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**ADDIS ABABA UNIVERSITY
COLLEGE OF DEVELOPMENT STUDIES
GRADUATE STUDIES PROGRAMME**



*Household Energy Consumption Patterns in Awassa Town and Its
Impacts on the Local Environment*



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*A Thesis Submitted to the College of Development Studies of Addis Ababa
University in Partial Fulfillment of the Requirements for the Masters of
Arts in Development Studies, Environment and Development*

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**May, 2011
Addis Ababa**

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ADDIS ABABA UNIVERSITY
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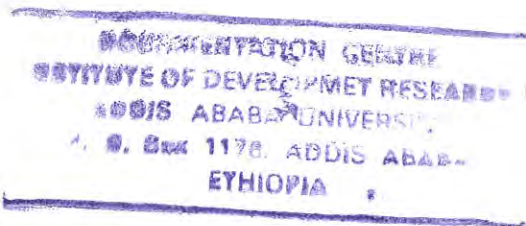
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By
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(Cover picture – Traditional (Sosit Gulicha) Injera Baking Stove)



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SCHOOL OF GRADUATE STUDIES**

**INSTITUTE OF DEVELOPMENT STUDIES
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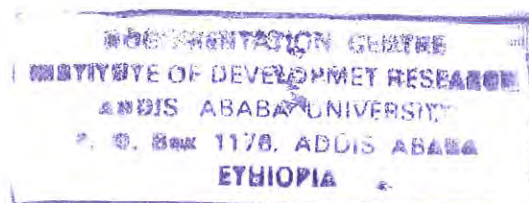
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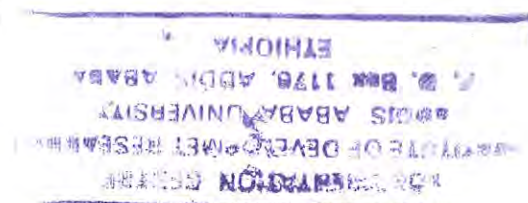
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Acronyms and Abbreviations

ACA	Awassa City Administration
CSA	Central Statistics Agency
EC	Ethiopian Calendar
EFAP	Ethiopian Forestry Action Program
EPA	Environmental Protection Authority
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focus Group Discussion
GTZ	German Technical Cooperation
IEA	International Energy Agency
LPG	Liquefied Petroleum Gas
MDG/MDGs	Millennium Development Goal/Goals
MoA	Ministry of Agriculture
OECD	Organization for Economic Cooperation and Development
OSSREA	Organization for Social Science Research in Eastern and Southern Africa
PPNR	Project for the Protection of Natural Resources
SNNPRS	Southern Nations, Nationalities, and Peoples Regional State
UN	United Nations



Abstract

This Research has studied household energy consumption patterns of Awassa Town and how it consequently entails different environmental impacts on the local environment. The main objective of the research was to study the patterns, i.e. the type of different fuels and the appliances the households use for different end uses in the Town and its consequent effects for deforestation and depletion of the forest resources in the area. Four Kebeles were included in the Study. Both qualitative and quantitative methods were employed:

- (1) A Survey questionnaire to collect different households' characteristics;
- (2) Key Informants Interview, Case Studies, and FGD were used to obtain qualitative data and for triangulation and cross checking the information obtained from the Survey during the research; and
- (3) Observation was used.

Results indicate that household energy consumption patterns of Awassa Town are highly dependent on Biomass fuel, i.e. firewood for baking Injera and charcoal for other cooking purposes. In addition to this the majority of the households use Traditional and Modified Traditional Injera Stoves. The households energy consumption patterns are determined by household income, education level of the household head and spouse, highest education level in a household, ownership of the house, type of the house, and households in a housing unit share electrometer or not. Therefore a very high dependency of the households in the Town on Biomass fuels.

The main conclusion of the research is that due to urban growth and the increase in the population of Awassa Town there is an increase in the demand of the total amount of firewood and charcoal consumption in the Town and hence the contribution to speed up and aggravate the deterioration and depletion of forest resources in the area. Consequently deforestation in the area would cause soil erosion, decline in soil fertility, water resource scarcity, decrease in agricultural production, and poverty in the rural communities living in the local environment.

Chapter 1 Introduction

1.1 Background

Energy has a multiplier effect with Millennium Development Goals (MDGs), above all a direct one with MDG 7: “Ensure Environmental Sustainability”, which is a pivot for other MDGs. Hence the inextricable link between energy and environment has paramount importance. All human activities: daily life, public services, urbanization, industrialization, transportation, construction, etc. are highly dependent on energy. Energy, while it is very important and decisive from household unit level to national and global development trends; the energy carrier, efficiency, magnitude and intensity used have impacts on our environment. Green House Gas emissions, air pollutions, deforestations¹, soil erosions, water pollutions, rise of temperature, etc. resulted from the human activities are deleterious to the environment. (Reddy, 2004) Nevertheless, until the 1970s, when environmental concern issues like the discussions of climate change, the occurrence of the oil shock, etc. awoke the World, much attention was not given to energy efficient end-uses, but only to the magnitude and intensity of energy used. It is after the Earth Summit that efficient energy end-uses and other initiatives have given due attentions, especially by OECD countries, and improvements are seen following technologies and appliances transformation at various levels to promote sustainable energy use through increase energy efficiency, support for renewable energy sources, and integrated energy resource planning. Renewable energy sources have attracted new R&D funds in some countries (e.g. Germany, Greece, Italy, the Netherlands and the United Kingdom), especially for wind and solar energy.

¹ UN Millennium Development Goals, Report of 2008 describes that as Deforestation continues to pose serious challenges, even though the net loss of forest area is slowing down. The Report says an estimated net decline of 7.3 million hectares of forest area per year over the period 2000-2005, compared to 8.9 million hectares annually in the previous decade.



Governments continued to develop and demonstrate alternative fuel technologies for methanol, hydrogen or CNG, and together with industry, continued to fund R&D directed towards burning coal more cleanly and efficiently. (IEA: Energy Policies of IEA countries, 1990) As a result there are now good examples, significant benchmarks, and success stories all around the world of efforts in these areas. However these efforts provide a good starting point, since they are dispersed, they cannot meet the tremendous energy challenges facing humanity during the 21st century. Above all when we see the energy disparities among countries – developed and developing - and even within countries and the disproportionate impacts on the poor (Siddiqi, 1995; Reddy, 2004; UN, MDG Report, 2008) it appears to be irreconcilable. Reddy (2004) more meaningfully describes this as: “Poverty is the most fundamental reality of developing countries – and the energy consumption patterns of poor people tend to add to their misery and aggravate their poverty.”

In spite of this, of all sectors, the household sector globally experiences the most pronounced changes in its patterns of fuel use over time. Typically a household may shift from using biomass to kerosene, LPG and finally to electricity for specialized cooking. On the other hand, it may shift from biomass to electricity (Tyler, 1996) due to rise in income, urbanization, government policies, etc. Even though the levels of urbanization vary across continents and countries, where urbanization has become an integral part of the socio economic growth of developing countries, urban energy consumption patterns are among the factors that increase demand for more energy.(Alam, et al., 1994, pp.108-9) Depending on the location, in urban areas energy is needed for the end-uses like cooking, water heating, space heating and cooling, lighting, etc., but the selection of the energy carriers and equipments for use tend to be very different which would be determined by the level of socio-economic development of a country and the user specifically. Past studies consistently indicate a strong correlation between household income levels and the types and amounts of fuel used. (Alam, et al, 1994) Following this, their impacts on the local environment vary, too.

However, this shift phenomenon, which is often referred to as a 'fuel transition' from traditional (biomass- based) to modern household fuels; pending to researches about the atmospheric effect, it showed a positive effect on the local air quality in developing Asian cities. (Tyler, 1996)

When we see the researches done to understand the impacts of human activities on the environment, there are two major approaches: population-environment and consumption-environment relations. Curran and Alex (2004) have given two major reasons why the population-environment and consumption-environment literatures have taken separate trajectories. First, the two research agendas have focused on different types of questions. Central questions in the population-environment literature are: how do basic fundamental demographic processes, like fertility, mortality, population growth rates, and migration affect environmental outcomes? What are the reciprocal relationships and interdependencies among demographic and environmental variables? How do intervening conditions affect the population-environment relationship? Whereas, the consumption-environment literature asks a set of related, but quite different questions. Which human activities are the most significantly disruptive to the environment? Who is most responsible for these destructive outcomes? What causes environmentally disruptive outcomes? And, how are environmentally disruptive activities changed? The second reason that the literatures have progressed along separate paths is that the population-environment research has largely focused on developing countries whereas the consumption-environment research has focused heavily on developed countries. Three-quarters of Population-Environment Research citations relate to developing countries and only one-quarter to developed countries. A related difference between the two literatures is that population-environment research has mostly focused on micro-level studies in rural subsistence economies, whereas the consumption-environment typically addresses consumption patterns among largely urban-based consumer societies in which it is assumed that most of the resources consumed are imported from outside the immediate area in which the consumption is

comply with the demands of the inhabitants of the Town, there would be an increase in the total amount of the production and supply of firewood and charcoal. Subsequently, this would speed up and aggravate the deterioration of the forest resources available in the local environment. Deforestation would lead to soil erosion and disruption of soil nutrients cycling systems, dry up of rivers and water scarcity, disappearance of wildlife animals, etc. Consequently, there will be decline in soil fertility which would entail poor production, food insecurity, and poverty among the rural communities living in the local areas. Finally, it would lead to the perpetuation of sever environmental, social and economical impacts on the local environment. Thus, household energy consumption patterns of urban areas and their consequent impacts need to be addressed before the situations get worse. This research paper is one of such initiatives done in Awassa Town.

1.3 Objectives of the Study

General Objective:

The General Objective of this research is to study household energy consumption patterns of Awassa Town and whether it creates stress on the local environment by contribute to the deterioration and depletion of the limited forest resources available in the areas.

Specific Objectives:

- ✓ To assess household energy consumption patterns, i.e. type of fuels and fuel mixes by end-uses, of Awassa Town

- ✓ To identify the household characteristics that determine household energy consumption patterns in the Town
- ✓ To analyze/study the multiplicative impacts of household energy consumption patterns of Awassa Town on the Local Environment
- ✓ To make an assessment of households' value towards energy saving and environmental sustainability

Main Research Questions:

- ✓ What are the main determinants of household energy consumption patterns of Awassa Town?
- ✓ What are the major impacts on the local environment resulted from the household energy consumption patterns in the Town?

Specific Research Questions:

- ✓ What are the patterns of household energy consumption, i.e. type of fuels and appliances for different end uses, in the Town?
- ✓ Could household characteristics (income, hh size, age structure, education level of the household head and/or spouse, etc.) be the determinant/driving factors for the household energy consumption patterns?
- ✓ Could the presence/absence of a maidservant in a household be a determinant factor for the preference of type of energy and the appliances used?
- ✓ Could lack of appropriate institutional structure for the transfer of energy-efficient technologies contributes for the pattern of energy consumption prevailed in the Town?
- ✓ Could lack of technical support in the production and supply of energy for urban residents be one of the factors aggravating the consequences of its impacts on the local environment?

1.4 The Scope and Limitation of the Study

Scope of the Study

Household energy consumption is an integration of the energy requirement by a household for direct and indirect needs. However, this paper tries to study only the direct one. Even among the direct energy consumption of the households it mainly deals with firewood and charcoal. Primarily, because of the fact that hhs energy consumption in the Country is biomass dependent and hence these are considered to be important. Secondly, these are accountable for the depletion of forest natural resource banks. Thirdly, considering the modern fuels, other than to show the patterns of the fuel mix households' use, it could not be possible to assess their impacts on the local environment.

Limitations of the Study

During the field work preparing the survey sample was difficult because Kebele administrative classifications were changing from time to time and currently, just a year before, there was a new rearrangement in different sub-towns. Due to this regarding number of residents and house numbers in the Kebeles very few or almost no documentation work was done, except at the sub-town level. Hence obtaining relevant information was mainly relied on sub-town and kebele administrators.

Another limitation which would be important in helping to a “Live-demonstration” of this research work is observation of the process of charcoal production technique, but during the field work I could not realize it. Because the charcoal vendors in the Town were not volunteers to give me any information about the transporters and suppliers who could bridge me with

charcoal producers. However, later on I have learnt² that it was because of the fact that producing and supplying charcoal is considered illegal while it is abundant in the market.

1.5 Significance of the Study, Justification and Gaps

Household energy consumption pattern is determined by a constellation of factors, among which development level of the economy, demographic and socioeconomic characteristics of the respective users, access and availability of alternative energy, government policy, culture- traditions and customs of the society, etc. In Ethiopia household energy demand and supply is not addressed or not well managed neither in favor of the consumers nor the Environment. Since the consumption pattern – the demand for and supply of - revolves per se, both parties are the losers. Despite the issuance of the Environmental Policy of the Country little is done on the ground. Among the articles in The Federal Environmental Policy the article in the Sectoral Policies which says: “To find substitutes for construction and fuel wood whenever capabilities and other conditions allow, in order to reduce pressure on forests”; and the article in the Energy resource that says: “To encourage Government leases for private entrepreneurs to plant fuel woodlots in peri-urban (suburbs of urban) areas” (EPA: 1997) are the most important ones in this regard. However efforts to implement these are not seen. Household energy consumptions are still not planned and managed neither at the national level by the government nor at the household unit level by individual consumers. How energy consumption pattern at the household level is important Grossman and Krueger (1995) describing about the Environmental Kuznets Curve say “...micro-level dynamics at the household or community level can lead to either dramatic changes or substantial inertia”.

² Interview/Discussion with representative of Regional Bureau of Agriculture and Rural Development, Natural Resources Development Department

Therefore, this study will put a rigorous effort to assess household energy consumption patterns, fuel mix, technologies and appliances the hhs use in Awassa Town. By doing so it will try to identify problems, provide input to solutions regarding household energy consumption patterns and interventions to prevent the subsequent impacts on the local environment primarily at the local and regional level, and then ultimately for the attainment of planned, integrated and sustainable management of supply and demand of household energy consumption patterns in the nation.

