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Analysis of Energy Consumption Patterns of Households in Urban Ethiopia: The Case of Nakamte Town

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Abstract
This study looks into households' energy consumption patterns in Nakamte town, Ethiopia. The objective of the study is to analyze household energy consumption patterns for the main energy sources (fuel-wood, charcoal, kerosene and electricity. The study used household-level survey data collected from 120 sample households in Nakamte town. A two- stage sampling procedure which consists of simple random and systematic random sampling techniques was employed to select the sample households. Descriptive analysis of the data shows predominance of traditional energy sources in household energy mix which has environmental damage such as deforestation, soil erosion and declining agricultural productivity, and loss in the natural habitat for the wildlife in the hinterlands. Since household energy transition is still at an early stage, the government of the country should harmonize energy policies with poverty reduction objectives and strategies. Increasing income, influencing households' energy choice and improvement of modern energy accessibility will play a critical role in the transition of households from traditional to modern energy sources.
Keywords: energy consumption, energy transition, Nakamte town

1. Introduction

Energy usage for cooking, heating and lighting is essential to human life and it was part of what first defined the human race as distinct from animals in pre-historic times. Energy use is central to all aspects of human welfare, including access to clean water, agricultural productivity, health care, education, job creation, climate change, and environmental sustainability. Electricity, gas, kerosene, charcoal, coal, wood and dung are the various forms of energy needed for cooking, heating, lighting and other tasks (UNDP and WHO, 2009). Yet, many people in developing countries still remain dependent on traditional biomass fuels for cooking and on inefficient sources of light such as candles and kerosene (Heltberg, 2003). Expanding access to modern energy services is an enormous challenge for developing countries, especially in the poorest countries. Currently, about 1.5 billion people in developing countries lack access to electricity and about 3 billion people rely on solid fuels for cooking (UNDP and WHO, 2009).

While rural households rely more on biomass fuels than those in urban areas, well over half of all urban households in Sub-Saharan Africa rely on fuel-wood, charcoal, or wood waste to meet their cooking needs (IEA, 2006). The heavy reliance on biomass energy in Sub-Saharan Africa is due to lack of adequate modern energy supplies and widespread poverty in the continent. While Sub-Saharan Africa makes up about 14 percent of the total population of developing countries, it accounts for almost 40 percent of the population without electricity access (UNDP and WHO, 2009). Indeed, majority of people in Sub-Saharan Africa live below the poverty line, and they cannot afford to pay for modern energy sources for cooking purpose.

With increasing population and urbanization over time, urban household energy consumption is an important issue for developing countries in general, and for poorer developing countries, such as Ethiopia, in particular. Ethiopia is endowed with a number of energy sources, including biomass, hydropower, natural gas and coal, geothermal, solar and wind. However, Ethiopia's consumption patterns are similar to those observed in other developing countries. Fuel-wood, animal dung and charcoal are widely used in rural areas as well as in urban centers including big towns. According to OECD/IEA (2012), Ethiopia is one of the countries with the largest population relying on traditional use of biomass for cooking in 2010. As of 2010, about 96% of people of the country relied on traditional use of biomass for cooking (OECD/IEA, 2012). Demand for biomass fuels is growing at a rate of 6 % annually (Lakew et al., 2011). The household sector is the key energy consuming sector in the country. Over 90% of biomass energy is consumed by households, rural and urban alike (Gebrehiwot, 1997). Households, even in major cities of Ethiopia, tend to increase the number of fuels they use as their incomes rise instead of completely switching from the consumption of traditional fuels (such as wood) to modern ones (such as kerosene and electricity) (Mekonnen and Kohlin,2008).

