy consumption with an increase in the number of cooking end use equipment as a whole. The higher the number of cooking equipment signifies the more the amount of end-use energy consumption. A significant relationship was also found between occupation of the FHH and cooking energy expenditure. The beta coefficient 0.170 at $p< 0.05$ significance level asserts that the probability of expending on total cooking fuels increases with increase in level of occupation. Statistically presented beta coefficients for education (0.019) show that it is more likely a household to consume more end-use energy at the higher level of education. One can infer from the result that the number of years of formal education of household head is one of the prerequisites to consume conventional fuels. Household heads with higher level of education are more receptive to adopting energy efficient devices. The fact that age of the household head negatively associated with the consumption of end-use cooking energy implies that FHHs with younger heads were more likely to consume higher end-use cooking energy than the older heads.

Conclusion

The study reveals that an increase in household income does not necessarily mean an overall switching, where biomass cooking fuels totally substitute for clean cooking energy sources. Electricity is likely to reach nearly all the households; nevertheless, most households do not enjoy the full benefits of electricity. Most FHHs move up the “energy ladder” and eventually switch to electricity for lighting not for cooking. Most urban and peri-urban FHHs cannot easily make a transition from biomass to electricity for baking and cooking end-uses since the high costs are major constraints for them.

It is observed that the problem of energy poverty is acute since the majority of FHHs consumed less end-use cooking energy services due to large dependence on traditional fuels that are used at very low efficiency. Wood fuels (wood and charcoal) are by far the most used cooking fuels for a large majority of urban FHHs in spite of the growing scarcity and price of these resources. The main reason for preferring this energy source is affordability of the fuel and the related stoves. It is becoming increasingly difficult for most people to obtain affordable energy technologies that convert energy to useful services. The provision and adoption of modern energy technologies (*Mirt* and LPG[16]) among FHHs has not been a great success in the town. LPG is not an alternative urban cooking fuel option due to lack of general availability and much higher cost for household use.

The ability to use any modern fuel is dependent on the energy-users’ ability to afford not only the fuel on a regular basis but also their ability to pay for the energy-using appliances. Most end use technologies used by most FHHs in the town are inefficient and such energy inefficient mode of utilization of traditional fuels leads to the massive waste of wood, and contributes to deforestation. An increase in household energy demand has led to massive deforestation on the outskirts of the town. This has resulted in serious shortage of wood fuels and higher prices. One great concern, however, is that local authorities do little to control access to the hinterland forests of the town from where wood fuel is extracted and supplied. As

[16]Liquefied Petroleum Gas

women are amongst the most vulnerable groups to energy related problems, it is important that special attention be given to urban FHHs and they deserve much closer attention from energy policy.

This study suggests that increasing end-use efficiency should be given greater emphasis as an important prerequisite and cost effective solution to tackle household level energy problems. It is important to change households cooking practices by employing proper end-use technologies. The government should develop policies and regulations that are directly targeted at reducing the upfront cost of access to energy-saving devices hence making it accessible and affordable. A price subsidy policy for modern fuel may be one of those policy instruments to reduce the consumption of wood fuels and increase the choice of modern energy sources.

There is a need to practice afforestation and encourage conservation of natural vegetation by growing trees so that the pressure on surrounding forests and soil resources could be alleviated and household energy-related problems tackled. The local government should give attention to the amount of depleted natural resources and control or restrict the flow of wood fuels into the town and take immediate actions over the illegal harvesting of forest resources. Limited numbers of urban-based wood fuel traders must be able to obtain exploitation permits. The policy should direct to alternative sources of energy like utilization of solar energy and biogas rather than still giving more emphasis on biomass fuels as a major source of energy for the majority. People should be aware that modern fuels are cheaper than traditional fuels in terms of useful energy service.

As women are amongst the most vulnerable groups to energy related problems, it is important that special attention be given to them in energy policy. Addressing gender issues in energy can lead to more gender-equitable sustainable livelihoods and will make an important contribution to reducing poverty. FHHs should be the focus of efforts to bring access to modern energy, since bringing energy to women helps lift communities out of poverty. Further research should be undertaken to investigate what changes in household circumstances may have an impact on energy consumption. To generate achievable policy strategies and development targets with regards to energy poverty, there is a need for more studies at the local level to allow further assessment of local dimensions of the subject. A further study could assess the long-term and wider range effect of energy poverty at household levels. Such studies could help in the design of better strategies and policy instruments in the energy sector.