1.6 Description of the Study Area

1.6.1 Location and Climate

1.6.1.1 Location

Awassa, which is the Capital of Southern Nations, Nationalities, and Peoples Regional State (SNNPRS), is a Town located in the Great Rift Valley proximate to Lake Awassa. It is 275km south of Addis Ababa on the asphalt road to Moyale. Its total area is currently fifty square kilometer excluding Tula, which is the rural sub-Town under the Town Administration. (City Municipality Magazine, 2002 E.C.; Zeleke and Serkalem: History of Awassa Town, 1999 E.C., p.72) It is bounded in the north by Oromiya Region, west by Lake Awassa, south by Awassa Zuriya Wereda, and east by Wondogenet Wereda.

1.6.1.2 Climate

The climate is classified in to the dry to sub-humid. The relative humidity of the Town shows a mean monthly value of 66.3%, while a minimum mean monthly humidity is 53.9% in February and the maximum reaches 77.3% in September. (Lemlem, 2007) In the last decade the annual temperature ranges between a minimum of 10.7^oc to a maximum of 33.8^oc with a mean temperature of 20^oc, according to Awassa Meteorological Agency/Station.

1.6.2 Vegetation Cover and Land Use/Land Cover of the Surrounding Areas

The Town is expanding towards south and east pushing areas which were previously used for different agricultural cultivation. On the outskirts of eastern part of the Town north to south it is industry zone. The suburb areas on both eastern and southern directions are deforested which are still cultivable lands and some are grazing livestock. Only scarce vegetation covers are seen. From south west of the Town and south of the Lake the rural Kebeles settlements are closer to the Town and the settlement is dense, but relatively better covered with vegetation and grass than all the surrounding areas. More over, from the western side, where Lake Awassa is laying long stretched parallel with the Town, there are vegetations that cover the long stripe of land between the Town and the Lake. (See Figure – 1) The canopy of these dispersed old trees on the shores of the Lake, which give shade to the coastal land and to the visitors of the Lake, are homes for different species of birds. However these are also progressively declining due to the expansion of recreations and resort hotels on the shores of the Lake.



Southwestern of Awassa Town



South of the Lake

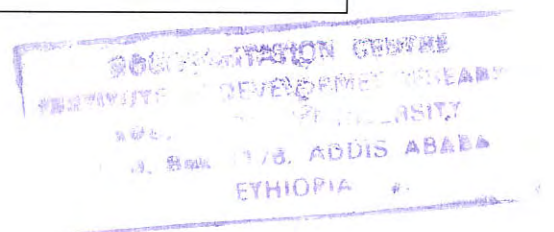


Southeastern of the Lake



The Shores between the Town and the Lake

Figure – 1 Vegetation Cover and Land Use/Land Cover in the Surroundings of Awassa Town



Chapter 2 Literature Review

2.1 Household Energy Consumption

2.1.1 Household Energy Consumption Patterns

Household Energy requirement is the amount and type of energies needed by a household for different consumptions and services required by the same. The total household energy requirements are composed of direct and indirect energy needed by the household. (Pachauri & Spreng, 2002) The direct energies are energies needed by the household associated with services in and around home, like for cooking and heating of food and beverage, space cooling and heating, transportation with personal vehicle, etc. (Alam et al, 1994; O'Neill and Chen, 2002) Where as the indirect energies are energy services needed for goods and services a household consumed, like clothing, processed foods and beverages bought, shoes, etc. (Alam et al, 1994)

First of all there is a wide difference between the industrialized and developing nations in energy consumption patterns. The energy equity differences within countries of the developing nations get much wider as that of between countries of developing and industrialized ones. For instance in South Asia there is a wide difference between low income and middle class households' energy consumption for cooking, transportation and access to electricity. (Siddiqi, 1995) Hence household energy consumption patterns vary widely depending on a number of characteristics. Primarily, demographic characteristics, i.e. household size, age, gender, etc. of the household have different influences. A household with larger size enjoys economies of scale in energy consumption in the household; where as the household would loss this in later age of the lifespan of the householders since the size declines. Secondly, socioeconomic characteristics of the household: income, education level of the household head and

wife are other important factors that influence energy consumption of the household. Thirdly, physical characteristics of housing unit of a household such as footage, appliance types, etc. have influences because the area and type of

the appliances the household uses for heating and cooling would require different amounts and types of energy. Fourthly, level of development, and geographic and climatic characteristics of a country are also among the major ones. Depending on the geographic and climatic conditions of a country the amount and types of energy require by a household for different heating and cooling services vary. (Pachauri and Spreng, 2002; O'Neill and Chen, 2002) For instance by Hyderabad, India, households' energy is needed for two end-uses: cooking and water heating, and to a lesser extent for space cooling during a hot dry summer month. (Alam et al, 1994)

2.1.2 Household Energy Consumption and Fuel Choices

Household Energy Consumption and Fuel Choice could be influenced by different factors. Among the factors that determine Household energy consumption and fuel choice next to affluence are access to and availability of, and prices and costs of a particular fuel in the area. For instance, for the similar income groups in rural and urban China due to lack of access to modern fuels, electricity and modern energy services the rural ones would be forced to use solid or inefficient fuels than the urban ones. (Pachauri and Jiang, 2008) In Tanzania, where there is a major misallocation of resources due to a considerable differences between the marginal costs of supplying fuels and the market prices paid by the consumers, household energy use varies by income group according to local fuel availability. (Hosier and Kipondya, 1993) On the other hand prices and costs do affect fuel choices. Higher prices of fuels resulted in households moving to the use of less efficient energy types. Particularly higher LPG prices associated with a significant shift away from LPG are observed. (Pachauri and

fuel consumption patterns at a household level. Significant differences in lifestyles between inner and outer areas of Sydney, Australia, leads to different energy use characteristics among the households. (Lenzen et al, 2004) In general, the family characteristics, the size of the household dwelling and the age of the head of the household are associated to higher household energy requirements. In contrast, the number of members in the household and literacy of the head are associated with lower household energy requirements. (Pachauri, 2004)

2.1.4 Trends of Household Energy Consumption and Fuel Transitions in Developing Countries

As cities in developing countries become more prosperous, energy use shifts from fire wood to fuels like charcoal, kerosene, and coal, and ultimately, to fuels such as liquefied petroleum gas (LPG), and electricity. (Barnes et al, 2005) In many Asian countries (Tyler, 1996), in Philippine (Garcia, 1994), in India (Pachauri and Spreng, 2002), and in India and China (Pachauri and Jiang, 2008) the shift towards more efficient modern fuels has occurred gradually along with the expanding urbanization and household incomes. (Barnes et al, 2005) This fuel transition is a decline in the proportion of solid (biomass and coal) energy consumption and an increase in the consumption of modern commercial fuels, which involves both substitution and addition as a result of demand. (Pachauri and Jiang, 2008)

The fuel transition can be seen in changes, according to Pachauri and Jiang, in three indicators: first, transitions in terms of changes in quantities of energy used by the households; second changes in the percentage of persons using different types of energy; and third, the shifting patterns and structure of households energy consumption. (Pachauri and Jiang, 2008) In Hyderabad, India, two fuel transitions simultaneously are

seen: replacement of biomass and solid fuels with LPG, and kerosene with LPG. (Alam et al, 1994)

Various factors such as: income levels, access and availability, price of fuels, (Pachauri and Jiang, 2008) government policies, cuisine, and household activity patterns affect the speed at which the transitions occur. (Alam et al, 1994) In Tanzania, for instance, there is a significant shift by households towards kerosene and electricity away from fuel wood, and charcoal, which can largely be explained by fuel price. (Hosier and Kipondya, 1993) In many developing countries the fuel transition conforms to progression up the energy ladder. (Pachauri and Spreng, 2002)

2.2. Impacts of Household Energy Consumption Patterns on the Local Environment

2.2.1 Charcoal Production Technique and Supply

Heating wood in the absence of air results the production of charcoal, volatile tars and a mixture of gases. The relative amounts of these three types of products depend on the equipment used and on the characteristics of the original wood. The moisture content is an especially important parameter. Dry wood produces more charcoal than wet wood. (Stassen, 2002)

Mass yields from a traditional mound kiln are about 25 percent. In other words, 1tonne of wood will give 250 kg of charcoal. With poorer techniques, however, yields often do not exceed 15 to 20 percent, in other words about 150 to 200kg from 1tonne of wood. Many charcoal makers, for example, use green wood, and the energy needed to dry it is provided by part of the load, reducing yields to 15 percent. (Stassen, 2002)

2.2.2 Deforestation and the Consequent Impacts on the Local Environment

The consumption of fire wood and charcoal has a direct impact on the forest natural resources. Above all the production of charcoal using traditional earth kilns requires a large amount of wood, which makes the total amount of fuel wood required both for fire wood and the production of charcoal very high. Tabuti et al describes this while expressing the decline of fire wood/plants around Bulamogi, Uganda it may be related to increasing demands from the growing human population of Bulamogi and growing national demand for charcoal.(Tabuti et al, 2003)

With regard to harvesting of fuel wood, especially when it is not sustainable, the direct impact is seen not only on the decline on the whole population of plants but also there could be the extinction of specific species. (Kangalawe et al, 2005; Tabuti et al, 2003) For instance, *Acacia drepanolobium*, which is preferable for its charcoal quality, can be harvested for sustainable charcoal yield over a 14-year cycle, (Okello et al., 2001) but if harvested unsustainably it is vulnerable for extinction.

Extinction of specific tree species and/or deforestation could happen due to harvesting wood and clearing trees for different purposes. A research done in Iramba District, Central Tanzania on Land-Use Dynamics and Land Degradation shows that causes for extinction of specific tree species and deforestation were: tree extraction for timber, clearing for more cultivable land, charcoal production, fire wood collection, bush fires, land degradation, expansion of settlements, and grazing livestock respectively according to their contribution to the impacts. (Kangalawe et al, 2005)

Deforestation, depending on the availability of natural resources in the respected area and its wideness, could have multiplicative impacts on the local environment. The consequent impacts of deforestation would include: decline or extinction of different

2.3 Conceptual Framework of the Study

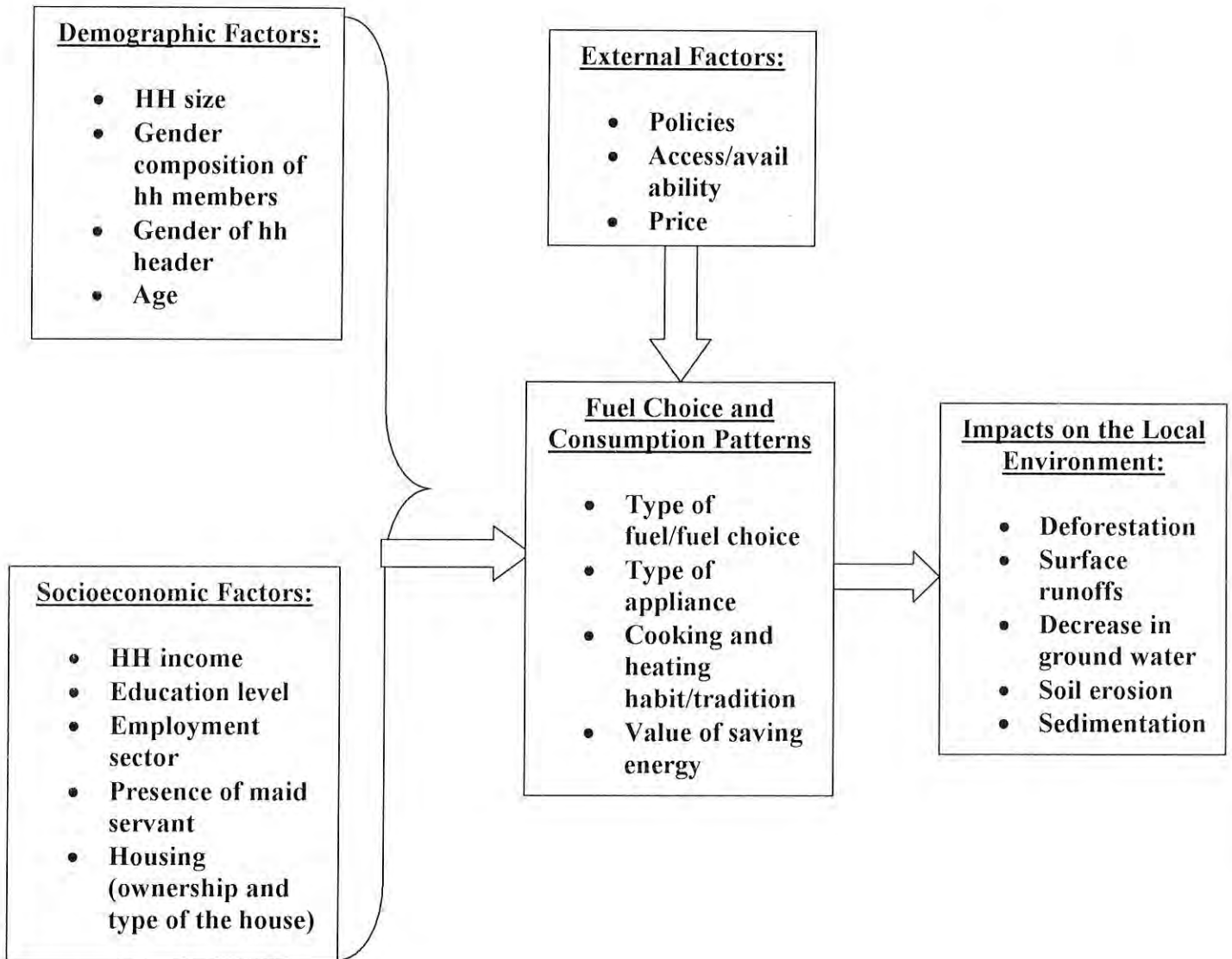


Figure – 2 Conceptual Framework of the Study
(Developed from the Literature Review)