Even though fuel-wood and charcoal remain the major sources of energy for urban households and this become an important environmental issue in Ethiopia, the market of these fuels has been remained unregulated. However, there are programs that aim to enhance the combustion efficiency of biomass fuels and use of alternative sources of energy in response to the wide ranges of problems created by use of biomass fuels (Gebrehiwot, 1997). The energy policy of the country highly focuses on the provision of modern energy sources to achieve a gradual transition from traditional to modern energy sources (Teka, 2006). Does the provision of modern sources of energy make urban households switch from fuel-wood and charcoal? This question requires

the analysis of household energy demand and its determinants in urban Ethiopia. However, only few studies were done with regard to household energy consumption patterns in urban areas of Ethiopia. Thus, this study is an attempt to fill the gap by looking at energy consumption pattern of households in Nakamte which is one of the towns found in Ethiopia.

The objective of this study is to analyze energy consumption patterns of households in Nakamte town. The study is limited to the four main energy sources (fuel-wood, charcoal, kerosene and electricity) that households in Nakamte town use to satisfy their domestic energy requirement for cooking, lighting, heating space, heating bath water and other tasks. The study used cross-sectional data, and hence does not allow comparison of energy consumption over time. Since different cities in the country have different sets of alternative energy sources with different shares in energy mix, the result of the study may not be used for understanding and addressing energy demand problems at the national level. However, this study is believed to contribute the understanding of linkage between urban household energy consumption and environmental problems by analyzing fuel-wood and charcoal demand within the context of overall energy consumption, which is a good indicator of environmental damage caused by households in Nakamte town.

2. Literature Review

2.1. Theoretical Literature

Household energy consumption can be defined as the energy consumed in homes to meet the needs of the householders. Demand for energy is derived from needs to use energy to obtain desired services. It is not derived from preferences for the energy commodity itself. Consumers demand energy ultimately for the services they derive from consuming it. The services derived from energy could be heating, lighting, and cooking and thus, energy products are means of fulfilling those services. Households prefer one energy source to another to meet their demand. Two hypotheses have been dominantly developed and tested empirically concerning why a household choose a particular energy source(s) than others. These are the energy ladder and energy stacking hypotheses.

Household fuel choice was viewed in the past through the lens of the 'energy ladder' model (Heltberg, 2005). The energy ladder hypothesis states that people with low incomes generally use traditional fuels as their main cooking fuel, and people with higher incomes tend to use modern fuels (Rajmohan and Weerahewa, 2007). The underlying assumption of the hypothesis, according to Masera et al (2000), is that households are exposed to a number of fuel alternatives which could be arranged in an order of increasing technological sophistication. Biomass fuels occupy the bottom of the list while electricity lies at the top. It is assumed that energy transition occurs from the bottom to the top with increasing income of households. The energy ladder model puts more emphasis on income in explaining fuel choice and focuses more on fuel switching. According to Heltberg (2005), the energy ladder model is a three-stage fuel switching process. As the household's income increases, households move from biomass to transitional fuels such as kerosene, coal and charcoal, and eventually to liquid petroleum gas (LPG) and/or electricity once their income is sufficient.

On the other hand, according to energy stacking (energy Mix) hypothesis, households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels (Masera et al., 2000). They proposed an alternate 'multiple fuel' model that integrates four factors demonstrated to be essential in household decision making under conditions of resource scarcity or uncertainty:(a) economics of fuel and stove type and access conditions to fuels, (b) technical characteristics of cook stoves and cooking practices; (c) cultural preferences; and (d) health impacts. Instead of completely switching from one fuel to another as income increases, households choose different fuels as from a menu. Chambwera (2004) developed energy mix model that serves as a conceptual framework in analyzing the urban fuel-wood demand among households in Zimbabwe, in case of Harare. The energy mix model used as a framework captures the reality that households use multiple energy sources, and the use of different energy sources is associated with several indicators of socio-economic status such as income, household size, etc.

Chambwera (2004) employed economic theory to analyze how urban households allocate their expenditure to different sources of energy. Economic theory postulates that consumers allocate their disposable income among different goods to maximize utility (Varian, 1992). In any particular period, households are assumed to choose a set of energy types that they use for household tasks under different circumstances to meet their total energy requirements. The total cost of this set of energy for any particular period must not exceed total energy outlay. The ultimate decision of a household concerns about allocation of its total energy expenditure to each source of energy to achieve maximum satisfaction. For any household with defined characteristics such as income and household size, it is possible to analyze its mix of energy sources and determine how much of each fuel it consumes based on its expenditure on it.