References

Abebe, D. and Koch, S. 2011. Clean Fuel-Saving Technology Adoption in Urban Ethiopia Paper provided by Economic Research Southern Africa in its series. *Working Papers* with number 229.

Adusei L. A. 2012. Energy Poverty: *Exploring Households Energy Constraints and Coping Strategies*. *Case Study of Sekondi-Takoradi, Ghana*. Master Thesis, 30 HEC, Uppsala 2012 Rural Development and Natural Resource Management – Master's Program Department of Urban and Rural Development.

African Development Bank (AfDB). 2014. Energy and Power. Retrieved February 2015 from http//www.afdb.org

Alam, M., Sathaye, J., and Barnes, D. 1998. "Urban household energy use in India: efficiency and policy implications. *Energy Policy* 26(11): 885-891.

Alemu, M and Koholin, G. 2008. "Determinants of household fuel choice in major cities in Ethiopia." *Environment for Development: Discussion paper series,* EfD-DP-08(18): 123.

Araya A. and Yisehak D. (2012). "Sustainable household energy for Addis Ababa, Ethiopia." *The Journal of Sustainable Development* Vol. 8, ISS. 1: 1–11.

Arba-Minch Town Administration Office. 2014. Annual magazine for the year 2013. Arba-Minch Municipality. No.12. 2014.

Arba-Minch Water Supply Service Office. 2013. Assessment of water supply in Arba-Minch town. *Yearly report.* Arba-Minch.

Barnes, D., Krutilla, K., and Hyde, W. 2004. *The Urban Household Energy Transition: Energy, Poverty, and the Environment in the Developing World.* World Bank. Retrieved September 19, 2012 from http://www.esmap.org/filez/pubs/8162007122407UrbanEnergyTransition.pdf

Becketti, S. 1994. A publication to promote communication among Stata users. Stata Technical Bulletin (STB). West 83rd Terrace, Lenexa, Kansas.

Bereket, K. 2000. *Affordability of Fuels and Patterns of Energy Demand in Urban Ethiopia*. Nairobi: AFREPREN.

Berhanu, E. 2011. *The Incidence of Urban Poverty in the Female-Headed Households in Addis Ababa, Ethiopia*. Addis Ababa, Ethiopia.

Cecelski, E. 2000. *Energy and Poverty Reduction: The Role of Women as a Target Group*. ENERGIA, paper presented at the Debate on Sustainable Energy in Danish-Development Assistance, Copenhagen: Landstingssalen, Christiansborg.

Cecelski, E. 2003. *Enabling equitable access to rural electrification: Current thinking on energy, poverty and gender*. Washington, DC.: The World Bank.

Cecelski, E. 2004. Re-thinking Gender and Energy: Old and New directions, Energy, Environment and Development (EED), ENERGIA/EASE *Discussion Paper*.

Clancy, J. 2006. *Urban poor livelihoods: Understanding the role of energy services*. Enschede University of Twente.

Clancy, J., Skutsch, M., and Batchelor, S. 2003. '*The Gender-Energy-Poverty Nexus: Finding the Energy to Address Gender Concerns in Development'*, Paper prepared for the UK Department for International Development (DFID), London. DFID Project CNTR998521, London.

CSA(Central Statistics Authority). 2014. *Population and Housing Census of Ethiopia: Result at Country Level*, Volume II, Analytical Report Urban and Rular Population Size, Addis Ababa.

DeCoster, J. 2004. Data Analysis in SPSS. Retrieved from http://www.stathelp.com/notes.html

DFID. 2011. 'Energy for the Poor: Underpinning the Millennium Development Goals'. Department for International Development, London. Retrieved June 16, 2014 from http://www.povertywellbeing.net/media/sla/docs/2-1.htm

Emebet, M. 2008. "Negotiating poverty: problems and coping strategies of women in Five Cities of Ethiopia." in *Urban Poverty in Ethiopia: the Economic and Social Adaptation of Women*. Addis Ababa University Press, Addis Ababa.