Chapter 3 Methodology

3.1 Research Strategy and design

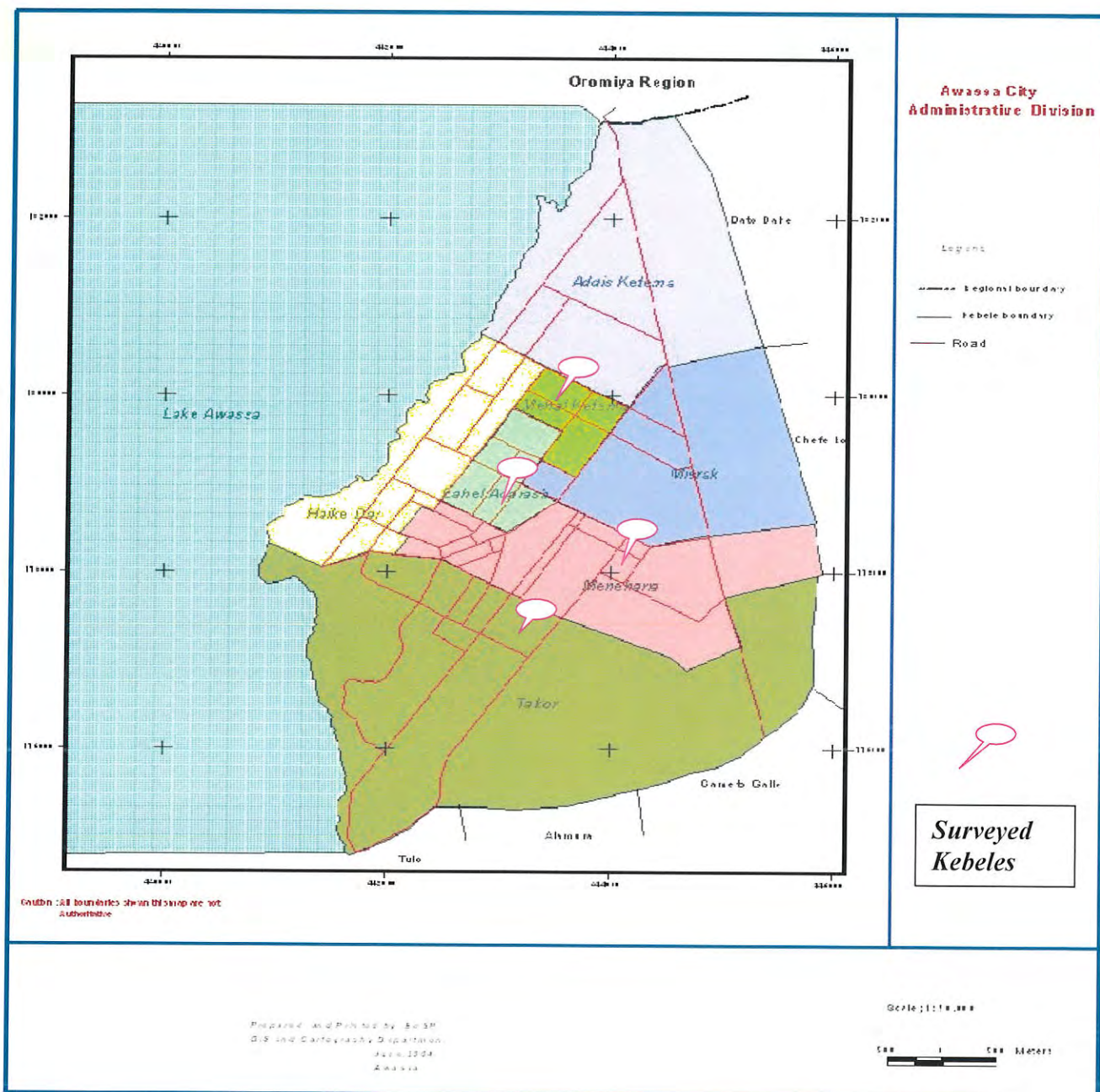
The research strategy is cross sectional which is based on data collected at a specific time. During the research different data collection and analysis methods were employed.

3.2 Data Collection

Awassa Town is divided in to eight sub-towns, of which seven are called urban sub-towns that have differentiated two to five Kebele each and a sub total of twenty urban Kebeles, while the eighth is farmer/rural sub-town having twelve Kebele, making the total thirty two kebele which are administered by the Awassa City Administration Council. (ACA, 2002 E.C) However, the Data collection of this research focuses only on the urban sub-towns. Data Collection was conducted during a one month (April 7-May 6, 2010) fieldwork season in Awassa.

In the research, different approaches were made to gather data on Household Energy Consumption Patterns in Awassa Town and the Consequent Impacts on the Local Environment. Both qualitative and quantitative approaches are employed to meet the different objectives of the research. Hence, a combination of different primary data collection methods and references of secondary sources were used to attain the different specific objectives of the research.





Map - 1 **The Seven Urban Sub-towns of Awassa Town Administration and the Four Surveyed Kebeles (Source: ACA)**

3.2.1 Primary Data Collection

(A) Questionnaire

Multiple stage sampling was employed to select households for the survey. At the first stage the seven urban sub-towns were clustered, based on the purpose of the research, in to two: areas which are dominantly industrial zones, government and private institutions in one, and dominantly residential areas on the other.³ Then four dominantly residential sub-towns were selected purposively. At the second stage sub-towns were stratified in living standards of the residents: poor, middle, and high. Among the four sub-towns two – Mehal Ketema and Bahil Adarash which are relatively densely populated and inhabited by a mix of low and middle income groups or poor and middle level living standards - are among the early settlements of the town. Where as, the other two - Tabor and Menaherya which are occupied by middle and high income groups - are of the recent settlements. (ACA: Socioeconomic Profile 1999-2001 E.C) At the third stage one kebele from each four sub-towns was selected purposively.⁴ Following this equal number of households from four Kebeles, i.e. a fixed number of fifty households from each, were selected so that to be able to obtain appropriate data on the patterns of household energy consumption in the Town. Therefore two hundred households were randomly been selected from these four Kebeles. At the final stage, based on the data obtained from the Administrations and Municipalities of the sub-towns and the respective Kebeles' administrations in each kebele different approaches were employed. At the first two Kebeles, i.e. Leku and Harar which are from Mehal Ketema and Bahil Adarash sub-towns respectively a systematic random sampling using a formula of $N =$ number of

³ Based on the information and discussions made with City Administration and the Municipality

⁴ Discussion with each sub-town administration was made and the selection was based on the stratification. Harar kebele from Bahil Adarash sub-town was selected, for instance, by the recommendation of Ato Behailu Getachew – Head of the Municipality, since it is inhabited by very poor and poor residents of the Town. And later on during the field work this was proved from the sample households characteristics in the kebele.

hhs divided by sample size, and N as a constant interval with equal chance every Nth hh is select to make the sample hhs for the survey. Hence in Leku and Harar Kebeles where there are 778⁵ and 675⁶ hhs in each kebele respectively, with equal chance and random probability by randomly selecting the first hh from 16 and 14 hhs at the right side of the Kebeles administration offices in Leku and Harar respectively to be the first observation, then every 16th hh from the prior and every 14th hh from the latter Kebele were selected until the fixed sample size was reached. Where as, in the other two Kebeles - Dume and Guwe Stadium⁷ which are from Tabor and Menaherya sub-towns respectively - a simple random sampling was used to select the households for the survey.

(B) Key Informants Interview

Important key informants - i.e. government officials, administrators and individuals, representing different offices and interest groups, on the basis of the research, to substantiate and triangulate the information obtained from Household Survey on household energy consumption patterns in the Town and scale up the qualitative approach of the research - were interviewed. The individuals were purposely selected based on the issues the research is willing to address. Among these three government officials: representatives of the Regional Bureau of Agriculture and Rural Development, Department of Natural Resources Development, the Regional Bureau of Environmental Protection, and Regional Office of Mining and Energy; four charcoal vendors; two firewood vendors in the market and moving around the

⁵ Discussion with W/ro Fanaye Muluneh, Head of Mehal Ketema sub-town administration, and information obtained from Ato Tenaye, information officer of the sub-town.

⁶ Information obtained from Ato Behailu Getachew, Head of the Municipality of Bahil Adarash sub-town

⁷ These two Kebeles are of the recent settlements and according to the information obtained from sub-towns and Kebeles administrations there are a large number of newly constructed houses which are not yet occupied and hence following a systematic random sampling there was not possible. Hence in these two Kebeles simple random sampling was used to select the Sample households from the occupied households for the Survey.

village; three firewood and charcoal retailers in the villages; one Injera vendor; and one “Mirt” Biomass Energy Saving Injera Stove Producer, a total of fourteen interviews were made.

(C) FGD

A couple of Focus Group Discussions (FGDs), which would enhance the qualitative approach of the research, were held. The FGDs, which were held one in Menaherya and the other in Bahil Adarash sub-towns comprising nine persons each, were facilitated by the Sub-Towns administrations. In each FGD two persons from each kebele in the respective Sub-Towns representing different groups of households based on their household characteristics and additional three persons from the administration offices of the respective Sub-Towns were selected to participate in the discussions. The FGDs yield important information about households’ fuel and appliance use, the attitudes to fuel use and fuel preferences, cooking and heating habits, the energy need to accomplish a specific task at a session, etc which helped very much for the researcher in the understanding, describing and analyzing the data collected.

(D) Observation

Personal observations in and around the Town were made. The observations helped to understand and qualitatively describe: primarily, the different household characteristics and the external factors such as: the availability of fuel types, the supply (inflow), market and price of them, etc. Secondly, how these factors are

determining household energy consumption patterns which in turn entail consequent impacts on the local environment. More over, observations of the different components of the local environment such as: vegetation cover and land use in and surrounding the Town, and water body, above all the existing condition of Lake Awassa were the most important. During the time important pictures, GPS marks and measurements were taken.

(E) Case Studies

During the field season an in-depth Case Studies in ten purposely selected households were conducted In the Case Studies detail interviews about: the demographic and socioeconomic characteristics of the hhs, type of fuels the households use for different end uses, the reasons why they choose certain type of fuels and the type of appliances they use, the amount of fuel/mix of fuels needed for accomplishing a specific task, for instance baking a specific number of Injera at a session, the availability/access of different fuels, prices, etc with the hhs were discussed. This was done to scale up the qualitative approach of the research by triangulating and cross checking the data collected on households' energy consumption patterns during the Survey. Therefore, it has helped much for the researcher to understand, describe, and analyze the demographic, socioeconomic and fuel consumption patterns of the hhs and the consequent impacts on the local environment.

3.2.2 Secondary Sources

To get the necessary secondary documents for the research, different sources were used from appropriate institutions. Books and articles were referred for the related literatures review; and Internet was browsed. In addition to this, to obtain necessary information, maps, etc related with the research topic and the sector documents from different offices were referred and collected.

3.3 Data Analysis

Data collected from the Survey were coded and entered into a computer using SPSS 15 Version. Following this, the data were checked and analyzed. Descriptive analysis is the main approach used in the study. Analysis was began by computing frequency tables and graphs of the different variables which helped to understand and describe the demographic, the socioeconomic, energy consumption patterns, the fuel mixes, appliances used and other important household characteristics of the sample households. Then a cross tabulations of the different independent variables and dependent variable were analyzed. To identify whether there is association or not between the variables and the strength of the association of the variables a Chi-Square test and Symmetric Measurements were done. In addition to these, analysis of energy consumption variance with different Independent Variables and ANOVA test are done.



Chapter 4 Energy Consumption

4.1 Household Characteristics and Energy Consumption Patterns

4.1.1 Demographic Characteristics of the Sample HHs

Respondents Characteristics

Of the two hundred respondents 111(55.5percent) are household Heads, 71(35.5percent) Spouses, 17(8.5percent) son/daughter of Head and Spouse, and 1(0.5percent) relative of Head/Spouse. Among these 122(61percent) are female and 78(39percent) male. Regarding age of the respondents, they are between the age of 18 and 85, while 50percent are less than 37 yrs, and a total of 167(83.5percent) are less than or equal to 50 yrs of age. When we see education level of the respondents 109(54.5percent) are Secondary school complete and above: comprising 41(20.5percent) Secondary school complete, which is the highest frequency, 37(18.5percent) Diploma/TVET and 31(15.5percent) Degree and above; where as the remaining 91(45.5percent) are below secondary school level.

Demographic Characteristics of the Sample HHs

There are a number of demographic variables included in the survey questionnaire. Among these household size, gender of hh head, marital status, hh members in broad age group, and number of female hh member are a few. Household's size of the Survey hhs vary from two, which is the minimum, to the maximum eight, with an average hh size of five. The highest frequency of hh size, when putting them in three categories,

fall between four and six, i.e. 123(61.5percent) hhs, followed by 39(19.5percent) hhs having more than or equal to seven and 38(19percent) hhs that have less than or equal to three hh size.

The other demographic variable was number of female household members. Number of female hh members of the Sample HHS show highest frequency of 78(39percent) for hhs having three female members, followed by 58(29percent), 27(13.5percent), 23(11.5percent), 9(4.5percent), 4(2percent), and 1(0.5percent) for hhs having two, four, one, five, six and seven female members respectively.

Of the 200 hh heads in the Survey 159(79.5 percent) are male and 41(20.5 percent) are female household heads. 149(74.5percent) of the hh heads are married and 51(25.5percent) of the hh heads, i.e. 41(20.5percent) female and 10(5percent) male are unmarried, widow/widowed, or widower. From the hh heads 33(16.5 percent), of whom 18(9 percent) female and 15(7.5percent) male, are unemployed or retired. In addition to this, out of the 149 married hhs 89(60percent) of the Spouses are unemployed.