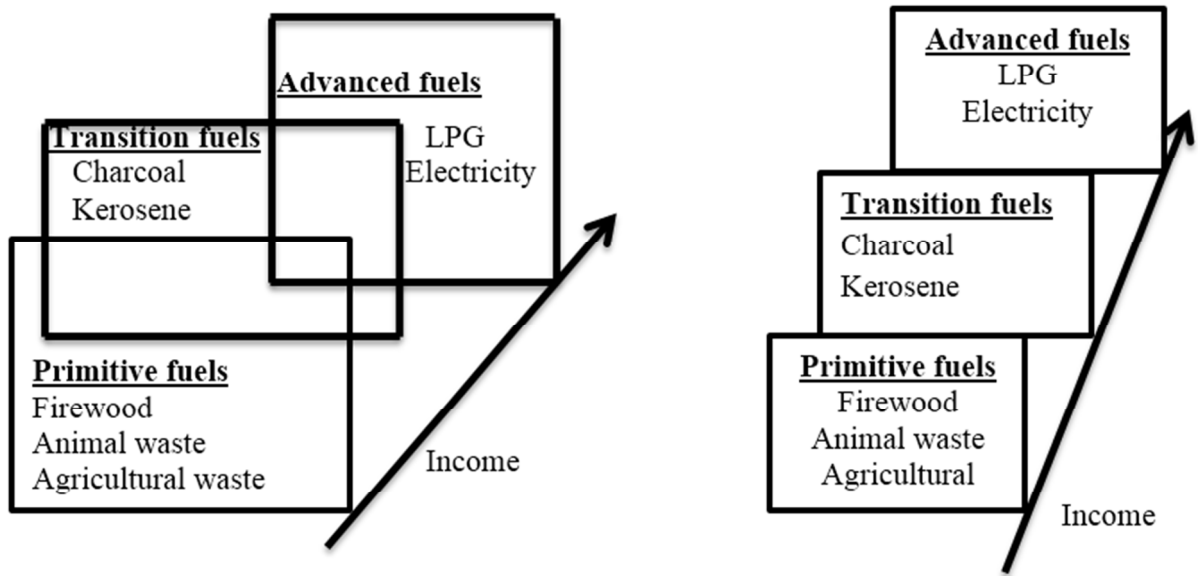

Figure 1: The energy ladder and energy stack hypotheses adopted from Masera et al (2000)

Chambwera (2004) took the principal sources of energy (electricity, kerosene and firewood) that households in Harare mix to satisfy their energy needs. When energy from different sources is measured in terms of expenditures, the household energy consumption scenario can be put as:

$TEE = Ee + Ef + Ek + Eo$

where TEE is total energy expenditure by a household

Ee, Ef, Ek and Eo are household expenditure on electricity, firewood, kerosene and others respectively.

Total energy expenditure itself is expressed as a share of household total expenditure such that

$w_{TEE} = \frac{TEE}{TE}$

where w_{TEE} is the share of total energy expenditure in household total expenditure, TE.

The share of each fuel in the expenditure mix is a ratio of its expenditure and total energy expenditure such that for all fuels in the mix the ratios add to unity, i.e. $\sum w_i = 1$.

where w_i is the share of fuel i and defined as

$w_i = \frac{E_i}{TEE}$

where Ei is the expenditure on fuel i.

2.2. Empirical Literature

The transition from traditional to modern fuels is important for urban people because of the potential to improve the quality of energy service, to lower indoor air pollution, and to reduce deforestation pressures in semi-urban environments (Barnes et al., 2004). Barnes et al (2004) found that the urban energy transitions are in fact quite varied, in terms of the timing of the transition period, and the transition fuels consumed. They explained urban household energy transition process as it has three stages, and classified cities of developing world into these stages using factor analysis. These stages are:

Stage1: High wood fuel utilization
Stage 2: Utilization of transition fuels
Stage 2A pattern: High charcoal use
Stage 2B pattern: High coal or kerosene use
Stage 2C pattern: Diversified transitional fuel use
Stage 3: Transition to LPG and electricity

Leach (1992) studied the substitution of traditional biomass fuels by modern energy sources in the household sector of developing countries, and found that the substitution is strongly dependent on urban size and, within cities, on household income, since the main constraints on the transition are poor access to modern fuels and the high cost of appliances for using them. Relative fuel prices appear to be of lesser importance.