Ethiopian Electrical Utility (EEU). 2012. Ethiopian Power System Expansion Master Plan Update (EPSEMPU). Retrieved September, 2013 from http://www.eeu.gov.et

ESMAP. 2006. Clean Household energy for India: Reducing the Risks to Health 2004, UNDP Energy Sector Management Assistance Program.

FAO. 2008. *Climate Change and Food Security: A Framework Document.* Food and Agriculture Organization. Rome: United Nations.

Farsi, M., Filippini, M., and Pachauri, S. 2005. Fuel choices in urban Indian households. Center for Energy Policy and Economics, Swiss Federal Institute of Technology, WEC, 8092 Zurich, Switzerland.

Gundimeda, H., and G. Köhlin. 2008. "Fuel demand elasticity for energy and environmental policies: Indian sample survey evidence." *Energy Economics* 30: 517–46.

Heltberg, R. 2005. "Factors determining household fuel choice in Guatemala," *Environment and Development Economics* 10: 337–361.

Kammen, M. and Kirubi, C. 2009. Poverty, Energy and Resource Use in Developing Countries. New York: New York Academy of Sciences.

Khandker, S., Barnes, D., and Samad, H. 2010. "Energy poverty in Rural and Urban India: "are the energy poor also income poor?"" *Policy Research Working Paper,* 54 63.

Köhlin, G., Sils, E., Pattanayak S., and Wilfong, C. 2011. "Energy, gender and development: "What are the linkages? Where is the evidence?"" *Policy Research Working Paper,* 58 00.

Masera, O., B. Saatkamp, and D. Kammen. 2000. "From linear fuel switching to multiple cooking strategies: A critique and alternative to the energy ladder model," *World Development* 28(12): 2083–2103.

Meikle, S. and Bannister, A. 2005. Focus on the significance of energy for poor urban livelihoods: its contribution to poverty reduction. *Working Paper* No. 126.ISSN 14743280.

Meron, A. 2005. *Female Headed Households and Poverty in Urban Ethiopia*. Master of Science in Economic policy Analysis, Addis Ababa.

Ministry of Finance and Economic development (MoFED). 2011. *Ethiopia's Progress Towards Eradicating Poverty*. Addis Ababa.

NCSF. 2012. National Council for Strength & Fitness Certified Personal Trainer Examination.2011 CPT Annual Exam Report. Exam Statistical Report.

Nebiyu, A. 2009. *Domestic energy consumption and deforestation in Harari region: Assessment of Students' Awareness and Views*. School of Graduate Studies. Department of Geography and Environment Education. Addis Ababa Ethiopia.

Nkomo, J. 2007. “Energy use, poverty and development in the SADC.” *Journal of Energy in Southern Africa*, Vol 18 No 3.

Ntobeg, N. 2007. *Rural Energy Systems and the Rural Development Process: A Case Study from Limpopo Province.* Pretoria: University of South Africa.

Reddy, S. 2004. *Economic and Social Dimensions of Household Energy Use*: *Case Study of India*, Indira Gandhi Institute of Development Research, Mumbai, India.

Samson, R., Stohl, D., Elpano, A, and De Maio, A. (2006). Enhancing Household Biomass Energy. Use in the Philippines**.** *Excerpt from Chapter 2: Strategies for Enhancing Biomass*. *Utilization in the Philippines*. *National Research Laboratories Subcontract Number AXE-030001-01. U.P. Los Baños, College, Laguna, Philippines.*

Samuel, F. 2002. *Households' Consumption Pattern and Demand for Energy in Urban Ethiopia*. M.Sc. thesis, Addis Ababa University, Ethiopia. PhD dissertation. Department of Social Sciences, Wageningen University.

Shanko, M., Abebe, T., and Lakew, H. 2009. ‘A report on Mirt biomass injera stove market penetration and sustainability study in Amhara, Oromiya and Tigray National Regional States’,GTZ Sun Energy.

The Energy and Resources Institute (TERI). 2010. *Alleviating Energy Poverty*: *Indian Experience*. Regulatory Studies and Governance Division, Darbari Seth Block, India Habitat Centre, Lodhi Road, New Delhi, India.