4.1.2 Socioeconomic Characteristics of the Sample HHs

During the Survey a number of socioeconomic variables that could help understand and describe the households' characteristics were asked to the respective respondents. These include education level of the household head, and of spouse', employment sector of the household head, and of spouse', household monthly income, hh other incomes, ownership of the house, type of the house, etc. When we see the education level of hh heads: of the 200 hh heads the highest frequency 47(23.5percent) – 43(21.5percent) male and 4(2percent) female – of hh heads are Degree and above. The other 32(16percent) 29(14.5percent) male and 3(1.5percent) female, 45(22.5percent) 40(20percent) male and 5(2.5percent) female, 17(8.5percent) 15(7.5percent) male and 2(1percent) female, 35(17.5percent) 23(11.5percent) male and 12(6percent) female,

2(1percent) only male, and 22(11percent) 7(3.5percent) male and 15(7.5percent) female are at the education level of Diploma/TVET, Secondary School complete, Junior and above, Elementary, Church and Madrasa, and Illiterate respectively.

Monthly Income of the Survey hhs shows the highest frequency of 116 hhs (58 percent of the hhs) in the low Income Category which is below birr 2000/month, where as the lowest frequency of 16 hhs (8 percent of the hhs) in the Upper Income Category which is above birr 4000/month, with a mean monthly income of birr 2278.3814, minimum of birr 89/month and maximum of birr 100,000/month, and 6 hhs (3 percent of the hhs) are missing. (See Table – 1)

Table – 1 Frequency of Income Category of the Sample HHs

Household Monthly Income Categories	Frequency	Percent	Cumulative Percent
Missing	6	3.0	3.0
<2000	116	58.0	61.0
2000 - 4000	62	31.0	92.0
>4000	16	8.0	100.0
Total	200	100.0	

In addition to this, out of the two hundred sample hhs forty five hhs have house rent, nine hhs foreign transfer, and one hh urban agriculture as additional income. Of the forty five hhs thirty two were not volunteers to tell the amount of the house rent they earn, where as the remaining thirteen hhs earn an average of birr 577; with the minimum earns birr 300 and the maximum birr 1000 per month.

The Sample Household heads employment sector shows the highest frequency of 59(29.5percent) hh heads being employed in Public Service sector followed by 41(20.5percent), 24(12percent), 23(11.5percent), 10(5percent), and 10(5percent) in Commercial, Education, Other, Health and Agriculture, and Industrial sectors respectively.

The other important socioeconomic variables are ownership and type of houses the hhs live in. Of the 200 hhs 156(78percent) are living in privately owned houses and 44(22percent) hhs live in rented houses. Of these 102(51percent) houses are Small Services where as 46(23percent) and 52(26percent) houses are Villa and Villa plus Small Services respectively. Out of the two hundred hhs 112(56percent) hhs live in a single housing unit, where as 19(9.5percent), 28(14percent), and 41(20.5percent) hhs live in two, three, and four & above hhs in a single housing unit respectively. Regarding electrometer sharing of hhs in a housing unit, 163(81.5percent) of the hhs do not share electrometer, while 37(18.5percent) of them share electrometer.

4.1.3 Energy Consumption Patterns and Fuels Mixes of the Sample HHs

In the study area households' energy consumption is mainly used to the end-uses of baking and cooking. Hence household energy consumption patterns of the sample households for the end uses of Baking Injera, preparing "wet", and Coffee are given a focus. For this reason the type of fuel and appliances the two hundred households use for baking Injera and the fuel mixes use for Other Cooking Purposes are dealt with.

4.1.3.1 Types of Energy and Appliances the HHS use for Baking Injera

From the two hundred households the highest number which is 108(54percent) hhs use firewood for baking Injera. Where as the next 64(32percent) hhs use Electricity, and the

remaining 26(13percent) hhs and 2(1percent) hhs use firewood plus residue of sawmill and dung respectively for baking Injera.

Table – 2 Frequency of Type of Fuels the HHs use for Baking Injera

Type of Fuel the Households use for baking Injera	Frequency	Percent	Cumulative Percent
Electricity	64	32	32
Dung	2	1	33
Firewood + Residue of saw-mill, twigs, branches, etc	26	13	46
Firewood	108	54	100
Total	200	100	

Out of 136 hhs that do not use Electric energy for baking Injera: 69(51percent) hhs use Traditional (Sosit Gulicha) Injera Stove, 34(25percent) hhs Modified Traditional Injera Stove, and 33(24percent) hhs Modern Energy Saving Injera Stove (Mirt and Lakech) for baking Injera.

4.1.3.2 Fuels Mixes the HHS use for Other Cooking Purposes

When we see independent fuel use patterns of the hhs for Other cooking Purposes, out of the two hundred sample hhs: 195(97.5percent) use charcoal, where as 17(8.5percent), 65(32.5percent), 7(3.5percent) and 1(0.5percent) use firewood, kerosene, electric and LPG respectively. Nevertheless, most of the Sample households use a mix of two or more different types of fuels for cooking purposes like preparing “Wet”, Coffee, Tea, heating water, etc. Even though the mixes of fuels vary among the hhs the fuels mixed

are: charcoal, kerosene, firewood, electric and LPG; but LPG and electric are of less important or not as such significant. Among the Sample hhs 58.5 percent use only one type of energy, i.e. 56.5 percent and 2 percent charcoal and firewood respectively for Other Cooking Purposes. Where as the remaining 40.5percent of the HHs use a mix of two energies - 31.5percent, 6percent, 2.5percent, and 0.5percent for charcoal and kerosene, firewood and charcoal, charcoal and electric, and firewood and kerosene respectively; and the other 1percent of the HHs use a mix of three different energies.

Five hhs, which account 2.5percent - a hh that accounts for 0.5percent uses firewood and kerosene mix, and the other four hhs that account for 2percent use only firewood - are the only ones that do not use charcoal for Other Cooking Purposes from the Survey Study. (See Table - 3)

Table -3 Fuels Mixes of the HHS Energy Consumption Patterns for Other Cooking Purposes

Fuel/Fuels Mixes	Frequency	Percent	Cumulative Percent
Charcoal only	113	56.5	56.5
Charcoal and Kerosene	63	31.5	88
Charcoal and Electric	5	2.5	90.5
Charcoal, Electric and LPG	1	0.5	91
Charcoal, Electric and Kerosene	1	0.5	91.5
Firewood and Kerosene	1	0.5	92
Firewood and Charcoal	12	6	98
Firewood only	4	2	100
Total	200	100	

4.2 Determinants of HH Energy Consumption Patterns

In this Study HH Energy Consumption Patterns which is the types of fuel and appliances the hhs use for baking and cooking purposes is a dependent variable. Energy Consumption Patterns of a household could be determined by a number of demographic and socioeconomic characteristics of the household. To understand and describe the determinants or the predictor variables a cross tabulation of the different demographic and socioeconomic variables, i.e. independent variables, and the dependent variable were made and the results are presented here.

Primarily, among the various independent variables that are considered to be predictors of hh energy consumption patterns: household size, gender of hh head, spouse's employment sector, number of female members in a hh and the presence or absence of a maid servant in a hh didn't show to have any association with the dependent variable. From cross tabulation of the independent variable or hh size with type of fuel hh uses for baking Injera we observe that high frequency of using different types of fuels for baking Injera fall among the hh sizes between 4 and 6: with electric a frequency of 18hhs by hh size 6 and firewood 24hhs by hh size 5. The lowest frequency of electric users 3hhs by hh size 2 and firewood users 9hhs by hh size 8. Hence no pattern or change in fuel type is seen when hh size changes.

The other independent variable, which was considered to be a predictor but didn't show, was number of female hh members in a hh. Despite the assumption that the presence of large number of female members in a hh may lead to the preference of biomass fuel for baking and cooking, it doesn't appear to be so. The highest frequencies of fuel preferences are seen among the hhs with 2-4 female members in a hh and the modal group which is 3 female hh members in a hh showing 28hhs using electric and 40hhs using firewood.

Secondly, from the results of the analysis the independent variables that are considered to be predictors and showed significant associations, at different level with the dependent variable of the household energy consumption patterns include: hh income, hh head education level, hh head employment sector, spouse's education level, highest education level in a hh, ownership of a house a hh live in, type of a house, number of hhs in a housing unit, and hhs in a housing unit share electrometer.

Household Income is one of the most important determinant factors of hh energy consumption patterns. In the Income category and fuel type for baking Injera cross tabulation, we see a pattern of fuel use for baking Injera among the different Income Categories. From the Cross tabulation, we clearly see that the majority of the First Income Category, which is the low income group, Eighty Four hhs of the One Hundred Sixteen hhs in the Category, using Biomass fuels; while a small number of them using Electric. In the Second Income Category, which is the middle income group, surprisingly Biomass Fuels and Electric energy users become equal, having a frequency of Thirty One hhs each. At the Third Income Category, which is the upper income group, the number of hhs using electric energy excels those of biomass fuels users within the same category, i.e. ten hhs out of the sixteen hhs within the Category use electric energy for baking Injera. (See Table - 4) Hence the pattern shows that where income is low the majority of the hhs tend to use biomass fuels, firewood and a mix of it and other energies for baking Injera; where as when income goes on increasing the number starts to decrease from firewood and other mixes of energies and an increase in electric users.

To explain this more I go on putting HH Head Education Level as layer variable, and it gives a very interesting explanation that 32 hhs out of 47 HHS with different Income Categories, but having the HH Heads Education Level of Degree and above, use electric stove for baking Injera. Primarily, this means that 32 HHS out of the 64 electric stove users HHS fall on this education level. Secondly, for the 2nd Income Category,

where the frequencies of biomass fuels and electric energy users for baking Injera come equal, i.e. 31 hhs each, the Education Level of HH Head clarifies that 21 hhs use electric energy, but only 9 hhs use biomass at this education level out of the 31 hhs for each energy types in this same Income Category. (See Appendix - 1) In addition to this, in the cross tabulation of HH Head education level and fuel type for baking Injera the highest frequency of biomass fuels users for baking Injera fall on Secondary school complete, 33 hhs. Therefore with this I can say that within the same income category education level influences fuel choice among the HHS.

Table - 4 Monthly Income Category * Fuel types for baking Injera Cross Tabulation

		Type of Fuel the Households use for baking Injera				Total
		Electricity	Dung	Firewood + Residue of saw-mill, twigs, branches, etc	Firewood	
HH Monthly Income Category	<2000	22	1	21	72	116
	2000 - 4000	31	1	3	27	62
	>4000	10	0	1	5	16
	Missing	1	0	1	4	6
Total		64	2	26	108	200

Moreover, a Chi-square test also shows that there are statistically very significant associations between the two independent variables: Income Categories of the HHs and HH Head Education Level with the dependent variable, i.e. fuel type for baking Injera at a value level of 0.001 and 0.000 respectively; and the associations are fairly strong with both independent variables. (See Table – 7)

Similarly, Income has a direct and positive relation with the HHS' fuel mixes for other cooking purposes. To understand and describe this, at the beginning a cross tabulation of Income Categories and each of the fuel mixes for other cooking purposes was used. Then a cross tabulation of Income Categories and one of the fuel mixes for other cooking purposes by putting either of the other fuel mixes as layer variable was applied. From the results the following can be demonstrated. First, among the 17hhs using firewood and a mix of it with other energy types for Other Cooking Purposes, 10hhs fall in the Low Income Category. As Income Category goes up firewood users decrease and a tendency towards using modern fuel mixes is seen. Where as, for the 3rd Income Category, the High Income Group, no hh uses firewood. Second, among the charcoal and kerosene fuel mix users the 1st and 2nd Income Categories are seen to be the highest frequencies, twenty six and twenty five respectively. But proportionally it is the 2nd and 3rd Categories that show relatively high frequencies, twenty five hhs out of sixty two and eleven hhs out of sixteen respectively. Third, all the seven hhs that use electric as a fuel mix and the only hh that use LPG as fuel mix fall on the Second Income Category. Fourth, the two hhs using fuel mixes of three different types of fuels: a mix of charcoal, kerosene and electric, and a mix of charcoal, LPG, and electric one hh in each of fuel mixes fall in the Second Income Category. (See Table - 5) Therefore, as Income increases going away from or a decrease in using biomass fuels and an increase in a mix of it with other modern fuels is clearly seen.