Most of country specific household energy studies found that households in developing countries use a mix of traditional and modern sources of energy. Jane (2011) indicated a pattern of fuel accumulation in which the use of electricity and modern technologies are utilized along with fuel-wood in Caoxiu Village1, Sichuan Province, China. Despite increases in household electricity use, the study showed little evidence of electricity displacing fuel-wood use; thus challenging modernization and its potential to work for environmental conservation. The transition from biomass to modern commercial sources is still at an early stage in rural Hubei,

China given that biomass still accounts for about two-thirds of the total energy used by rural households (Peng et al., 2010). The finding confirmed that fuel stacking model is a more accurate description of household energy than the energy ladder model.

Israel (2000) found that high fixed costs of purchasing durable goods combined with credit constraints are barriers to modern energy use in Bolivia. Development projects encouraging households to switch to a cleaner fuel need to be aware of potential fixed-cost problems, even if the alternate fuel is attractive from a per unit cost perspective. This finding suggested that policies designed to encourage households to switch to a cleaner fuel might target either subsidies or credit access for purchase of the necessary durable goods.

Farsi et al (2010) suggested that in order to encourage households to make fuel substitutions that will result in more efficient energy use and less adverse environmental, social and health impacts, a subsidization of the LPG price, a promotion of higher levels of education and promotion of general economic development could be effective instruments.

Ajao (2011) analyzed urban households demand for charcoal within the context of overall household cooking fuel consumption in Ogbomoso Metropolis, Nigeria using an Almost Ideal Demand System. It was observed that household characteristics such as educational level of the household head, household size, electrification status, assets and fuel characteristics such as prices of charcoal, fuel-wood, and LPG are very important in determining household budget allocation to charcoal among urban households.

Household energy choice and energy demand in Ethiopia has been examined by a number of empirical studies. Kebede et al (2005) made an in-depth analysis of costs of different energy sources and their affordability in urban Ethiopia. They found that while kerosene is relatively cheap even for the very poor, electricity is extremely expensive even for the non-poor. The study concluded that Ethiopian urban households are at a very low level with respect to a transition to modern fuels. Faye (2002) conducted an analysis of household energy consumption pattern in selected urban areas of Ethiopia. The analysis indicated that the use of traditional fuels dominates households' consumption pattern. He subdivided energy consumed by households into traditional and modern, and analyzed the energy consumption pattern using probit model. The analysis depicted that the probability of consuming traditional fuels declines with increase in income and the prices of the traditional fuels, and increases with the increase in prices of the modern fuels. On other hand, the probability of consuming modern fuels increases with increase in income and prices of the traditional fuels, and declines with an increase in modern fuels prices. Abebaw (2007 assessed why some households use more fuel-wood than others using cross-sectional survey data from households in Jimma town. The result of the study revealed that the relationship between per capita income and per capita fuel-wood consumption is non-linear. The study concluded that energy policy and development projects aimed at reducing fuel-wood dependency in urban areas of Ethiopia should work not only to increase the supply of modern energy but also reduce poverty to the poor households.

3. Research Methodology

This chapter covers briefly the research methodology used in this study including the description of the study area, types and sources of data, method of data collection, sampling design and specification of models and their estimation procedures.