Wickramasinghe, A. 2007. *Issues of Affordability and Modern Energy Technology: Barriers to the Adoption of Cleaner Fuels for Cooking.* National Network on Gender and Energy (NANEGE) Sri Lanka: University of Peradeniya.

Appendices

Annex 1: costs and conversion factor calorific values (energy contents) of various fuels

Fuel type	Unit	Energy content (MJ/unit)	Avera-ge price in ETB	Constants to convert expenditure into gross energy content (MJ)	Fuel efficien-cy ratio	Constants to convert expenditure into end use energy content (MJ)
Fuel wood	kg	15.07	2.30	6.56	0.10	0.573
Charcoal	kg	29.73	3.25	9.16	0.20	1.902
Sawdust	kg	16.75	1.00	16.75	0.16	0.536
Kerosene	lt	33.62	12.50	2.69	0.50	1.175
Electricity	kWh	3.60	0.389	9.22	0.75	6.915

Source: UNDP, 2007 & MoWE, 2011

Annex 2: varying rates of payment for electricity consumed

Slabs of electricity consumed (kWh)	0 - 50	51- 100	101 - 200	2001 - 300	301 - 400	401 - 50	501 & above
Range of payment (in ETB)	0 -13.50	13.51 - 36.00	36.01 - 100	100.01 - 165	165.01 - 28.00	28.01 - 295.00	295.01 & above
Rate of payment (ETB/kwh)	0.2730	0.3564	0.4993	0.5500	0.5666	0.5880	0.6943

Source: Ethiopian Electric Utility, Arba-Minch branch, 2014

Annex 3: the coefficient correlation matrix

	Cooking fuel expense	Family income	Education	Occupation	Age	Family size	House owner ship	No. of End use equipment	Quality of End use equipment	Quality of the house
Cooking fuel expense	1	.603**	.418**	.362**	-.136*	-.144*	.325**	.541**	.495**	.423**
Sig		.000	.000	.000	.025	.018	.000	.000	.000	.000
Family income	.603**	1	.694**	.429**	-.170**	-.248**	.451**	.463**	.542**	.654**
Sig	.000		.000	.000	.005	.000	.000	.000	.000	.000
Education	.418**	.694**	1	.416**	-.115	-.157**	.417**	.213**	.580**	.483**
Sig	.000	.000		.000	.058	.009	.000	.000	.000	.000
Occupation	.362**	.429**	.416**	1	-.154*	-.210**	.133*	.120*	.428**	.333**
Sig	.000	.000	.000		.011	.000	.028	.047	.000	.000
Age	-.136*	.170**	-.115	-.154*	1	.687**	.191**	-.090	-.160**	-.055
Sig	.025	.005	.058	.011		.000	.002	.139	.008	.363
Family size	-.144*	-.248**	-.157**	-.210**	.687**	1	.163**	-.057	-.201**	-.124*
Sig	.018	.000	.009	.000	.000		.007	.349	.001	.041
House ownership	.325**	.451**	.417**	.133*	.191**	.163**	1	.165**	.385**	.588**
Sig	.000	.000	.000	.028	.002	.007		.006	.000	.000
No. of End use equipment	.541**	.463**	.213**	.120*	-.090	-.057	.165**	1	.454**	.280**
Sig	.000	.000	.000	.047	.139	.349	.006		.000	.000
Quality of End use equipment	.495**	.542**	.580**	.428**	-.160**	-.201**	.385**	.454**	1	.511**
Sig	.000	.000	.000	.000	.008	.001	.000	.000		.000
Quality of the house	.423**	.654**	.483**	.333**	-.055	-.124*	.588**	.280**	.511**	1
Sig	.000	.000	.000	.000	.363	.041	.000	.000	.000	

Source: Computerized data from field survey, 2014

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Annex 4: model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.695	.482	.465	14.00346

Source: computerized data from field Survey, 2014

Annex 5: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	47879.476	9	5319.942	27.129	.000
	Residual	51377.403	262	196.097		
	Total	99256.879	271			

Source: computerized data from field survey, 2014