Table – 5 Income Categories * Fuel Mixes for Other Cooking Purposes Cross Tabulation

HHs Monthly Income Category	Charcoal 4 cooking		Firewood 4 cooking		Kerosene 4 cooking		Electricity 4 cooking		Other Fuels (LPG, etc.) 4 cooking	
	No	Yes	No	Yes	NO	Yes	No	Yes	no	LPG
Missing	1	5	5	1	3	3	6	0	6	0
<2000	1	115	106	10	90	26	116	0	116	0
2000 - 4000	3	59	56	6	37	25	55	7	61	1
>4000	0	16	16	0	5	11	16	0	16	0

The third independent variable which has a significant association with hh energy consumption patterns is Spouse's Education level. A cross tabulation of this variable with fuel type for baking Injera shows a highest frequencies for electric users 20hhs and firewood users 28hhs for spouse's education levels of Diploma/TVET and Elementary respectively. Where as, the lowest frequencies for electric user 1hh and firewood users 3hhs show for Illiterate and Degree and above education level respectively. More over, a chi-Square test also shows a statistically significant association at a value level of 0.004 and fairly strong relation between the two variables. (See Table – 7)

The fourth independent variable considered to be a predictor is Highest Education Level in a hh. A cross tabulation of this variable and fuel type for baking Injera show highest frequencies for electric users 41hhs and firewood users 34hhs to Degree and Above, and Secondary School Complete respectively. The lowest frequencies - both electric null and firewood 7hhs – are seen for where Elementary Level is the Highest

Education Level in the HHS. In the relationship of these two variables, electric users go declining while highest education level in the hhs go decreasing; where as firewood users go decreasing from the highest frequency of the same at Secondary School Complete level towards both direction to higher and lower directions of highest education level of the hhs, though the figure is different. A Chi-Square test of these two variables also shows a statistically significant association at a value level of 0.000 and fairly strong relationship. (See Table – 7)

The fifth independent variable is Ownership of a house a hh live in. A cross tabulation of this variable and fuel type for baking Injera shows the highest frequencies of all fuels for privately owned houses. However when we see the proportion of different fuel users the frequency of electric users is higher, i.e. it shows 61hhs out of the total 64hhs fall in privately owned houses; where as the frequency of firewood users is 79hhs out of the total 108hhs. So this gives a signal that relatively those hhs living in privately owned houses have a tendency to use electric energy for hh consumption. A Chi-Square test also shows that there is a statistically significant association at a value level of 0.000 and a fairly strong relationship between the two variables. (See Table – 7)

The sixth independent variable is Type of house a hh live in. A cross tabulation of this variable with fuel type for baking Injera shows some pattern of fuel use for baking Injera by the type of houses. Electric users increase in number as the type of house goes through from Small Services, to Villa only and Villa plus Small Services showing the frequencies of 13hhs, 22hhs, and 29hhs respectively for the type of houses; where as when we see other fuels the reverse is true. For instance firewood users decrease in number through the type of houses Small Service, Villa only and Villa plus Small Services showing frequencies of 67hhs, 21hhs, and 20hhs respectively. (See Table - 6) In addition to this, a Chi-Square test also shows that there is a statistically very significant association at a value level of 0.000 and fairly strong relationship between these two variables. (See Table – 7)

Table – 6 Type of house the households live in * Type of Fuel the Households use for baking Injera Cross tabulation

Type of house the households live in	Type of Fuel the Households use for baking Injera				Total
	Electricity	Dung	Firewood + Residue of saw-mill, twigs, branches, etc	Firewood	
Small Service	13	2	20	67	102
Villa only	22	0	3	21	46
Villa plus Services	29	0	3	20	52
Total	64	2	26	108	200

The seventh independent variable showing significant association is households in a housing unit share electrometer. This variable was included in the assumption that those hhs in the same housing unit and that share electrometer may not use electric for baking and cooking purposes due to the disagreements between the hhs to pay for the bill. Accordingly, from the cross tabulation of the independent variable with the dependent variable fuel type for baking Injera shows that no hh that share electrometer with other hh in a housing unit uses electric for baking and cooking purposes. All 37hhs that share electrometer with other hhs in a housing unit use firewood, firewood plus residue of saw mill, and dung for baking Injera by 23hhs, 13hhs, and 1hh respectively. A Chi-square test also shows that there is a statistically very significant association at the value level of 0.000 and fairly strong relationship between the two variables. (See Table – 7)

The last two independent variables included in the Survey and considered would be predictors in this Study were HH Head employment sector and Number of HHs in a Housing unit. However cross tabulations of both these independent variables with the dependent variable fuel type for baking Injera do not show any patterns of hhs fuel consumption, but the Chi-Square tests for both independent variables show a statistically significant associations at a value levels of 0.033 and 0.000 respectively with the dependent variable.

Table – 7 A Chi-Square test Statistical significance Values and Strength of relationships among the various independent variables and the dependent variable

No.	Independent Variables	Significance Value	Strength
1	Income Category	0.001	0.377
2	HH Head Education Level	0.000	0.499
3	Spouse's Education Level	0.004	0.438
4	Highest Education Level in a HH	0.000	0.455
5	Ownership of the house a hh live in	0.000	0.315
6	Type of the house a hh live in	0.000	0.442
7	HHs in a hh unit share electrometer	0.000	0.409

4.3 Analysis of Variance

4.3.1. Energy Consumption Variance with different Independent Variables

Analysis of Energy Consumption Variance with the most important Independent Variables: HH Income Category, HH Head Education Level, Spouse's Education Level, Highest Education in a hh, Ownership of the house, Type of a house, and If HHS in a

housing unit share electrometer or not, is made. (See Appendix - 4) The results are described below. The first Independent Variable is HH Income Category. Mean electric consumption is high in the middle income category, and consumption variance is also relatively high/wider in the same category. Consumption is lower and consumption variance narrow in both the upper and lower income categories. Mean Kerosene consumption goes on increasing and consumption variance getting wider from the lower income category towards the upper. Where as mean firewood consumption goes decreasing and consumption variance goes increasing from lower to upper income category. Mean charcoal consumption goes increasing from lower to upper income category, but consumption variance is wide in the middle category and relatively narrow in both lower and upper income categories. ANOVA assumption holds for kerosene and firewood consumption variance between groups by showing statistically significant value of 0.000 and 0.019 respectively. Leven statistics rejects ANOVA assumption for charcoal by significant value of 0.016.

The second is HH Head Education Level. Mean electric consumption is similarly high for both groups of HHS with HH Head at primary and tertiary level of education. However, consumption variance is significantly higher for the prior group, and lower for the later one. Mean kerosene consumption goes decreasing from higher to lower HH Head Education Level, but consumption variance is lower for the secondary education level and a little wider for the other groups. Mean firewood consumption goes increasing and consumption variance, as well, getting wider from higher to lower HH Head Education Level. However, mean charcoal consumption is high and there is no significant difference between the groups except for the illiterate HH Heads, where mean consumption is lower. But consumption variance is different among groups and it goes on increasing from higher to lower HH Head Education Level. ANOVA assumption shows statistically significant value for variances between groups at value level of 0.013, 0.001, 0.004 and 0.034 for electric, kerosene, firewood, and charcoal consumptions respectively. However Leven statistics rejects the ANOVA assumption

for electric and kerosene consumptions by showing statistically significant value of 0.005 and 0.000 respectively.

The third is Spouse's Education Level. Mean electric consumption is highest for HHS with Spouse's at a Primary Education Level and lowest for Illiterate. But consumption variance is lowest for HHS with Spouse's at Tertiary Education Level and it goes increasing towards lower education level of the same. Mean kerosene consumption is similar for both tertiary and secondary education level groups, where as is lower for hhs at primary and null for the Illiterate ones. However consumption variance is a little wide for tertiary groups. Mean firewood consumption is low at tertiary level and goes increasing towards lower education level. Consumption variance is narrow at tertiary level and goes increasing towards lower education level and is wider for the Illiterate one. Mean charcoal consumption is not significantly different among the groups, however some how it is higher at secondary and lower at Illiterate level. But consumption variance is low for secondary and high for Illiterate. ANOVA assumption holds for variance of firewood consumption between groups at a statistically significant value level of 0.024. Nevertheless Levene statistics rejects ANOVA assumption for kerosene and charcoal by showing significant value of 0.000 and 0.001 respectively.

The fourth is Highest Education Level in a HH. Mean electric consumption is high for Tertiary Level and it goes decreasing towards lower education level and is very low at Primary Level. In addition to this consumption variance is low at Tertiary Level; where as, the highest variance is at Secondary Level and it decreases a little at Primary Education Level. Mean Kerosene consumption is high at Tertiary Level and it goes decreasing towards lower education level and is null at Primary Level. But consumption variance is a little wider at Tertiary Level. Mean firewood consumption is low at Tertiary Level and high at Secondary and Primary Levels. Even though no significant difference is seen in mean consumption between these two groups, there is difference in consumption variance. Consumption variance is narrower at Primary Level and wider at

Secondary Level. Mean charcoal consumption is high at Tertiary Level and it goes decreasing towards lower education level. But consumption variance is very low at Tertiary Level and goes increasing towards lower education level and is wider at Primary Level. ANOVA assumption holds for kerosene, firewood and charcoal consumption variance between groups by showing statistically significant value of 0.001, 0.024 and 0.059 respectively. However, Leven statistics rejects ANOVA assumption for kerosene and firewood by showing significant value of 0.000 and 0.013 respectively.

The fifth independent variable is Ownership of a house. Mean electric consumption is very high at HHS living in a Privately Owned houses and is very low at HHS living in a Rent. But consumption variance is narrow and no significant difference is seen between groups. Mean kerosene consumption is higher for Privately Owned houses and low for Rented. But no significant difference is seen between groups in consumption variance. Mean firewood consumption is lower in Privately Owned houses and higher in Rented houses. In addition to this consumption variance is narrow at Privately Owned and wide at Rented houses. Mean charcoal consumption is high in Privately Owned houses and low in Rented. More over consumption variance is very narrow in Privately Owned houses and wide in Rented. ANOVA assumption holds for electric and kerosene consumption variance between groups by showing statistically significant value of 0.000 and 0.006 respectively. Where as, Leven statistics rejects the ANOVA assumption for electric, kerosene and firewood with a significant value of 0.022, 0.000 and 0.025 respectively.

The sixth is Type of the house the HHS live in. Both mean electric consumption is low and consumption variance is narrow for HHS living in Small Services and both go increasing towards Villa and Villa plus Services. Like wise mean kerosene consumption is low and consumption variance narrow at Small Services and both go increasing towards Villa and Villa plus Services. Mean firewood consumption is high

for Small Services and it goes decreasing towards Villa and Villa plus Services. But consumption variance is narrow at Small Services and wider for both groups of Villa and Villa plus Services. Mean charcoal consumption is relatively low and consumption variance narrow for Small Services and mean charcoal consumption is equivalently high and consumption variance wide for both groups of HHS living in Villa and Villa plus Services. ANOVA assumption holds for electric and kerosene consumption variance between groups by showing statistically significant value of 0.000 and 0.002 respectively. However, Leven statistics rejects ANOVA assumption for electric, kerosene and charcoal with significant value of 0.046, 0.000 and 0.027 respectively.

The last variable is whether HHS living in a housing unit share electrometer or not. Mean electric consumption is very high in the HHS that do not share electrometer and low in the HHS that share electrometer. However consumption variance is narrow and similar in both groups. Mean kerosene consumption is relatively high for group of HHS that does not share electrometer and very low for HHs that share electrometer. Consumption variance is narrow in the prior group and wide in the later. Mean firewood consumption is low and consumption variance narrow for HHS that do not share electrometer and mean consumption is high and consumption variance wide for HHS that share electrometer. Mean charcoal consumption is high for HHS that do not share electrometer and low for that share. But consumption variance is very narrow for the prior group and wide for the later. ANOVA assumption holds for electric and kerosene consumption variance between groups by showing statistically significant value of 0.000 and 0.013 respectively. However Leven statistics rejects ANOVA assumption for kerosene with a significant value of 0.000. (See Appendix - 4)

Therefore from the analysis of variance we can understand and conclude that hhs Energy Consumption Patterns, i.e. fuel choice and level of consumption, could be influenced by a number of factors. Among these hh income, wealth or asset of a hh - like ownership and type of a house - and education level in a hh. Better energies:

electric, kerosene, and charcoal are directly related with income, wealth, and education level in the hh. As it is clearly seen in the analysis of variance mean kerosene consumption is null in the groups of hhs with illiterate spouses and where highest education in hhs is at primary level. Where as, firewood consumption is reversely related with these factors. However the consumption variances within groups of similar income, wealth or asset, and education level indicate that there are also other factors which influence it.

4.4 Summary of Case Studies and FGDs

4.4.1 Summary of Case Studies

An in depth interview with ten hh wives were held to understand and describe information obtained from the Survey about hh energy consumption patterns in the Town. The ten HHS have a different hh size from the minimum 5 to the highest ten with an average of 7 hh members. All hhs included in the Case Study have additional income in the form of rent, transfer from abroad and some do run mini businesses.

Of the ten hhs 7hhs live in Villa plus Small Services of their own, and 3hhs live in Small Services one privately owned where as two rent from Kebeles. Six of the HHS use firewood plus residue of sawmill, three HHS use electric, and one hh uses only firewood for baking Injera. Four HHS use Modified Traditional Injera Stove, three HHS Electric Injera Stove, and the remaining three hhs use Modern Energy saving Injera Stoves. When we see frequency of Injera baking in hhs – 7hhs bake Injera twice a week, and two hhs each bakes daily and while one triple a week. All electric stove users complain about electric power fluctuation and reported at least twice a month are forced to switch to using firewood for baking Injera.

A bucket of dough depending on its thickness results 25-30 Injera.⁸ Using a Modified Traditional Injera Stove 8-10 birr of firewood or a quarter sack of sawmill residue plus 4-5 birr firewood will be required to bake this amount. According to those who use Modern Energy Saving Injera Stoves 25-50percent of the fuel can be saved from this amount of Injera baking at a session. However all four hhs, who are currently using Modified Traditional Injera Stoves, have heard or know about modern energy saving Injera stoves, neither of them take the initiative to shift to it.

For other cooking purposes, all ten households use charcoal. Of whom 4households use only charcoal, 2hhs charcoal and electric, 2hhs charcoal and firewood, and the other two hhs each uses charcoal and kerosene and charcoal and LPG. However, all hhs use charcoal for cooking food and beverage, and those who use a mix of other fuels use the other, especially modern fuel, only for heating in the morning when they are in hurry. A very interesting thing here is that those affluent do not look worried neither for energy saving nor using a cleaner energy. One of the interviewees, who is educated and knows well about energy saving, doesn't put it in practice. One of the reasons she mentioned were a tradition or a custom which is believed to be that stew or "wet" cooked by charcoal is tastier than cooked by kerosene or other modern fuels. She emphasizes that simmer cooking for both food and a beverage, above all Coffee is better for good taste. The second reason is price of fuel. Most respondents raised the issue of price and they said that they couldn't afford to usually use kerosene and other modern fuels in permanent bases for cooking except for seldom heating purposes.

This issue is raised in the FGDs held in two sub-towns. (See the following section) From the Case studies it is noticed that, primarily, in addition to the rise of the price of fuel, there seem to have some underlying tradition of simmer cooking behind energy

⁸ Since counting Injera in a hh is considered taboo, exact number directly couldn't be obtained. Hence I deliberately included a woman running a mini business for triangulation. And it is found that a mini business woman used to baking 50-60Injera a day uses double energy that of other hhs use for baking 25-30 Injera at one session.

sharing Injera Stove is common, lack of institutional supervision and control on the production and supply of the Stoves make people cautious¹¹ on the quality and durability of the Stoves and hence about the technology, etc. Therefore most of the residents use Traditional and Modified Traditional Stoves and only limited numbers of residents use Modern Energy Saving Injera Stoves, according to the participants.