3.1. Description of the Study Area

Nakamte town is one of the oldest towns in Ethiopia established in the mid-19th century. The municipality of Nakamte town was established in 1934 and designated as a town in 1942. The first plan of the town was drawn in 1967. It is situated on a flat, hilly landscape. It is located at a distance of 331 KM west of Finfinne (Addis Ababa), 110 KM North East of Gimbi, the principal town of West Wollega Zone and 250 KM North West of Jima Zone in Oromia Regional State. The town's altitude ranges from 1960 M to 2170 M above sea level where as its average annual rain fall is 1854.9 MM and the average temperature ranges from 14℃ to 26℃. Currently, it is the capital city of East Wollega Zone of Oromia Regional State with the total land area estimated to be 5480 hectare. Administratively, it is divided into six kebeles (sub-towns): Calalaki, Bakanisa Kase, Bake Jama, Darge, Burka Jato and Kasso. Based on the 2007 population and housing census result, the population of Nakamte town is projected to be 84,506 in 2013. As national urban standard, the population of the town is expected to grow by about 4.11 % per year. This high growth rate may continue in the near future as a result of high young age population, high birth rate & high migration from rural to urban. The average household size of the town is estimated to be 6 and the total population of Nakamte constitutes 4.36 % of the zonal population[1]. Despite the age and geographical convenience of Nakamte town, it is highly under developed due to low attention given to its development by the previous governments of Ethiopia. The town is characterized by mutually contributing socio-economic problems. Ever increasing rate of population pressure from excessive in migration, low-income, urban poverty, poor infrastructure, unemployment and strikingly high and ever increasing HIV/AIDS prevalence

[1] see profile of the town with the website *www.oromiyaa.com/english/images/NekemteTown.pdf*

rate are among the town's socio-economic problems. The major source of income for the town's households include salaries, earning from self-employment, domestic work and daily labor, petty trade and pension. The town has a 24 hour hydro-electric power, and there are different types of fuel stations in the town such as Mobile, Shell, Nock and Total which sell benzene, kerosene and gasoline.

3.2. Types and Sources of Data and Method of Data Collection

Even though this study used both primary and secondary data, it relayed mainly on the primary cross-sectional data. The primary data needed for the study mainly focused on at-home consumption of sources of energy (fuel-wood, charcoal, kerosene and electricity) and household characteristics. A questionnaire was used to collect data, and it was administered to heads of households through interviews by trained enumerators. In the absence of the head of the household, other members of the household such as grown up child who can provide the required information was interviewed. For the interview, two trained enumerators were deployed and the interviews were coordinated by the researcher. It is known that households do not keep records of their total expenditure, expenditure on each energy source and incomes obtained from different sources. So, the household survey entirely depended on recall method. Secondary data, such as total number of households of Nakamte town obtained from the town's administration and data on population census and consumer price indices of Oromia region obtained from Central Statistical Agency of Nakamte branch were also used as an input for analysis.

3.3. Sampling Technique and Sample Size Determination

Two-stage sampling procedure was applied to select the required number of sample households. First, sample kebeles were selected randomly. To do so, the kebeles of the town were grouped as either center or distant kebele. Accordingly, Calalaki, Kasso, Burka Jato and Bakanisa Kase were grouped as center, while Darge and Bake Jama were grouped as distant. Two sample kebeles were selected purposively; one from the center and the other from the distant. In this way, Calalaki and Bake Jama were selected purposely as a sample of center and distant kebeles, respectively. Second, sample households (units of analysis) were selected from the sample kebeles (Calalaki and Bake Jama) in a systematic random sampling manner.

This study applied a simplified formula provided by Yamane (1967) to determine the sample size at 95% confidence level and 5% degree of variability (Israel, 2012). In addition, 9% level of precision is recommended in order to get the sample size which represents a true population. According to Hussey and Hussey (1997), no survey can ever be believed to be free from error or provide 100% surety and error limits of less than 10% and confidence levels of higher than 90% can be regarded as acceptable.

The sample size determination formula provided by Yamane (1967) is as follows (Israel, 2012).

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

where "n" is the sample size, "N" is the population size of sample kebeles ($N = 4{,}246$), and "e" is the level of precision or sampling error ($e = 0.09$). There are 13,431 households in Nakamte town, among which 2,729 and 1,517 resides in Calalaki and Bake Jama kebeles, respectively (Nakamte City Administration, 2013).

$$n = \frac{4{,}246}{1 + 4{,}246(0.09)^2} \cong 120$$

There is no list of household units in both sample kebeles. Therefore, systematic random sampling based on a given interval between houses was employed during household selection. Accordingly, one household was selected out of 35 households in each sample kebele to make 120 household units. Sampling was started from the most distant household unit in Bake Jama kebele, and from the most center household in Calalaki kebele. Sample size in each sample kebele was determined proportionally to their respective total number of households. Accordingly, about 77 and 43 households were participated in the study from Calalaki and Bake Jama kebeles, respectively to make a total sample of 120.

3.4. Methods of Data Analysis

Descriptive statistics, such as percentages, ratios and mean values were used to summarize and describe sample households' energy consumption pattern.

4. Results and Discussions

This chapter presents results of the study obtained from descriptive analysis. In this section, descriptive analysis of energy consumption patterns of the sampled households is presented.

4.1. Household Energy Consumption Pattern

Fuel-wood, charcoal, kerosene and electricity are the main alternative sources of energy that are consumed by households in Nakamte town. While fuel-wood and charcoal are used primarily for cooking, kerosene and electricity are used for both cooking and lighting purposes. Energy consumption pattern varies among different income groups (Faye, 2002; Maliti and Mnenwa, 2011). In order to compare energy consumption pattern

between different income groups, the sample households are grouped into low- expenditure and high-expenditure households based on the monthly estimated average expenditure of the sampled households of Nakamte town. The analysis used household total expenditure as a proxy of household income due to the possible under-reporting of income by households. The monthly average expenditure of the sampled households is about Br. 1995. Households whose monthly total expenditure is less than Br. 1995 are grouped as low-expenditure, while households whose monthly total expenditure is greater than Br. 1995 are grouped as high-expenditure households.

Table 1 below shows that the percentage of households that use fuel-wood for cooking is the highest followed by charcoal, electricity and kerosene. As we move from low-expenditure to high-expenditure households, the percentage of households using electricity and kerosene for cooking purpose increases from 9.84% to 57.63% and from 4.92% to 23.73%, respectively; while that of fuel-wood and charcoal shows no variation between the two expenditure groups. Moreover, the percentage of households that use fuel-wood and charcoal dominates in both expenditure groups. This indicates even if some households shift to electricity and kerosene, they still consume fuel-wood and charcoal; supporting the energy stacking hypothesis.

Table 1: Percentage of households using a particular energy source for cooking purpose

Energy sources	% of total households using energy source	% of low-expenditure households using energy source	% of high-expenditure households using energy source
Fuel-wood	100	100	100
Charcoal	95.83	95.08	96.61
Kerosene	13.3	4.92	23.73
Electricity	33.33	9.84	57.63

Source: Author's computation of survey data (2013)

On the other hand, as seen in table 2 below, the percentage of households that use electricity for lighting is the highest followed by kerosene and no household use fuel-wood and charcoal for lighting purpose. 97.5% of the sampled households use electricity, while the remaining 2.5% use kerosene for lighting purpose. Kerosene is used for lighting purpose only by households that live in un-electrified places or houses that are not connected to the electricity line. In the usage of energy sources for lighting purpose, there is small variation between low and high- expenditure households.

Table 2: Percentage of households using a particular energy source for lighting purpose

Energy sources	% of total households using energy source	% of low-expenditure households using energy source	% of high-expenditure households using energy source
Fuel-wood	0	0	0
Charcoal	0	0	0
Kerosene	2.5	4.92	0
Electricity	97.5	95.08	100

Source: Author's computation of survey data (2013)

The sampled households in Nakamte town use a mix of fuel-wood, charcoal, kerosene and electricity in different combinations to satisfy their demand, especially for cooking purpose. In contrary, the sampled households do not use a mix of energy sources for lighting purpose; they use either electricity or kerosene.