The increase in fuel price is the most important point raised during the Discussions as a push and pull factor. Most of the participants in the Discussions and Case Studies¹² too, raised this issue. People who were using firewood plus sawmill residue returned back to using only firewood because of the rise in price and the decrease in quality of sawmill residue, i.e. price, availability and quality. The same reason was raised for cooking and heating, due to price increase in kerosene. This pushed a number of people who were using kerosene or a mix of it to return back to and be exclusively dependent on charcoal. Currently those HHS that use kerosene as a mix, they use very little of it especially during the rush time for heating beverage and food previously cooked by charcoal and other fuel. However, there is also a pull factor in the people, i.e. an underlying tradition among hhs that food and a beverage, above all Coffee, cooked and heated with charcoal is tastier than with kerosene or any other modern fuels. Therefore Simmer cooking with charcoal is preferred by most of them. More over, it is not only cooking and heating Stew or 'Wet' and Coffee that were associated with cooking and heating tradition, but also baking Injera by Electric Stove is still not acceptable in some hhs since they believe that the Injera may not be as good as the one baked with biomass fuel.¹³

¹¹ The interview made with Mirt Biomass Injera Stove Producer has helped me to understand that as there are some producers of Mirt Modern Biomass Injera Stove who do not keep well the ratio of Sand and Cement mixture during the production

¹² See Summary of Case Studies

¹³ A discussion with W/ro Beyenech Wata, who is Head of Women and Children Affairs at the Menaherya Sub-Town Administration, from her experience

Finally regarding energy saving, despite it is for economic reason, most of the participants expressed that as they usually reuse charcoal by turning it off after finishing their jobs. Nonetheless, one participant from each FGD was obtained who have an awareness of the impacts of hh energy consumption patterns on the local environment. The one from the FGD – 1 is the most aware and who explains the depletion of the forest resource while firewood and charcoal are being supplied to urban consumers.

4.5 Values and Eco-consciousness for saving Energy

To understand the respondents' Value and Eco-consciousness for saving energy four consecutive questions or variables were asked. The first question was that to what extent does the respondent perceive that saving energy is important? For this question four answers arranged in ordinal scale were given: Very Important, Important, Not Important, and I don't Know. Of two hundred respondents 68(34percent) replied Very Important, 126(63percent) Important, and 'Not Important' and 'I don't know' 3(1.5percent) each.

Then at the second level leaving those 6 respondents who replied Not Important and I don't know, the other 194 respondents were asked that why do they think saving energy is important? Of the 194 respondents 149(77percent) replied Economic and 45(23percent) replied both Economic and Environmental.

At the third level, leaving out 149 respondents those who replied the previous question 'it is for Economic', the remaining 45 were asked an open question that why their answer was so? Out of 45 36(80percent) replied that depletion of forests or Deforestation as their reason, where as 9(20percent) replied that their reason is beyond Deforestation and expressed their concern that it may even contribute to Global Climate Change.

Finally, the last question that was asked for these same respondents was that to what extent they do perceive that energy utilization patterns do have subsequent impacts on the local environment. Of the two ordinal scale answers given, i.e. Very Serious and Serious, 21(47percent) of the respondents chose 'Very Serious' and 24(53percent) 'Serious'.

The four consecutive questions which are related with values and eco-consciousness included in the Survey Questionnaire may help us to understand, at some level, how the respondents do have value to energy saving and their awareness of the energy - environment nexus. The next step, therefore, will be testing how the respondents' value to energy saving and eco-consciousness or awareness of this is related with hh characteristics or variables in the Sample hhs. Hogan and Paolucci in their Article on Family and Consumer Sciences Research Journal entitled "Energy Conservation: Family Values, Household Practices and contextual Variables" described that the value of eco-consciousness was positively related to wife's education, husband education and his occupation.

Regarding these hypotheses a cross tabulation of the respondents' answers and the respective hh characteristics were made. Of the 45 eco-conscious respondents 30 were hh heads, 13 spouses and 2 sons/daughters of head and spouse. The majority of the respondents were at the Education level frequencies of 8, 16, and 8 for the Degree and Above, Diploma/TVET and Secondary School Complete respectively. Similarly, the HH Heads Education Level of the eco-conscious respondents has frequencies of 14, 8, and 13 for Degree and Above, Diploma/TVET and Secondary School Complete respectively. In addition to this, excluding the 14 eco-conscious respondents who are member of unmarried, widow or widower hhs, the Education level of the wives of the remaining eco-conscious respondents hhs have frequencies of 2, 12, and 8 for Degree and Above, Diploma/TVET and Secondary School Complete respectively. While the employment sector which was categorized on the assumption that a prior awareness and

association of eco-consciousness to happen for the education, health & agriculture, and industrial sectors, contrary to the assumption very few frequencies are observed to these sectors. Rather the highest frequency of eco-conscious respondent is observed for HH Head or husband employed in Public Service Sector.

Therefore, as it is described by Hogan and Paolucci, in this Study it is observed that there is a positive relation between eco-consciousness and HH Head or husband education and wife's education level. But unlike the Article by Hogan and Paolucci, a relationship between HH Head or husband employment sector and eco-consciousness is not seen in this study.

4.6 Trends of HH Energy Consumption Patterns in Awassa Town

A Household Energy Base Line Survey of Awassa Zuriya Wereda was done by Ministry of Agriculture/GTZ Household Energy/Protection of Natural Resources Project in 1999. From the Survey a detail report on all the surveyed areas – rural and urban alike - was produced by the Project Consultant. As one of the focus areas of the Survey, data on fuel consumption, supply, market, price, etc. of Awassa Town were collected and the respective report was included in the Survey final report. The Survey, which has collected data from two hundred hhs in Awassa Town using a survey questionnaire and made an in depth follow up of fifteen hhs, has reported that the hhs energy need in the Town was essentially met with biomass fuel. The report says that, however their contribution to the total energy consumption varies firewood and charcoal are used by the majority of the HHS for baking and cooking respectively. (See Table - 8)

The report shows types of fuels used by the HHS for different end uses in Awassa Town. Firewood was used by 55percent of the hhs, charcoal by 45percent, kerosene by 37percent, electric by 8percent, sawmill residue by 6percent and dung by 1percent of

the hhs. This shows that the major fuels used by the hhs were firewood, charcoal, and kerosene.

Nevertheless, the Survey data¹⁴ collected after eleven years by this researcher shows that among the HHS 54percent use firewood, 97.5percent use charcoal, 32.5percent kerosene, 32percent electric, 13percent sawmill residue, 1percent and 0.5percent dung and LPG respectively for different end uses of baking, cooking and heating. Despite the mixes of different fuels the hhs use for different end uses of baking, cooking and heating purposes, the result shows that there is still a high dependency of the hhs in the Town on biomass fuels: 97.5percent of the hhs use charcoal and 54percent use firewood.

Therefore the trend of HH Energy Consumption Patterns of Awassa Town for different end uses of baking, cooking and heating of food and beverages is presented on the following table.

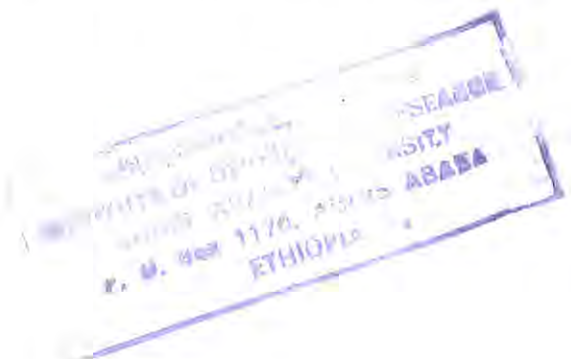
Table - 8 Trends of Fuel Consumption Patterns in Awassa Town (% of HHs)

Fuel	Data from the 1999 Survey	Data from the 2010 Survey
Wood	55%	54%
Charcoal	45%	97.5%
Kerosene	37%	32.5%
Electric	8%	32%
Sawmill residue	6%	13%
Dung	1%	1%
LPG	-	0.5%

¹⁴ The Survey data of this research is collected in the second half of April and beginning of May 2010

From the table we can easily understand that: first, there is a very significant increase in percent of the hhs using charcoal as energy, i.e. from 45percent in 1999 to 97.5percent in 2010. As it will be discussed in the next part of the Thesis such a leap in the use of charcoal has a serious pressure on the local environment since its production demands more wood. Second, the hhs using kerosene showed a decline from 37percent in 1999 to 32.5percent in 2010. This is in line with the claims by the hhs during the Case Studies and FGDs. Those who were interviewed in the Case Studies and participants in the FGDs have repeatedly raised the issue of kerosene and their shift away from using it due to the price increase on it. More over, from the discussions the most important trend seen was not only shifting away from using kerosene as a fuel, but also those who are currently using kerosene they use it rarely. Mostly for heating foods that have been already cooked with other fuels and when they are in a rush, like in the morning sessions when they are in hurry to go to work.

Third, on the other hand there is a high percent increase in the hhs using electric energy for different end uses. HHS using electric energy in the 1999 Survey shows as it was only Eight percent, where as the result from the Current Survey shows that the HHS using electric for different end uses rises to Thirty two percent. Fourth, while previously LPG was not seen, currently it becomes among the fuels mixes in the hhs. Fifth, however there is no significant change in the percent of hhs using wood as a fuel, i.e. it is only a one percent decrease that is seen. Therefore, despite the prevalence of high dependency on biomass fuels by the hhs, the increase in the percent of the hhs using electric energy for different end uses and the coming up of LPG in the fuel mixes of the hhs show that there is a significant fuel consumption transition from traditional to modern fuels among the hhs in the Town.



Chapter 5 Impacts on Environment

5.1 Impacts of HH Energy Consumption Patterns on the Local Environment

5.1.1 Type of Fuel and Appliance

In Ethiopia eighty eight percent of the overall energy consumption is used by the household sector, four percent by the industry, three percent by transport sector and the rest five percent by other service giving sectors. The major energy consumption sector, i.e. the household sector consumption carrier is basically covered by biomass - ninety four percent - the next five percent is covered by different liquid energies and only one percent is by electricity. (MoA/PPNR, GTZ, 2008) Therefore this clearly indicates that there is a very high demand from the household sector for the consumption of biomass, firewood and charcoal, (See Figure - 3) energy which in turn entails a very significant impact on the Natural Resource base. More over it is not only the demand for these energies, but the way they are produced, supplied, and the efficiencies and effective nesses of the various appliances used also aggravate the problems.

Type of Fuel and Appliances for Baking Injera among the Sample HHS

From the two hundred Sample HHS one hundred thirty six (sixty eight percent) of them use biomass fuel for baking Injera, but with different types of appliances, i.e. Injera Stoves. It is only 33(16.5percent) of the HHs that use Modern Energy Saving Injera Stoves. The remaining 69(34.5percent) of them use Traditional, and 34(17percent) Modified Traditional Injera Stoves. The Traditional Injera Stove, which is set using three stones structure, (see picture - 1) is open and exposed to wasting energy and high

consumption of fuel. The Modified Traditional Injera Stove is semi-closed. In addition to the energy what it releases through its openings, (See picture - 2) the structure depending on the quality of its construction, service years, etc creates a variation in the wideness of the opening, through which fuel is supplied and fire is set, to the main plate on to which Injera is baked at different houses. These conditions determine the amount of fuel consumption and energy saving. Since most of the appliances seen are not in good conditions, Modified Traditional Injera Stoves are considered to be not much better than the Traditional ones in the perspective of energy saving.

Where as when we see the Modern Energy Saving Injera Stoves: (see pictures 3 and 4) (1) they are closed structures, (2) have only one opening which is very narrow to supply fuel and set fire, and (3) the appliances have a very short height, the gape between the floor and the plate, making the flame/energy service reach well and maximize the efficiency of energy use with very small amount of fuel or energy during the service which make them important.

Therefore, regarding the different parameters of energy efficiency and saving discussed above, fuel consumption, efficiency and energy saving characteristics of these different Injera Stoves vary accordingly. Using Traditional Injera Stove for baking one Injera requires firewood of 0.338 kg; where as using Mirt Energy Saving Injera Stove 0.154kg is sufficient. (MoA/PPNR, GTZ) Therefore a hh baking thirty Injera at a session requires 10.14kg of wood for one session. If twice a week is their baking program, the hh consumes 20.28 kg of firewood per week only for baking Injera, which makes 81.12kg per month and 973.44kg/a tone of firewood per annual.¹⁵

¹⁵ According to the Regional Bureau of Agriculture and Rural Development, Natural Resources Development Department the Regional annual average fuel wood consumption is about 1022kg per household, which is some how similar with the result of this study, but considerably higher than that of the national average, i.e. about 700kg.



Picture - 1 Traditional (Sosit Gulicha)



Picture - 2 Modified Traditional

Types of Injera Stoves



Picture – 3 Mirt Energy Saving



Picture – 4 Lakech Energy Saving

Preferring Charcoal for Other Cooking Purposes

Urban women interviewed during household energy surveys, by the World Bank's Energy Sector Management Assistance Programme, in Ethiopia, Madagascar, Mali, the Niger and Senegal (Girard, 2002) told as they did not like to cook with wood because they found it difficult to kindle, awkward, dangerous for children, smoky and messy. Where as charcoal is perceived to lack most of these negative effects, and is preferred by them. In addition to this it is priced more competitively than LPG and kerosene, which are still too expensive for many people.

On the other hand, there are people, even if they can afford a more efficient energy sources for cooking like LPG or electricity that still use charcoal. This, primarily, shows that there are underlying cultural reasons and habits of cooking and heating in the residents, i.e. Simmer-cooking. (See the Summary of Case Studies and FGDs) Secondly, it also gives evidence of the abundant availability and relatively cheapness of charcoal in the market. For instance, from the Survey it is observed that a hh with an average hh size of five uses a sack of charcoal, which is around 35kg and costs on average eighty birr, per month for different cooking and heating purposes. By this a household wins both the tradition of simmer cooking and economic advantages. Nevertheless, the preference of charcoal and the persistence of its consumption pattern would make the requirement of the hh consumption of charcoal 420kg per annum. To produce this in traditional earth kiln it needs about two tones of wood. There fore the preference of urban dwellers to use charcoal, the inefficiencies inherent to its use, and rapid urbanization, place a heavy strain on local wood resources.