Table 3: Percentage of households consuming a mix of energy sources for cooking purpose

Household fuel mixes	% of total households using energy source	% of low-expenditure households using energy source	% of high-expenditure households using energy source
Only fuel-wood	3.33	4.92	1.69
Fuel-wood + Charcoal	58.33	81.97	33.9
Fuel-wood + Charcoal + Kerosene	5	3.28	6.78
Fuel-wood + Charcoal + Electricity	24.17	8.20	40.68
Fuel-wood + kerosene + Electricity	0.83	0	1.69
Fuel-wood + Charcoal + Kerosene + Electricity	8.33	1.64	15.25

Source: Author's computation of survey data (2013)

A look at the above table indicates more than 58% of the sampled households in the town use a mix of fuel-wood and charcoal followed by a mix of fuel-wood, charcoal and electricity. This demonstrates how much the

use of fuel-wood and charcoal by households in the town is prevalent and the existence of the threat of environmental damages in the surrounding hinterlands. We also observe except fuel-wood, no fuel is consumed separately. Furthermore, fuel-wood, which is the least convenient fuel according to the energy ladder hypothesis, is consumed in combination with all the other types of energy sources, implying households fail to shift from the consumption of it. Comparison between low and high expenditure shows while low-expenditure households mainly consume a mix of fuel-wood and charcoal, the high-expenditure households for the most part consume a mix of fuel-wood, charcoal and electricity. More to the point, as we move up from low-expenditure to high-expenditure, households increase the fuels they use for cooking purpose rather than switching from traditional energy sources, indicating the failure of energy ladder hypothesis in explaining energy consumption pattern of the study area.

The household energy consumption pattern can also be examined in terms of budget they allocate for each energy source. Since a household in Nakamte town uses a mix of at least two energy sources for the purpose of both cooking and lighting, his/her energy expenditure comprises of expenditure on at least two sources of energy. Table 4 shows the overall energy expenditure pattern of the sampled households in the study area. Accordingly, households in the study area spend about 14% of their budget on different energy sources.

Table 4: The overall energy expenditure pattern of the sampled households

Energy sources	Expenditure share of the energy source in total energy expenditure (%)
Fuel-wood	37.50
Charcoal	36.45
Kerosene	3.79
Electricity	22.26

Source: Author's computation of survey data (2013)

Looking at the expenditure share of each energy source in total energy expenditure indicates that fuel-wood takes the largest share (37.50%) followed by charcoal (36.45%), electricity (22.26%) and kerosene (3.79%). About 73.95% of total energy budget of households is allocated to traditional energy sources (fuel-wood and charcoal); only about 26.05% of total energy budget of households is allocated to modern energy sources (kerosene and electricity). These figures show that household energy consumption of the town is dominated by traditional energy sources (fuel-wood and charcoal). This implies environmental damages such as deforestation, soil erosion and declining agricultural productivity, and loss in the natural habitat for the wildlife in surrounding areas (Pundo and Fraser, 2006). It also indicates a tremendous potential for increasing demand for modern fuels as substitutes to fuel-wood and charcoal.

In order to examine whether there is variation in energy expenditure pattern between different income groups, we will see expenditure share of energy and energy expenditure shares of energy sources for low-expenditure and high-expenditure groups.

Table 5: Expenditure share of energy and energy expenditure shares of energy sources for low-expenditure and high-expenditure households

Expenditure shares (in %)	Expenditure groups	
	Low- expenditure households (Br. 250-1,995)	High-expenditure households (Br.1,996-6,000)
Share of energy exp. in total exp.	20.84	11.48
Share of fuel-wood exp. in total energy exp.	47.03	31.11
Share of charcoal exp. in total energy exp.	35.99	36.75
Share of kerosene exp. in total energy exp.	3.08	4.27
Share of electricity exp. in total energy exp.	13.90	27.86

Source: Author's computation of survey data (2013)

As indicated in the above table, the share of energy expenditure in household total expenditure for the low-expenditure group is almost twice (20.15%) of that of the high-expenditure group (11.48%). This is consistent with the finding of Faye (2002) that the low-income households use a higher proportion of their income on energy as compared to high-income households. Observation through the share of individual energy sources in energy budget indicates that except for fuel-wood, energy expenditure shares of the other energy sources are higher in high-expenditure group. This is consistent with the finding of Maliti and Mnenwa (2011) that, as compared to the poor, the non-poor households consume more of electricity and charcoal. While fuel-wood is the most important source of energy for low-expenditure households, charcoal is an important source of energy for high-expenditure households. However, the energy expenditure share of charcoal for both expenditure groups is high and very much close to each other, implying that charcoal is an important source of energy not only for the high-expenditure but also for low-expenditure households. This is due to the fact that households prefer charcoal to kerosene and electricity, especially for preparing coffee. Therefore, the effect of income on the consumption of

charcoal might be negligible. This finding is contrary to the theoretical assumption that inconvenient sources of energy, such as charcoal, are the source of energy for the poor (low-expenditure) households. Kerosene is found to have the lowest energy budget share for both expenditure groups. As seen from table 5, only small number of households uses it. This may be mainly due to its usage being able to cause damage and it requires great care to use in the home. Moreover, the share of kerosene expenditure in total energy expenditure increases by small amount as we move up from low-expenditure to high-expenditure groups. On the other hand, table 5 shows that the share of electricity expenditure in total energy expenditure of low-expenditure households is only 13.9%, while that of high-expenditure households is 27.86%. This finding verifies that increased income influences the transition of households towards the most efficient sources of energy, such as electricity. In short, as income increases, the usage of modern energy sources (kerosene and electricity) increases, but at the same time, the usage of traditional energy sources, like charcoal, increases. This mixing approach may indicate that the increase in income might be too little to permit a complete switch from traditional to modern sources of energy.

Grouping all sources of energy into traditional and modern also gives a pattern which can indicate urban household energy transition from traditional to modern sources of energy as income increases. In this way, fuel-wood and charcoal are grouped as traditional; and kerosene and electricity are grouped as modern sources of energy (UNDP and WHO, 2009).

Table 6: Total energy expenditure share of traditional and modern energy sources for low-expenditure and high-expenditure households

Expenditure shares (in %)	Expenditure groups	
	Low- expenditure households (Br. 250-1995)	High-expenditure households (Br.1995-6000)
Share of expenditure on traditional energy source in total energy exp.	83.01	67.87
Share of expenditure on modern energy source in total energy exp.	16.99	32.13

Source: Author's computation of survey data (2013)

As shown in table 6, the share of modern energy expenditure in total energy expenditure increases from 16.99% to 32.13% , while the share of traditional energy expenditure in total energy expenditure decreases from 83.01% to 67.87% as we move up from low-expenditure to high-expenditure households. In other words, the share of traditional energy expenditure in total energy expenditure is higher for low-expenditure, but the share of modern energy expenditure in total energy expenditure is higher for high-expenditure households. Thus, as compared to the low-expenditure households, the high-expenditure households spend relatively more on modern energy sources. However, about 68% of energy budget of high-expenditure households is still allocated to traditional energy sources (fuel-wood and charcoal). Generally, the descriptive analysis indicates that households in Nakamte town use a mix of traditional and modern sources of energy, rather than completely switch to modern energy sources as their income increases.

5. Conclusion and Policy Implications

Based on the descriptive analysis of cross-sectional data collected from sample households in Nakamte town, this study shows that the consumption of traditional energy sources, like fuel-wood and charcoal, dominates in household energy mix, and the household energy transition away from traditional biomass toward modern energy sources is still at an early stage. This high dependence on biomass fuel implies the existence of environmental damages such as deforestation, soil erosion and declining agricultural productivity, and loss in the natural habitat for the wildlife in the hinterlands. Even though there is a problem of accessibility of modern energy sources at large in Ethiopia, household energy consumption pattern is also affected by household-specific characteristics, such as affordability, preference, etc. Thus, the government of the country should harmonize energy policies with poverty reduction objectives and strategies. Increasing income, influencing households' energy choice and improvement of modern energy accessibility will play a critical role in the transition of households from traditional to modern energy sources.

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