5.1.2 Charcoal Production Technique and Supply

Charcoal is produced by heating wood in the absence of air. The relative amount of the charcoal and the type of the product depend on the equipment and the characteristics of the original wood used to produce it. Different tree species yield different qualities and amounts of charcoal. In addition to these, the moisture content of the wood is an especially important parameter, since dry wood produces more charcoal than do wet wood.

Using a traditional earth mound kiln the production of charcoal yields are about 25 percent. In other words, 1tonne of wood will give 250 kg of charcoal. With poorer techniques, however, yields often do not exceed 15 to 20 percent, about 150 to 200kg from 1tonne¹⁶ of wood. In addition to this, many charcoal producers, for example, use green wood and the energy needed to dry it is provided by part of the load, which would reduce yields to 15 percent.

In most countries of the developing economy still low efficient traditional charcoal production using earth kiln is used. This is produced in two ways: one wood would be put in dug-out earth pits, lit and covered with earth. The combustion of part of the wood produces enough heat to carbonize the remainder. The second one is heaps of wood were formed and covered with earth and sod/turf and lit through openings in the earth cover. These both methods persist in many developing countries because they are cheap and some are even badly maintained and allow entering too much oxygen to the kiln, so that additional losses are caused. Therefore, in both methods, low yield and inconsistent quality of charcoal are the results due to difficulty to maintain uniform carbonization

¹⁶ When we see the carbon content of wood and charcoal it is 50 and 90 percent respectively, giving the following carbon equivalents:
1000kg of wood → 500kg of carbon; 250kg of charcoal → 225kg of carbon; 150kg of charcoal → 135 kg of carbon Hence when a tone of wood is carbonized, 365 kg are released into the atmosphere with a poorly managed technique and 275 kg with improved methods. Improved technique thus prevents the emission of 90kg of carbon per tone of carbonized wood, equivalent to 300kg of carbon or 1.1 tones of CO₂ per tone of charcoal consumed. (Stassen, 2002)

and yields of 1kg of charcoal from 8 to 12 kg of wood (Stassen, 2002) or on average only around 15percent sometimes even less is common.

However, from the improved traditional methods, by equipping earth kilns with chimneys made from oil drums and by introducing small-scale steel or brick kilns yields of 1kg of charcoal from 4 to 5 kg of air-dried wood are possible. Steel and brick kilns are less labor intensive than improved traditional earth mounds. Nevertheless they may be less accessible to small-scale traditional charcoal makers because of their higher costs.

Another most important problem related with charcoal is its supply. The handling of bags/sacks of charcoal shows signs of inefficiency. Bags are often smashed on to the ground while loading and off loading which increases significantly the proportion of fines in the bags, which some times mount up to 20percent (on average 5percent), (Knopfle, 2004) One of the reasons for this is the illegal production and supply characteristics of charcoal. Charcoal production and supply to Awassa Town is completely illegal, this is proved from interviews made with the Regional Bureau of Agriculture and Rural Development, Natural Resources Development Department and charcoal vendors in the market. According to the interview made with the representative of The Bureau, it neither encourages traditional charcoal production nor gives any technical support for charcoal producers. No tax is laid on it. However charcoal has high demand and it is highly consumed by the residents. It is also abundantly available in the market. (See Figure – 3 below)



Figure – 3 Fire Wood and Charcoal Market in Awassa

Therefore charcoal is illegally and traditionally produced and illicitly trafficked to the Town.¹⁷ (See picture - 5) Banning charcoal production and/or marketing in Africa, as it has, for instance, been tried in Mauritania and Kenya, (Girard, 2002) doesn't show to be effective; rather it drives producers into underground and precludes proper control and corruptions prevail. In Uganda charcoal traffickers bribe polices on the check points

¹⁷ During the field season this researcher has observed a truck fully loaded with charcoal in the market under the control of the Town Police members who said that it is caught for illicit trafficking of charcoal. However the next day this researcher has seen the truck leaving the market after off-loading the charcoal (see picture – 5)

200Ushs per bag to traffic charcoal into Kampala. (Knopfle, 2004) Similar effects are here in Ethiopia. Charcoal production and marketing is deemed illegal, but both production and marketing are the day to day activities to a significant number of individuals of the society.¹⁸ Hence lack of appropriate supervision, control, technical support and management of the production and supply of it, would lead to the illegal processes of it which would in turn open a window of corruption and uncontrolled damages on the forest resource bases. More over, since tax is not collected from charcoal related activities, there will be no economic benefit for the country from the interactions. (Interviews made with officials and charcoal vendors have proved this)



Picture – 5 Charcoal Supplies to Awassa Market

5.1.3 Deforestation and Its Consequences

Deforestation continues to pose serious challenges, even though the net loss of forest area is slowing down. Globally there is an estimated net decline of 7.3 million hectares of forest area per year over the period 2000-2005, compared to 8.9 million hectares

¹⁸ Charcoal vendors in Awassa market told me that they don't have trade license for charcoal, assumed it is illegal, but obtained a license as green grocers. However they are vending charcoal in the open market, this is not unique to Awassa off course.

annually in the previous decade.(UN: MDGs Report, 2008) In Ethiopia there is an estimated decline of 200,000 hectares of forest area annually.

A research done by a Project for the Protection of Natural Resources (PPNR)/ Ethiopian Ministry of Agriculture (MoA) shows there was a demand for 68.5 million meter cubes of biomass fuel in 1997 E.C. However, the capacity to supply the same sustainably, with out negative impacts on the forest resources was only 10.4 million meter cubes, that shows a difference of 58.1 million meter cubes. (MoA/PPNR, GTZ) There fore, the use of biomass fuels (fire wood and charcoal) for baking and cooking by the significant percent of the hhs in Awassa Town shows that there is high demand for these fuels which would in turn speed up and aggravate deforestation in the areas.

Consequently, deforestation would result different sever environmental impacts in the area. Primarily, it entails soil erosion and disruption of soil nutrients cycling systems. Subsequently, land degradation and a decline in soil fertility would be the effect and hence decline of agricultural production, food insecurity, and poverty would perpetuate among the rural communities in the area. Hence this would create social and economic problems in the local environment.

Secondly, there is also the possibility of extinction of some tree species. Above all, since charcoal is often traditionally produced from species that yield a dense, slow-burning charcoal for instance like Acacia , which can be harvested for sustainable charcoal yield over a long-year cycle , these species are slow growing and are therefore particularly vulnerable to over-exploitation.

Thirdly, deforestation, i.e. the displacement of trees, shrubs, and groundcover change, eliminates the natural effects of shading, cooling and evaporation. Fourthly, it also decreases ground water recharge cycle. Forests help rain water to slowly pass through the soil into the ground and enhance ground water recharging, where as deforestation

would result in a decline in this cycle and an increase in the surface runoff. This would lead to a decline in ground water and dry up of rivers soon after the rainy season and consequently a problem of water scarcity in the area. Fifthly, runoffs would produce double impacts, i.e. soil erosion and land degradation on the upper lands, and sedimentations on the lower landscapes of the catchment area. Lemlem (2007) says this could be one of the reasons for the rise of the water level of Lake Awassa: first, from the sedimentation of the north-western and western surface runoffs fed by ephemeral streams; and second, by the Tikur Wuha River which carries the loads of surface runoffs from the deforested north-eastern high lands of the catchment areas due to the disappearance of Lake Cheleleka that was serving as sediment-trap for Lake Awassa.



Picture-6 Wastes left over by Visitors of the Lake



Picture-7 One of the Gullies which channels the surface runoffs in to Lake Awassa

In addition to these, the wastes left over on the shores by different visitors of the Lake and carried by the runoffs from the Town into the Lake are aggravating the problem. Therefore, due to these causes currently the Lake is gradually changing into swamp. This is well observed during the field season. (See picture – 8 below)



Picture – 8 Lake Awassa changing into Swamp

Chapter 6 Conclusions and Recommendations

6.1 Conclusions

This Study has arrived at some useful findings that would help in explaining how household energy consumption patterns would entail consequent impacts on the local environment. Based on the Survey data, the Case Studies and FGDs conducted during the field season it is well understood that household energy consumption patterns in Awassa Town is highly dependent on biomass fuels. Primarily, most of the hhs use firewood only or firewood plus sawmill residues for baking Injera. More over, more than fifty percent of the hhs use Traditional and Modified Traditional Injera Stoves, which consume almost double energy of that is required by those who use Modern Energy Saving Injera Stoves.

Secondly, due to fuel choice, access/availability, price, simmer-cooking habit/tradition the majority of the hhs use charcoal as a mix or only it for other cooking purposes. Hence this shows that urban growth and the increase in number of the population of the Town coupled with the high dependency of the HHS on firewood and charcoal can be concluded that HHS energy consumption patterns of Awassa Town is speeding up and aggravating deforestation and depletion of forest resources in the local area.

Thirdly, regarding the impacts of household energy consumption patterns on the local environment, above the use of Biomass fuels, i.e. firewood and charcoal, it is the appliances the hhs use and the way the fuels are produced and supplied that aggravate the consequences: (1) for baking Injera it is due to the fact that the majority of the hhs use Traditional and Modified Traditional Injera Stoves which requires double that of

6.2 Recommendations

As it is clearly seen in other developing countries fuel transition from biomass into modern and commercial fuel is occurred following with growing household income and urbanization level. Hence it is not possible to expect promptly a significant shift away from biomass fuels. Therefore the primary measures to be taken regarding Injera baking are:

- To encourage, as per the National Environmental Policies, Government leases for private entrepreneurs to plant fuel wood lots in per-urban areas
- To find substitutes, as per the National Environmental Policies, for construction and fuel wood whenever capabilities and other conditions allow
- To work on/for the transition to use Modern Energy Saving Injera Stoves. There are different perceptions among the hhs, in the production quality, price, durability, etc. Hence supervision of the quality of the production of these stoves,
- creating awareness and promoting the use of the same, and
- subsidizing to the low income groups whenever it is necessary

By trying to implement these, it is believed, significant positive effects on the hhs energy consumption patterns for baking Injera could be gained.

Regarding charcoal production and supply as well, banning the production and/or marketing of charcoal, as it has been done so far, has proved no positive results. Like other African countries, in Ethiopia in general and specifically in Awassa bans do not in fact reduce production, but simply drive producers underground, thereby precluding proper control of production procedures. Therefore, the sustainable production and use of charcoal could be realized through:

- proper management and provision of technical support for improved charcoal production

- establishing legal and systematic framework of its supply together with rational marketing system, and
- levying appropriate tax on it to enhance the economy and NRs Management

Taking these measures may result in efficient and sustainable production, supply and consumption of charcoal and would also contribute significant positive effects for the conservation of the forest resources as well.

Finally, to intervene the gradual change of Lake Awassa into swamp, a forestation campaign at least immediately close to it which could serve it as sediment-trap and then enlarging the radius of the a forestation may help saving the Lake from the disappearance like that of Lake Cheleleka.

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Appendices

Appendix – 1 Household Income Category * Type of Fuel the Households use for Baking Injera * House Hold Head Education Level Cross tabulation

House Hold Head Education Level			Type of Fuel the Households use for baking Injera				Total
			Electricity	Dung	Firewood + Residue of saw-mill, twigs, branches, etc	Firewood	
Degree and Above	HH Monthly Income Category	<2000	4		1	2	7
		2000 - 4000	21		1	8	30
		>4000	7		1	2	10
	Total		32		3	12	47
Diploma/TVET	HH Monthly Income Category	<2000	8	0	2	10	20
		2000 - 4000	2	1	1	7	11
		>4000	0	0	0	1	1
	Total		10	1	3	18	32
Secondary School (Ex--12th grade) complete	HH Monthly Income Category	<2000	4		5	19	28
		2000 - 4000	6		1	6	13
		>4000	2		0	1	3
		Missing	0		0	1	1
	Total		12		6	27	45
Junior and Above	HH Monthly Income Category	<2000	2		2	8	12
		2000 - 4000	0		0	3	3
		>4000	0		0	1	1
		Missing	0		0	1	1
	Total		2		2	13	17
Elementary	HH Monthly Income Category	<2000	2	1	9	15	27
		2000 - 4000	2	0	0	3	5
		>4000	1	0	0	0	1
		Missing	0	0	0	2	2
	Total		5	1	9	20	35
Church and Madrasa	HH Monthly Income Category	<2000				2	2
	Total					2	2
Illiterate	HH Monthly Income Category	<2000	2		2	16	20
		Missing	1		1	0	2
	Total		3		3	16	22

Appendix -2 HHS Income Category * Survey Kebele Cross tabulation

		Survey Kebele				Total
		Guwe Stadium	Harar	Leku	Dume	
HH Monthly Income Category	<2000	18	39	35	24	116
	2000 - 4000	21	10	10	21	62
	>4000	10	0	2	4	16
	Missing	1	1	3	1	6
Total		50	50	50	50	200

Appendix – 3 Survey Kebele * Type of Fuel the Households use for baking Injera Cross tabulation

		Type of Fuel the Households use for baking Injera				Total
		Electricity	Dung	Firewood + Residue of saw-mill, twigs, branches, etc	Firewood	
Survey Kebele	Guwe Stadium	21	0	0	29	50
	Harar	8	0	10	32	50
	Leku	11	2	14	23	50
	Dume	24	0	2	24	50
Total		64	2	26	108	200

Appendix – 4 Analysis of Variance Table

Independent Variables	Groups	Statistics	Electric Consumption	Kerosene Consumption	Firewood Consumption	Charcoal Consumption
HH Income Category	<2000	Mean	Birr66.3714	Birr14.5474	Birr41.4310	Birr64.1164
		Std. Deviation	Birr52.18061	Birr29.73236	Birr37.99204	Birr23.64110
		Std. Error	Birr6.23678	Birr2.76058	Birr3.52747	Birr2.19502
	2000 - 4000	Mean	Birr86.5897	Birr22.8065	Birr31.8548	Birr66.8065
		Std. Deviation	Birr52.19030	Birr33.00216	Birr39.35165	Birr26.12633
		Std. Error	Birr8.35714	Birr4.19128	Birr4.99766	Birr3.31805
	>4000	Mean	Birr68.3333	Birr51.0625	Birr15.0000	Birr77.3438
		Std. Deviation	Birr16.56027	Birr40.76840	Birr28.04758	Birr11.59988
		Std. Error	Birr4.78054	Birr10.19210	Birr7.01189	Birr2.89997
	B/n Groups	ANOVA Sig.	.126	.000	.019	.111
		Levene Sig.	.153	.096	.326	.016
	HH Head Education Level	Tertiary	Mean	Birr82.0526	Birr30.8375	Birr25.6625
Std. Deviation			Birr41.66380	Birr37.47892	Birr34.67934	Birr21.06431
Std. Error			Birr5.51851	Birr4.19027	Birr3.87727	Birr2.35506
Secondary		Mean	Birr54.8387	Birr17.4758	Birr40.7581	Birr66.1613
		Std. Deviation	Birr32.69770	Birr29.74350	Birr32.85671	Birr25.57227
		Std. Error	Birr5.87268	Birr3.77743	Birr4.17281	Birr3.24768
Primary		Mean	Birr86.7391	Birr10.1389	Birr51.5278	Birr67.8611
		Std. Deviation	Birr79.63851	Birr28.12132	Birr52.37201	Birr23.55195
		Std. Error	Birr16.60578	Birr4.68689	Birr8.72867	Birr3.92533
Illiterate		Mean	Birr50.0714	Birr7.2727	Birr35.7273	Birr51.7273
		Std. Deviation	Birr36.12045	Birr19.00672	Birr22.11912	Birr28.80010
		Std. Error	Birr9.65360	Birr4.05225	Birr4.71581	Birr6.14020
B/n Groups		ANOVA Sig.	.013	.001	.004	.034
		Levene Sig.	.005	.000	.122	.120
Spouse's Education Level		Tertiary	Mean	Birr71.7333	Birr24.4048	Birr22.3095
	Std. Deviation		Birr34.70261	Birr38.00196	Birr28.43262	Birr23.67887
	Std. Error		Birr6.33580	Birr5.86383	Birr4.38725	Birr3.65373
	Secondary	Mean	Birr73.5000	Birr25.0784	Birr34.9216	Birr71.7647
		Std. Deviation	Birr49.41293	Birr30.34656	Birr32.31027	Birr19.94551
		Std. Error	Birr9.02153	Birr4.24937	Birr4.52434	Birr2.79293
	Primary	Mean	Birr78.2759	Birr17.9574	Birr49.0213	Birr68.1489
		Std. Deviation	Birr62.00916	Birr30.47590	Birr48.83000	Birr21.75354
		Std. Error	Birr11.51481	Birr4.44537	Birr7.12259	Birr3.17308
	Illiterate	Mean	Birr68.7500	Birr.0000	Birr36.4444	Birr55.0000
		Std. Deviation	Birr20.96624	Birr.00000	Birr25.56908	Birr29.36835
		Std. Error	Birr10.48312	Birr.00000	Birr8.52303	Birr9.78945
B/n Groups	ANOVA Sig.	.953	.235	.024	.048	
	Levene Sig.	.310	.000	.490	.001	

Highest Education Level in a HH	Tertiary	Mean	Birr77.9625	Birr27.6000	Birr29.8957	Birr67.9739
		Std. Deviation	Birr44.16122	Birr37.08710	Birr34.51910	Birr21.71959
		Std. Error	Birr4.93738	Birr3.45839	Birr3.21892	Birr2.02536
	Secondary	Mean	Birr67.1500	Birr12.0200	Birr44.9733	Birr64.5733
		Std. Deviation	Birr60.78991	Birr24.61438	Birr43.31842	Birr26.12867
		Std. Error	Birr9.61173	Birr2.84222	Birr5.00198	Birr3.01708
	Primary	Mean	Birr30.0000	Birr.0000	Birr41.0000	Birr49.5000
		Std. Deviation	Birr20.00000	Birr.00000	Birr7.43864	Birr32.01128
		Std. Error	Birr8.94427	Birr.00000	Birr2.35230	Birr10.12286
	B/n Groups	ANOVA Sig.	.082	.001	.024	.059
	Levene Sig.	.446	.000	.013	.109	
Ownership of a house	Private	Mean	Birr82.1553	Birr23.7532	Birr34.6603	Birr67.2885
		Std. Deviation	Birr49.69964	Birr35.14548	Birr38.86129	Birr23.760
		Std. Error	Birr4.89705	Birr2.81389	Birr3.11139	Birr1.90232
	Rent	Mean	Birr27.7727	Birr8.4091	Birr41.2273	Birr60.4091
		Std. Deviation	Birr17.98394	Birr20.16711	Birr34.17048	Birr25.38386
		Std. Error	Birr3.83419	Birr3.04031	Birr5.15139	Birr3.82676
	B/n Groups	ANOVA Sig.	.000	.006	.311	.096
	Levene Sig.	.022	.000	.025	.225	
Type of a house	Small service	Mean	Birr49.7069	Birr14.3088	Birr41.6863	Birr62.3627
		Std. Deviation	Birr32.52530	Birr29.21930	Birr32.10872	Birr25.22838
		Std. Error	Birr4.27078	Birr2.89314	Birr3.17924	Birr2.49798
	Villa	Mean	Birr85.2174	Birr18.5652	Birr31.8478	Birr69.2391
		Std. Deviation	Birr36.16497	Birr30.33271	Birr41.69144	Birr22.64993
		Std. Error	Birr7.54092	Birr4.47231	Birr6.14707	Birr3.33955
	Villa plus Services	Mean	Birr96.1364	Birr33.8846	Birr28.9231	Birr69.4038
		Std. Deviation	Birr61.91577	Birr38.60237	Birr43.55067	Birr23.02621
		Std. Error	Birr9.33415	Birr5.35319	Birr6.03939	Birr3.19316
	B/n Groups	ANOVA Sig.	.000	.002	.097	.127
	Levene Sig.	.046	.000	.098	.027	
Share Electrometer	No	Mean	Birr79.8785	Birr23.1380	Birr34.6442	Birr67.0675
		Std. Deviation	Birr49.90060	Birr34.07410	Birr38.63835	Birr23.72993
		Std. Error	Birr4.82407	Birr2.66889	Birr3.02639	Birr1.85867
	Yes	Mean	Birr29.2222	Birr8.2162	Birr42.5405	Birr60.0811
		Std. Deviation	Birr22.83587	Birr24.84523	Birr34.17081	Birr25.89442
		Std. Error	Birr5.38247	Birr4.08453	Birr5.61765	Birr4.25702
	B/n Groups	ANOVA Sig.	.000	.013	.254	.114
	Levene Sig.	.081	.000	.078	.310	

Appendix – 5 Questionnaires

A Survey Instrument to collect data on Household Energy Consumption Patterns of Awassa Town and the Subsequent Impacts on the Local Environment

This is a survey questionnaire for an independent study by Tilahun Gebreselassie, who is a post graduate student of Environment and Development in College of Development Study, Addis Ababa University. In this survey there are several questions that you are kindly requested to answer about the way you are living which will provide the necessary in formations to understand your real pattern of energy consumption at the household level, and your knowledge about the environment. Your answer is confidential which will be used only by the researcher for the academic purpose. So, however your honest answers are helpful, basically for this study that is Household Energy Consumption Patterns of Awassa Town and Its Impacts on the Local Environmental; the information of urban household energy utilization pattern and factors driving consumption will be useful for national energy planning framework for deriving strategies for a more rational energy utilization and increased reliability of energy supply to urban households. Therefore, ultimately the benefit is more national and for rational utilization of energy in the country. Hence, once again I humbly request your kind cooperation and patience to respond care fully to each and every question considering the importance of the study to you and your country in general by contributing a drop of value for local, regional and global endeavors that are under way for the sustainability of our environmental.

Name of Interviewer _____ Signature _____

Questionnaire number _____

Date: ___/___/2010 Time: - from ___ to ___

Section - I Demographic and Socioeconomic

1. General Information about the respondent

1.1 Full Name of the respondent _____

1.2 Age _____ Sex _____

1.3 Address: -Sub town/city/location _____

Kebele _____ House No. _____

2. Household characteristics
2.1 Please list all household members
living in the house using the
Table Codes Below:

- 2.1.1 Write Full Name
 2.1.2 Age: - Write in years
 2.1.3:- Sex: - 1 = M; 0 = F
 2.1.4:- 1 = 1st Degree and Above
 2 = Diploma/TVET
 3 = Secondary School (Ex-
 12th grade) Complete
 4 = Junior and above
 5 = Elementary

- 6 = Church & Madrasa
 7 = Illiterate
 2.1.5:- 1 = Employed;
 0 = Unemployed
 2.1.6:- 1 = Education Sector
 2 = Health & Agriculture
 3 = Industrial Sector
 4 = Public Service Sector
 5 = Commercial Activities
 6 = Others (specify)
 2.1.7:- 1 = Head
 2 = Spouse
 3 = Son/Daughter

- of Head and Spouse
 4 = Son/Daughter of Head or
 Spouse
 5 = Relative of Head/Spouse
 6 = House Maid
 7 = Others (Please Specify)
 2.1.8:- Monthly Income – in Birr
 Other Income to the Household:
 1 = Rent
 2 = Transfer
 3 = Other (Please Specify)

Serial No.	2.1.1 Full Name	2.1.2 Age	2.1.3 Sex	2.1.4 Education Level	2.1.5 Employment	2.1.6 Employment Sector	2.1.7 Relationship to the household head	2.1.8 Income (In Birr)	
								Monthly	Other Income to the household

- 2.2 For how long have the family been living in this house?
 (1) ____ years (2) Don't know
- 2.3 Ownership of the house?
 (1) Private (2) Rent (From government, public, or private)
 (3) Other (Please Specify)
- 2.4 What type of house do the household live in?
 (1) Ground plus (1/2/3) (2) Villa + service rooms
 (3) Villa only (4) Small Service
 (5) Other (Please specify)
- 2.5 How many households are there in the housing unit?
 (1) One (2) Two (3) Three
 (4) Four and above (*If the answer is "One" go to Section II*)
- 2.6 Do the households in the housing unit share electricity (Electro Meter)?
 (1) Yes (2) No (*If the answer is "No" go to Section II*)
- 2.7 If "Yes" for how many do they share?
 (1) Two (2) Three (3) Four and above

Section - II Household Energy consumption

- 1.1 What type of fuel do the household use for baking Injera?
 (1) Electricity (2) Firewood (3) Dung
 (4) Other _____ (Please specify)
{If the answer is "Electricity" go to question n0. 1.6}
- 1.2 Why do the household prefer to use this type of energy?
 (1) Cheap price of biomass fuel (fire wood, leaves, etc.)
 (2) Expensive to use electricity
 (3) House Maid's misuse of Electric Stove
 (4) Because of sharing Electrometer with other households
 (5) Other _____ (Please specify)

1.3 If the answer is (2) or (3), has the household ever used Electric Stove for baking Injera?

- (1) Yes (2) No

1.4 If the answer is 'No', how does the household conceive that electric energy is expensive? _____

1.5 If the household uses other than electric energy for baking Injera what type of stove is using?

- (1) Modern _____ (write name) (2) Traditional
(3) Other _____ (Please specify)

1.6 For how long the household has been using this type of stove for baking Injera?

- (1) _____ Years (2) Don't know

1.7 What other type of Stove or cooking fuel the household had been using before shifting to the current stove/fuel type?

1.8 Why shift?

1.9 What type of fuel does the household use for other cooking purposes?

- (1) Electricity (2) Kerosene (3) Fire wood
(4) Charcoal (5) Other _____ (Please Specify)

1.10 From where do you get firewood?

- (1) Market/Vendors (2) Collect from suburbs of the Town
(3) Shops in village (4) Other _____ (Please specify)

1.11 If it is from market, usually when do you buy (fire wood)?

- (1) Monthly (2) In two weeks (3) weekly
(4) No regular time (5) I don't know

1.12 From where do you get charcoal?

- (1) Market / Vendors (2) Shops in village
(3) Other _____ (Please specify)

- 1.13 If it is from market, how do you usually buy charcoal?
 (1) In Bag from wholesaler (2) In small quantity from retailers
 (3) No regularity (4) Other _____ (Please specify)
- 1.14 What type of lighting do the household use, during the night?
 (1) Electricity (2) Lantern/Kerosene (3) Wood
 (4) Other _____ (Please specify)
{If the answer is "Electricity" go to question no. 1.16}
- 1.15 Why do the household prefer to use this type of lighting?
 (1) Due to cheaper price of the fuel
 (2) Unable to get access to Electricity
 (3) Other _____ (Please specify)
- 1.16 What is the quantity of the different energy consumption of the Household and its cost in Birr in a specific period?

Energy	Estimates/period	Estimates in Birr
Electricity	Kw/month	
Kerosene	Liter/week	
Fire wood	Kg/week	
Charcoal	Kg/week	
Dung	Kg/week	
Others (Specify)		

Section III Values and Awareness of Environmental Sustainability

1.1 To what extent do you perceive that saving energy is important?

- (1) Very important (2) Important
(3) Not Important (4) I don't know

1.2 Why do you think saving energy is important?

- (1) Economic (2) Environmental
(3) Others _____ (Please specify)

1.3 Can you explain why? _____

1.4 To what extent do you perceive that energy utilization pattern does have a subsequent impact on the environment?

- (1) Very serious (2) Serious
(3) Not Serious (4) I don't know

End of Interview
Thank You For Your Cooperation!!

